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E-cigarettes and expectancies: Why do some users keep smoking?

Paul T. Harrell¹, Vani N. Simmons^{1,2}, Barbara Piñeiro^{1,3}, John B. Correa², Nicole S. Menzie², Lauren R. Meltzer¹, Marina Unrod^{1,2}, and Thomas H. Brandon^{1,2}

¹Department of Health Outcomes and Behavior, Moffitt Cancer Center, Tampa, FL, USA

²Department of Psychology, University of South Florida, Tampa, FL, USA

³Department of Clinical Psychology, Faculty of Psychology, University of Santiago de Compostela, Spain

Abstract

Background and aims—Many smokers who have tried electronic cigarettes (“e-cigarettes”) continue to smoke, perhaps influenced by their beliefs about the outcomes of using e-cigarettes (“e-cigarette expectancies”). The primary aims of this study were to compare expectancies of dual users to former smokers, and to examine the association between expectancies and intentions to quit or reduce “vaping” among former smokers.

Design and Setting—A large cross-sectional online survey of e-cigarette users conducted in the USA.

Participants—We surveyed current e-cigarette users (N=1815), including both current cigarette smokers (“dual users,” n=381) and former smokers (n=1434). We further subdivided former smokers into those with (n=686) and without (n=748) intentions to reduce or quit e-cigarette use.

Measurements—The primary outcomes were self-reported past-month smoking status and, among former smokers, current intentions to reduce or quit e-cigarette use, both adjusted for potential confounders. E-cigarette expectancy items were primarily derived from a previously validated measure of smoking expectancies.

Findings—Dual users reported less positive expectancies than former smokers about e-cigarettes, rating e-cigarettes as more physically irritating ($\beta=-0.10$, $p<0.001$) and addictive ($\beta=0.06$, $p=0.016$), as well as less satisfying ($\beta=-0.11$, $p<0.001$). Former smokers with intentions to quit e-cigarettes also rated e-cigarettes less positively than former smokers without intentions to quit e-cigarettes, rating them more likely to damage health ($\beta=0.16$, $p<0.001$) and cause addiction ($\beta=0.10$, $p<0.001$), but less likely to taste good ($\beta=-0.08$, $p=0.006$).

Correspondence to: Paul T. Harrell, Ph.D., Moffitt Cancer Center, 4115 Fowler Avenue, Tampa, FL 33647, Paul.Harrell@Moffitt.org.
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Conclusions—Positive e-cigarette expectancies among e-cigarette users are associated with a greater likelihood of having quit smoking, but lower likelihood of intention to quit e-cigarette use.

INTRODUCTION

Cigarette smoking is estimated to kill 6 million people worldwide annually (1). Electronic nicotine delivery systems (“e-cigarettes”) are likely a form of harm reduction for cigarette smoking, by providing a less toxic nicotine delivery method (2, 3). Although there is evidence that tobacco smokers in the general population using e-cigarettes in a quit attempt are more likely to report abstinence than those attempting to quit via Nicotine Replacement Therapy (NRT) or without a quit aid (4), there is currently limited data available on this issue and most tobacco smokers who have tried e-cigarettes continue to smoke (5, 6). Individuals who use e-cigarettes and yet continue to smoke, hereafter referred to as “dual users,” maintain their exposure to smoking-related toxicants. It is possible that e-cigarettes serve to help these individuals maintain their cigarette smoking, perhaps by allowing use in places where smoking is forbidden or stigmatized. Understanding why some e-cigarette users continue to smoke, and how they differ from those who quit smoking, could help in intervention and media campaign development to ensure that e-cigarette users refrain from tobacco smoking.

Social-cognitive theory suggests that use of substances is influenced by expectancies, that is, beliefs regarding the outcomes of use (7, 8). Expectancies are thought of as informational structures in long-term memory that shape input into the central nervous system and guide management of behavior through both conscious and unconscious mechanisms (9). More broadly, expectancy is a principle that is active in a variety of different neurobehavioral processes that provide evolutionary advantage by preparing the organism for future events (10, 11). Expectancies for the outcomes of drug use, i.e., drug expectancies, initially develop from observation, testimonies, or commentaries from trusted sources, such as the media, peers, or family members (12). After use initiation and during continued use, expectancies tend to become stronger, more associated with other elements in long-term memory, more specific, and more positive (7, 13). Drug expectancies can shape the experience of substance use (14, 15), which in turn can drive future behavior (16, 17), predicting cessation success even after controlling for dependence, negative affect, and stress (18). Importantly, expectancies can be modified by media campaigns (19, 20) and thus understanding associations with usage patterns is relevant for the development of such campaigns.

Positive e-cigarette expectancies have been found to be associated with e-cigarette usage among college students (21) and hospitalized smokers (22). In addition, ex-smoking e-cigarette users overwhelmingly have more positive expectancies for e-cigarettes than for nicotine replacement therapies and tend to have more positive expectancies for e-cigarettes than for cigarettes, with the exception of beliefs related to negative affect reduction, weight control, stimulation, and stress reduction (23). Less is known about how expectancies may be associated with cigarette smoking among e-cigarette users, as the above research with e-cigarette users was limited to those who had already quit tobacco smoking. Thus, after comparing dual users and former tobacco smokers on descriptive variables, Aim 1 was to provide estimates of independent associations between e-cigarette expectancies and

continued cigarette smoking. In addition, although available evidence strongly suggests that e-cigarettes are a less harmful form of nicotine delivery, our understanding of the health consequences of long-term use of e-cigarettes is limited, and cessation of e-cigarette use is likely to be a beneficial outcome (2, 3, 24). Therefore, Aim 2 was to provide estimates of independent associations between e-cigarette expectancies and plans to reduce or quit e-cigarette usage among ex-smokers.

We anticipated that, after adjusting for the influence of demographic variables and e-cigarette usage characteristics, positive e-cigarette expectancies would be associated with a lower likelihood of continued smoking, similar to a previously observed relationship between positive expectancies for nicotine replacement therapies and more immediate plans to quit smoking (25). We reasoned that many of the same expectancies that are related to quitting smoking would be negatively associated with plans to reduce or quit vaping.

METHOD

Participants

This study expands on a previously published paper that examined only former smokers who had transitioned to e-cigarettes (23). Here, we compare these former smokers to e-cigarette users who continued to smoke, i.e., “dual users.” The online survey was hosted on the Moffitt Cancer Center website and advertised as a way for e-cigarette users to help researchers “learn more about e-cigarette use.” Links to the online survey were advertised via local press releases, which were picked up by social media and online e-cigarette forums. We publicized the survey in August, 2013, and discontinued it in November, 2013, when the response rate had tapered off. Out of 2,271 survey responses, we removed 91 repeat IP addresses, 130 blank entries, 50 respondents who smoked less than 100 cigarettes in their lifetime, and 185 that did not complete the expectancy questions. Our sample thus included 1,815 participants who reported having used e-cigarettes in the past month. All participants were at least 18 years old, had reported a history of daily smoking, and had smoked at least 100 cigarettes. Participants provided electronic informed consent before beginning the survey and were not compensated. Table 1 summarizes participant characteristics for the entire sample and for dichotomized sub-samples of dual users ($n = 1434$) and former smokers ($n = 381$).

Measures and Procedure

Components of the survey that were analyzed in this study included the following:

Demographics—The following demographic information was collected: age, gender, race, marital status, education, and income.

Smoking History—Participants answered a series of questions about their current or past use of tobacco cigarettes. Participants who reported using tobacco cigarettes in the past 30 days were categorized as dual users, that is, users of both tobacco cigarettes and e-cigarettes. The majority of dual users smoked at least weekly in the past month with over a third reporting daily smoking. Those who denied using cigarettes in the past 30 days were

categorized as former smokers. Participants in both subgroups provided identical information on age of onset of cigarette use.

E-Cigarette History—Participants answered several questions about their e-cigarette use. Specific questions assessed the following: (1) date of initiation of e-cigarette use; (2) frequency of use of e-cigarettes; and (3) characteristics of e-cigarettes they were currently using, including brands, flavors of e-liquids, nicotine concentrations of e-liquids, and any device modifications made by the participant. When asked about brands of e-cigarettes they used, participants were given a list of 15 popular brands (e.g., Blu, NJOY) and an “other” option that provided the opportunity to write in brands not mentioned in the list. All individuals were coded as using either “First generation” (e.g., Blu, White Cloud, V2Cigs, NJOY, Halo), “eGo” (those who reported only using the very popular eGo battery type), or “Mods” (e.g., Innokin, ProVape, “Mods,” “Advanced Personal Vaporizer,” Vamo, Kanger, other brands). Similar terminology for coding has been used in recent reports on e-cigarettes (26–28).

Social Influence—Participants were asked if any of their friends or anyone in their household currently use e-cigarettes. They were additionally asked if they participated in online e-cigarette forums.

E-cigarette expectancies—E-cigarette expectancies were created based on prior research and described previously (23). Nine of the items were from the following factors of the Smoking Consequences Questionnaire-Adult (SCQ-A) (29): Negative Affect Reduction, Stimulation/State Enhancement, Health Risk, Taste/Sensorimotor Manipulation, Social Facilitation, Weight Control, Craving/Addiction (specifically craving reduction), Negative Physical Feelings (focused on mouth and throat), and Negative Social Impression. Items were chosen based on factor loadings (all > .60) and ability to be modified for e-cigarettes. Additional items assessed the degree to which e-cigarette users experienced e-cigarette cravings and the degree to which e-cigarettes helped with stress reduction, provided satisfaction, or were addictive. An additional two questions assessed convenience and cost. Items were rated on a scale from 1 (“Strongly Disagree”) to 7 (“Strongly Agree”).

Plans to Quit E-cigarettes—All participants were asked to describe how they felt about stopping or reducing e-cigarette use. We focus here only on former smokers, i.e., e-cigarette users who have not smoked any cigarettes in the past month ($n = 1434$), as we were interested in the eventual cessation of e-cigarettes among those who had already succeeded at using e-cigarettes to quit smoking. The majority of former smokers indicated no plans to stop or reduce use of e-cigarettes ($n = 748$, 52.2%). The remainder of participants were coded as those who “plan to quit/reduce” use of e-cigarettes and includes those who have no plans to stop using e-cigarettes, but plan to reduce use ($n = 250$, 17.4%), those who plan to stop use, but not in the next year ($n = 278$, 19.4%), and those who plan to stop in the next year ($n = 105$, 7.3%), 6 months ($n = 47$, 3.3%), or the next 30 days ($n = 6$, 0.4%).

Statistical Analysis

Logistic regression was used to determine odds of past-month cigarette smoking, among the full sample, and odds of plans to reduce or quit e-cigarette use, among former smokers, based on demographic and e-cigarette use characteristics. Next, linear regression was used to determine relationships between e-cigarette expectancies and date of last cigarette smoked, as well as plans to quit e-cigarettes. In adjusted models, covariates included all demographic, cigarette smoking, and e-cigarette use variables.

RESULTS

Demographics

As shown in Table 1, adults over the age of thirty were less likely to be dual users. E-cigarette users who were single had greater odds of being dual users compared to married participants. Finally, those who started smoking after 20 were more likely to be dual users. No demographic differences were significantly related to plans to reduce or quit use of e-cigarettes (all $ps > .05$).

E-cigarette use patterns

Table 1 displays e-cigarette use patterns in relation to past-month cigarette smoking and intentions to reduce or quit e-cigarette use. Individuals with longer histories with e-cigarettes were less likely to be dual users. Similarly, those who used e-cigarettes daily were less likely to be dual users than those who used only weekly or monthly. Dual users were more likely to use tobacco flavored e-cigarettes and nicotine levels above 8 milligrams.

Future e-cigarette use intentions

Among former smokers, those who had used e-cigarettes for 12 months or more were significantly less likely to report plans to reduce or quit e-cigarette use than those who had used for shorter periods of time. We did not find differences related to daily use or use of tobacco flavoring, but those who used higher levels of nicotine in their e-cigarettes and those who used over 10 times per day were less likely to report any plans for reduction or cessation of vaping. Finally, those who planned to quit or reduce their use were less likely to modify their e-cigarettes or read or participate in online e-cigarette forums.

E-cigarette expectancies

As shown in Table 2, high expectancies for e-cigarette satisfaction, craving reduction, and stress reduction were associated with decreased likelihood of dual use in both unadjusted and adjusted models. In contrast, expectancies that e-cigarettes are addictive, expensive, cause negative physical symptoms, or lead to withdrawal symptomatology were associated with increased risk of continued tobacco smoking in both unadjusted and adjusted models. Although not significant, convenience differed from other positive expectancies by virtue of its positive association with dual use.

Finally, in a subsample of former smokers, we examined associations between expectancies and plans to quit or reduce the use of e-cigarettes. As shown in Table 3, in adjusted analyses, those who reported expectancies that e-cigarettes were good tasting were less likely to have

plans to reduce or quit e-cigarette use. In contrast, those who reported e-cigarettes were riskier to health, caused negative physical feelings, led to negative social impressions, addiction, craving, or withdrawal reported plans to reduce their e-cigarette usage. In addition, adjusted analysis suggested that those who expected e-cigarettes to reduce their nicotine craving were more likely to intend to attempt to quit vaping.

DISCUSSION

Over three-quarters of e-cigarette user survey respondents reported they had not smoked any cigarettes in the past month. The minority that reported smoking were more likely to be younger and single. These dual users were more likely to be recent e-cigarette users, use e-cigarettes less than daily, use tobacco flavors, and use higher levels of nicotine fewer times per day. Adjusting for all demographic, smoking, and e-cigarette use characteristics, negative e-cigarette expectations were associated with continued smoking (i.e., dual use), whereas positive e-cigarette expectancies tended to be associated with having quit smoking. The majority of former smokers indicated no plans to reduce or quit e-cigarette use. Those who reported intention to reduce or quit their e-cigarette use were more likely to be recent e-cigarette users who used low levels of nicotine (4–8 milligrams) few times per day and did not modify their e-cigarette or participate in e-cigarette forums. Adjusting for demographics and use characteristics, negative e-cigarette perceptions, particularly in relation to health risks, were associated with higher likelihood of intentions to quit, but positive expectancy of e-cigarette taste was associated with no plans to reduce or stop e-cigarette use.

Demographics

Dual users tended to be younger. This is consistent with findings that e-cigarette use among college students is less likely to be motivated by the desire to quit smoking (30). The current dataset only includes those with a prior history of smoking and thus is not relevant to the issue of e-cigarettes as a gateway into smoking tobacco, but e-cigarette use should continue to be investigated for its potential to maintain tobacco use, particularly in younger populations. Married individuals were less likely to have smoked in the past month than those who had never been married, perhaps due to social pressure provided by a partner.

E-cigarette Usage

Longer duration of e-cigarette use was associated with greater likelihood of having quit smoking. This association may be due to cohort effects as individuals who began using e-cigarettes recently potentially differ substantially from those who used prior to widespread e-cigarette advertising. Alternatively, it is plausible that prolonged e-cigarette usage provides enhanced efficacy in smoking cessation. According to a U.S. nationally representative survey from June, 2013, almost half of current and former smokers have tried e-cigarettes, but less than 4% were current e-cigarette users with “established use” (used e-cigarettes >50 times in lifetime). In general, those who had tried e-cigarettes were more likely to be current tobacco smokers, but e-cigarette users who met criteria for established e-cigarette use were more likely to have quit smoking (5, 6). In the present study, respondents with longer histories of e-cigarette use were also less likely to have plans to reduce or quit their e-cigarette use. Interpretation of this finding is complicated by the inclusion of only

current e-cigarette users, but it does demonstrate a significant population of e-cigarette users who have no plans for reducing e-cigarette use even after over a year of e-cigarette use and abstinence from smoking. Indeed, only 0.4% of former smokers in this sample reported planning to quit their e-cigarette use in the next thirty days. This is in stark contrast to tobacco smokers, among whom 10 – 30% report planning to quit smoking in the next thirty days (31). Daily users of e-cigarettes in the present study were less likely to smoke, consistent with the idea that e-cigarettes function similarly to nicotine replacement therapies.

E-cigarette users who used tobacco flavors were significantly more likely to be dual users, congruent with other research (27). Flavors are a contentious issue, as concerns about attractiveness to children have led to prohibitions against flavors in traditional tobacco products, with the exception of menthol (32). Research has shown that menthol smokers have a more difficult time quitting (33, 34). However, we found that the use of non-tobacco flavors was associated with lower likelihood of current smoking. This introduces the possibility that non-tobacco flavors may aid the transition from smoking to vaping. However, the causal role, if any, of e-cigarette flavors in influencing continued use of tobacco cigarettes or e-cigarettes cannot be determined from our data.

Higher nicotine levels were associated with higher prevalence of dual use and reduced likelihood of plans to reduce or quit their e-cigarette use. Although this may support regulation of nicotine levels, caution is warranted as these findings are cross-sectional. High levels of nicotine may be needed initially for e-cigarettes to function as a substitute for smoking, but perhaps the dose can be tapered down over time. Although we found that controlling for length of e-cigarette use did not eliminate this finding, more research on this issue, particularly of a longitudinal or experimental nature, is needed to help establish causality. In addition, nicotine level of e-cigarette liquid is only one variable related to nicotine delivery; e-cigarette design, battery voltage, user behavior, and prior history of e-cigarette use also influence the level of nicotine consumed by the user (35–37).

Expectancies

Several expectancies were found to discriminate dual users from former smokers. Positive e-cigarette expectancies, such as satisfaction, taste, and stress reduction, were associated with abstinence from smoking, whereas those who felt e-cigarettes were irritating to the mouth or throat, expensive, withdrawal-causing, and addictive reported recent cigarette smoking. However, positive expectancy for taste and lower expectancies for health risks and other negative consequences were associated with intentions for continued, long-term e-cigarette use among former smokers. There are a number of possible explanations for these findings. Although we controlled for e-cigarette use characteristics in an attempt to mitigate this possibility, it may be that these expectancies are merely epiphenomena demonstrating that those who had the most satisfactory experiences with e-cigarettes are most likely to switch from smoking to exclusive use of e-cigarettes. On the other hand, it may be that expectancies had developed via routes other than personal product experience. For example, information from public health campaigns about health risk or addictiveness may have discouraged use, whereas advertising campaigns encouraging perception of e-cigarettes as satisfying or pleasant tasting may have encouraged use.

Currently proposed FDA regulations mandate labeling of e-cigarettes containing nicotine to note that nicotine is an addictive chemical (38). Consistent with research among nonsmokers (39), we found evidence that this labeling could be an effective deterrent, as expectancies related to addictiveness were associated with intentions to reduce e-cigarette use. However, we also found that beliefs related to e-cigarette addiction were associated with continued cigarette smoking. This suggests a need for monitoring of labeling requirements to examine their effects in relation to cigarette smoking.

Ratings of e-cigarette convenience provide an exception to the general finding of positive e-cigarette expectancies protecting against smoking. This is consistent with the notion that dual users vape when smoking cigarettes is prohibited or otherwise difficult (28). Secondhand exposure to e-cigarette aerosol can expose nonsmokers to toxic chemicals, albeit generally at much lower levels than conventional cigarette smoke (40–43). The present data suggest the possibility of maintained tobacco addiction when e-cigarettes are more convenient and permissible than smoking. However, another possibility is that whereas dual users may prefer smoking, and only use e-cigarettes at times when smoking would be forbidden or otherwise inconvenient, exclusive e-cigarette users may be less likely to use for this strategic purpose and consequently may be less likely to rate e-cigarettes as convenient. Thus, although these results could be interpreted to support the expansion of current smoking prohibitions to include e-cigarette use, causal inferences are unclear.

In terms of other notable expectancies, dual users were more likely to report that e-cigarettes are harmful for health. Messages informing tobacco smokers that e-cigarettes are harmful may unintentionally convince tobacco smokers that e-cigarettes are no different than cigarettes and discourage them from making an effort to transition to e-cigarettes despite evidence that harm could be significantly reduced (44–46). E-cigarette satisfaction and taste were strongly associated with quitting smoking and reduced intention to quit e-cigarettes. Nicotine level is a robust predictor of reports of both satisfaction and taste among smokers (15, 47, 48).

Study limitations

There are several limitations of this study. The sample was recruited via an online survey. Online surveys have been a popular and useful approach for conducting exploratory research in this area (49–52) and provide a crucial resource for providing preliminary data in a rapidly evolving field. Nonetheless, they face several significant limitations. First, self-report may result in measurement error (e.g., smoking status was not biochemically verified). Secondly, there is likely a bias towards those who are highly enthusiastic about e-cigarettes (51). Tobacco smokers who have been unsuccessful with e-cigarettes may be less likely to complete the survey, which likely partially explains the high reports of success we found compared to other reports (5, 53). The relatively smaller number of dual users is in itself another limitation as this group is likely the most at risk and thus arguably the most important to understand. Therefore, these results are in need of replication with a larger, more representative group. The cross-sectional nature of the survey is another limitation which precludes any understanding of causal effects. In particular, intentions to quit or reduce drug use are known to be unstable (54) and, although there is some evidence these

intentions are related to attempting or successfully quitting (55), the connection is fairly tenuous and debatable. Below, we discuss some research designs which can help extend and further substantiate these findings.

Summary

The current study provides valuable information quantifying the association of e-cigarette expectancies on cigarette smoking and intention to reduce or quit their e-cigarette use. Available research suggests that e-cigarettes can substantially reduce the level of harm associated with nicotine use by cigarette smoking (3), although the long-term effects of e-cigarette use are currently unclear (2). The distinct usage characteristics and expectancies associated with quitting smoking and intentions to quit e-cigarettes have important potential ramifications for the treatment of cigarette smoking, one of the worldwide leading causes of death (1, 24). We found that positive expectancies about e-cigarettes (with the exception of convenience) were associated with quitting smoking, while negative expectancies were associated with dual use. Further research is needed to better understand these findings. In particular, longitudinal designs using more representative samples, possibly using real-time assessment, would strengthen the predictive validity of e-cigarette expectancies (17). Moreover, experimental research (e.g., expectancy manipulations) could strengthen causal conclusions (14–16, 56). If these expectancies indeed play causal roles in e-cigarette initiation, quitting cigarette smoking, and cessation of e-cigarette use, policy must carefully titrate the messages about, and thus the appeal, of e-cigarettes to promote smoking cessation, while balancing the goal of keeping appeal low for non-smokers.

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Table 1

Demographic, cigarette smoking, and e-cigarette use variables and odds of dual use (past-month tobacco smoking) among all 1815 e-cigarette users and plans to quit/reduce e-cigarette use among 1434 former smokers.

	All E-cigarette Users (N=1815)		Predicting Dual Use		Former Smokers Only (n=1434)		Predicting Plans to Quit/Reduce Vaping	
	Former Smokers n = 1434	Dual Users n = 381	OR (95% C.I.)	AOR (95% C.I.) ^{1,2,3,4}	No Plan to Reduce E-cig n = 748	Plan to Reduce E-cig Use n = 686	OR (95% C.I.)	AOR (95% C.I.) ^{1,2,3,4}
Total N = 1815 n (%)								
Age								
18-29	471 (26.0)	152 (39.9)	1.00	1.00	158 (21.1)	161 (23.5)	1.00	1.00
30-44	681 (37.5)	120 (31.5)	0.45 (0.34-0.59) ***	0.39 (0.27-0.57) ***	287 (38.4)	274 (39.9)	0.94 (0.71-1.23)	0.97 (0.71-1.33)
45-59	508 (28.0)	82 (21.5)	0.40 (0.30-0.55) ***	0.34 (0.22-0.52) ***	231 (30.9)	195 (28.4)	0.83 (0.62-1.11)	0.92 (0.65-1.31)
60+	155 (8.5)	27 (7.1)	0.44 (0.28-0.70) ***	0.39 (0.21-0.73) **	72 (96.6)	56 (8.2)	0.76 (0.51-1.15)	0.80 (0.48-1.34)
Sex								
Male	1212 (66.8)	266 (69.8)	1.00	1.00	496 (66.3)	450 (65.6)	1.00	1.00
Female	603 (33.2)	115 (30.2)	0.84 (0.66-1.07)	1.36 (0.96-1.93) [†]	252 (33.7)	236 (34.0)	1.03 (0.83-1.28)	1.13 (0.86-1.48)
Race								
White	1671 (92.1)	345 (90.6)	1.00	1.00	689 (92.1)	637 (92.9)	1.00	1.00
Other	144 (7.9)	36 (9.4)	1.28 (0.86-1.90)	1.41 (0.83-2.40)	59 (7.9)	49 (7.1)	0.98 (0.61-1.33)	0.84 (0.53-1.33)
Marital Status								
Married	1039 (58.3)	865 (61.6)	1.00	1.00	466 (63.8)	399 (59.2)	1.00	1.00
Single	743 (41.7)	204 (54.0)	1.88 (1.50-2.37) ***	1.56 (1.13-2.15) **	264 (36.2)	275 (40.8)	1.22 (0.98-1.51) [†]	1.25 (0.96-1.61)
Education								
HS/Less than HS	314 (17.3)	246 (17.2)	1.00	1.00	138 (18.4)	108 (15.7)	1.00	1.00
Some College/Tech School	1288 (71.0)	1010 (70.4)	1.00 (0.74-1.34)	0.90 (0.59-1.36)	516(69.0)	494 (72.0)	1.22 (0.92-1.62)	1.23 (0.88-1.70)
Graduate Study	213 (11.7)	178 (12.4)	0.71 (0.45-1.12)	0.69 (0.37-1.27)	94 (12.6)	84 (12.2)	1.14 (0.78-1.68)	1.09 (0.69-1.71)
Income								
< \$40,000/year	737 (40.6)	559 (39.0)	1.00	1.00	304 (40.6)	255 (37.2)	1.00	1.00
\$40,000-\$89,000/year	721 (39.7)	584 (40.7)	0.74 (0.57-0.95) *	0.94 (0.67-1.31)	305 (40.8)	279 (40.7)	1.09 (0.86-1.38)	1.03 (0.79-1.35)
> \$90,000/year	357 (19.7)	291 (20.3)	0.71 (0.52-0.98) *	1.05 (0.67-1.65)	139 (18.6)	152 (22.2)	1.30 (0.98-1.73) [†]	1.30 (0.92-1.83)

	All E-cigarette Users (N=1815)			Predicting Dual Use			Former Smokers Only (n=1434)			Predicting Plans to Quit/Reduce Vaping		
	Total N = 1815 n (%)	Former Smokers n = 1434	Dual Users n = 381	OR (95% C.I.)	AOR (95% C.I.) ^{1,2,3,4}	No Plan to Reduce E-cig Use n = 748	Plan to Reduce E-cig Use n = 686	OR (95% C.I.)	AOR (95% C.I.) ^{1,2,3,4}	OR (95% C.I.)	AOR (95% C.I.) ^{1,2,3,4}	
Age Started Smoking Cigs												
< 15 years	811 (44.7)	666 (46.4)	145 (38.1)	1.00	1.00	356 (47.6)	310 (45.2)	1.00	1.00	1.00	1.00	
16-20 years	846 (46.6)	656 (45.7)	190 (49.9)	1.33 (1.05-1.69)*	1.24 (0.91-1.72)	338 (45.2)	318 (46.4)	1.08 (0.87-1.34)	1.03 (0.81-1.31)	1.03 (0.81-1.31)	1.03 (0.81-1.31)	
> 20 years	158 (8.7)	112 (7.8)	46 (12.1)	1.89 (1.28-2.78)**	2.28 (1.37-3.79)**	54 (7.2)	58 (8.5)	1.23 (0.83-1.84)	1.13 (0.71-1.80)	1.13 (0.71-1.80)	1.13 (0.71-1.80)	
How long ago using e-cig? ¹												
1-6 months	711 (42.1)	567 (39.7)	144 (55.0)	1.00	1.00	240 (32.3)	327 (47.9)	1.00	1.00	1.00	1.00	
6-12 months	410 (24.3)	360 (25.2)	50 (19.1)	0.55 (0.39-0.77)**	0.61 (0.42-0.90)*	173 (23.3)	187 (27.4)	0.79 (0.61-1.04)	0.82 (0.62-1.10)	0.82 (0.62-1.10)	0.82 (0.62-1.10)	
12-24 months	296 (17.5)	260 (18.2)	36 (13.7)	0.55 (0.37-0.81)**	0.62 (0.39-0.97)*	150 (20.0)	110 (16.1)	0.54 (0.40-0.72)***	0.62 (0.45-0.85)**	0.62 (0.45-0.85)**	0.62 (0.45-0.85)**	
More than 24 months ago	272 (16.1)	240 (16.8)	32 (12.2)	0.53 (0.35-0.79)**	0.69 (0.44-1.09)	181 (24.3)	59 (8.6)	0.24 (0.17-0.34)***	0.27 (0.18-0.39)***	0.27 (0.18-0.39)***	0.27 (0.18-0.39)***	
How often do you use e-cigs? ²												
Daily	1721 (94.8)	1381 (96.3)	340 (89.2)	1.00	1.00	725 (96.9)	656 (95.6)	1.00	1.00	1.00	1.00	
Non-daily	94 (5.2)	53 (3.7)	41 (10.8)	3.14 (2.06-4.80)***	3.40 (1.89-6.11)***	23 (3.1)	30 (4.4)	0.69 (0.40-1.21)	0.83 (0.43-1.63)	0.83 (0.43-1.63)	0.83 (0.43-1.63)	
Flavors												
Non-Tobacco	1503 (82.8)	1207 (84.2)	296 (77.7)	1.00	1.00	640 (85.6)	567 (82.7)	1.00	1.00	1.00	1.00	
Tobacco	312 (17.2)	227 (15.8)	85 (22.3)	1.53 (1.15-2.02)**	1.61 (1.09-2.38)*	108 (14.4)	119 (17.3)	0.80 (0.61-1.07)	1.19 (0.86-1.66)	1.19 (0.86-1.66)	1.19 (0.86-1.66)	
Nicotine Level of E-cigarette ²												
Zero (0 milligrams)	50 (2.9)	44 (3.2)	6 (1.6)	1.07 (0.43-2.66)	0.29 (0.06-1.37)	24 (3.4)	20 (3.1)	0.77 (0.41-1.44)	0.47 (0.22-0.98)*	0.47 (0.22-0.98)*	0.47 (0.22-0.98)*	
Low (4-8 milligrams)	381 (21.0)	338 (24.9)	43 (11.7)	1.00	1.00	162 (22.8)	176 (27.3)	1.00	1.00	1.00	1.00	
Medium (9-16 milligrams)	658 (36.3)	519 (38.2)	139 (37.7)	2.11 (1.46-3.04)***	2.02 (1.28-3.20)**	256 (36.0)	263 (40.8)	0.95 (0.71-1.24)	0.87 (0.65-1.17)	0.87 (0.65-1.17)	0.87 (0.65-1.17)	
High (16-24 milligrams)	584 (34.1)	456 (31.3)	170 (46.1)	2.94 (2.04-4.24)***	3.32 (2.10-5.24)***	247 (34.7)	178 (27.6)	0.66 (0.50-0.88)**	0.67 (0.49-0.92)*	0.67 (0.49-0.92)*	0.67 (0.49-0.92)*	
Extra High (over 24 mg)	42 (2.4)	31 (2.3)	11 (3.0)	2.79 (1.31-5.95)**	3.40 (1.36-8.47)**	23 (3.2)	8 (1.2)	0.32 (0.14-0.74)**	0.35 (0.14-0.85)*	0.35 (0.14-0.85)*	0.35 (0.14-0.85)*	
How many times per day do you use e-cig(s)?												
1-9 times per day	554 (30.6)	409 (28.5)	145 (38.1)	1.00	1.00	159 (21.3)	250 (36.4)	1.00	1.00	1.00	1.00	
10-20 times per day	730 (40.2)	589 (41.1)	141 (37.0)	0.68 (0.52-0.88)**	0.92 (0.64-1.32)	313 (41.8)	276 (40.2)	0.56 (0.43-0.73)***	0.60 (0.45-0.81)**	0.60 (0.45-0.81)**	0.60 (0.45-0.81)**	

	All E-cigarette Users (N=1815)		Predicting Dual Use		Former Smokers Only (n=1434)		Predicting Plans to Quit/Reduce Vaping	
	Former Smokers n = 1434	Dual Users n = 381	OR (95% C.I.)	AOR (95% C.I.) ^{1,2,3,4}	No Plan to Reduce E-cig n = 748	Plan to Reduce E-cig Use n = 686	OR (95% C.I.)	AOR (95% C.I.) ^{1,2,3,4}
Total N = 1815 n (%)	531 (29.3)	436 (30.4)	0.62 (0.46-0.82)**	0.92 (0.62-1.37)	276 (36.9)	160 (23.3)	0.37 (0.28-0.49)***	0.44 (0.32-0.61)***
20+ times per day								
Type of E-cigarette ³								
First Generation "Cigalike"	285 (15.7)	213 (14.9)	1.00	1.00	106 (14.2)	107 (15.6)	1.00	1.00
eGo	592 (32.6)	439 (30.6)	1.03 (0.75-1.43)	1.03 (0.66-1.60)	229 (30.6)	210 (30.6)	0.91 (0.66-1.26)	1.07 (0.74-1.57)
Mods/Other	747 (51.7)	782 (54.5)	0.58 (0.42-0.80)***	0.70 (0.45-1.08)	413 (55.2)	369 (53.8)	0.89 (0.65-1.20)	1.24 (0.87-1.78)
Do you modify your e-cig? (Ref. = No)								
Yes	1238 (68.2)	1010 (70.4)	0.63 (0.50-0.79)***	1.05 (0.75-1.47)	556 (74.3)	454 (66.2)	0.68 (0.54-0.85)**	0.74 (0.56-0.97)*
Use of E-cigarettes by Friends/Family								
No use by friends, household members	212 (11.7)	149 (10.4)	1.00	1.00	71 (9.5)	78 (11.4)	1.00	1.00
Use by friends, but not a household member	963 (53.1)	749 (52.2)	0.68 (0.49-0.94)*	0.75 (0.31-1.85)	370 (49.5)	379 (55.2)	0.93 (0.66-1.33)	0.92 (0.46-1.86)
Use by another household member	64 (3.5)	50 (3.5)	0.66 (0.34-1.28)	0.94 (0.59-1.51)	25 (3.3)	25 (3.6)	0.91 (0.48-1.73)	0.97 (0.65-1.45)
Use by friends and household member	576 (31.7)	486 (33.9)	0.44 (0.30-0.63)***	0.60 (0.36-1.02) [†]	282 (37.7)	204 (29.7)	0.66 (0.46-0.95)*	0.68 (0.45-1.04) [†]
Online E-cigarette Forums? (Ref. = No)								
Read and/or participate	1527 (84.1)	1234 (86.1)	0.54 (0.41-0.72)***	0.72 (0.48-1.09)	681 (91.0)	553 (80.6)	0.41 (0.30-0.56)***	0.46 (0.32-0.67)***

[†] p < .10,

* p < .05,

** p < .01,

*** p < .001

¹ Removed 126 who started using e-cigarettes less than a month ago (119 of whom smoked cigarettes in past month) due to redundancy of question

² Removed 100 individuals who did not know nicotine level or reported other nicotine level

³ Removed 44 individuals who gave no information about type of e-cigarette used

⁴ Adjusted for all variables in table.

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Associations of e-cigarette expectancies and perceived convenience/cost with past month smoking among 1815 e-cigarette users.

Table 2

	Total N = 1815 M (SD)	Former Smokers n = 1434 M (SD)	Dual Users n = 381 M (SD)	Unadjusted β	Adjusted β [†]
<i>“Positive” Effects</i>					
Satisfaction	6.58 (0.86)	6.65 (0.78)	6.31 (1.08)	-0.16 ^{***}	-0.11 ^{***}
Craving Reduction	6.33 (1.15)	6.35 (1.13)	6.23 (1.22)	-0.05	-0.06 [*]
Taste	6.47 (1.02)	6.52 (0.95)	6.31 (1.21)	-0.08 ^{***}	-0.05 [†]
Weight Control	3.99 (1.74)	4.02 (1.76)	3.90 (1.67)	-0.03	-0.02
Social Facilitation	4.08 (1.85)	4.12 (1.86)	3.92 (1.82)	-0.04	-0.03
Stress Reduction	5.06 (1.60)	5.10 (1.61)	4.91 (1.57)	-0.05 [*]	-0.07 ^{**}
Negative Affect Reduction	4.95 (1.74)	4.97 (1.76)	4.88 (1.67)	-0.02	-0.05 [†]
Stimulation	3.90 (1.62)	3.92 (1.63)	3.81 (1.57)	-0.03	-0.04 [†]
Convenience	5.92 (1.38)	5.89 (1.97)	6.02 (1.41)	-0.04 [†]	0.03
<i>“Negative” Effects</i>					
Health Risks	2.23 (1.40)	2.17 (1.36)	2.49 (1.51)	-0.09 ^{***}	0.04
Negative Physical Feelings	2.20 (1.53)	2.08 (1.47)	2.65 (1.69)	-0.15 ^{***}	0.10 ^{***}
Negative Social Impression	2.78 (1.55)	2.75 (1.55)	2.89 (1.56)	-0.04	0.01
Addiction	4.40 (1.66)	4.33 (1.65)	4.65 (1.64)	-0.08 ^{**}	0.06 [*]
Craving	4.41 (1.70)	4.37 (1.69)	4.55 (1.72)	-0.04	0.03
Withdrawal	3.62 (1.84)	3.55 (1.81)	3.86 (1.90)	-0.07 ^{**}	0.05 [*]
Cost	2.95 (1.68)	2.85 (1.64)	3.36 (1.79)	-0.12 ^{***}	0.08 ^{**}

[†] $p < .1$,

* $p < .05$,

** $p < .01$,

*** $p < .001$

Note. All expectancies rated on a scale from 1 (“strongly disagree”) to 7 (“strongly agree”).

[†] Adjusted for all demographic, cigarette smoking, and e-cigarette use variables.

Table 3

Associations of e-cigarette expectancies and intention to quit/reduce e-cigarette usage among 1434 ex-smoking e-cigarette users.

	No Plan to Quit/Reduce E-cig <i>n</i> = 748 <i>M</i> (<i>SD</i>)	Plan to Quit/Reduce Use <i>n</i> = 686 <i>M</i> (<i>SD</i>)	Unadjusted β	Adjusted β 1
<i>“Positive” Effects</i>				
Satisfaction	6.72 (0.76)	6.58 (0.80)	-0.09 ***	-0.04
Craving Reduction	6.33 (1.17)	6.37 (1.09)	0.02	0.07 *
Taste	6.64 (0.82)	6.39 (1.07)	-0.12 ***	-0.08 **
Weight Control	4.09 (1.73)	3.94 (1.79)	-0.04	0.00
Social Facilitation	4.20 (1.81)	4.03 (1.90)	-0.04	0.01
Stress Reduction	5.18 (1.60)	5.00 (1.60)	-0.06 *	-0.03
Negative Affect Reduction	5.03 (1.76)	4.90 (1.77)	-0.04	0.00
Stimulation	4.03 (1.65)	3.80 (1.60)	-0.07 **	-0.03
Convenience	5.88 (1.38)	5.90 (1.36)	-0.01	-0.02
<i>“Negative” Effects</i>				
Health Risks	1.88 (1.26)	2.47 (1.40)	-0.21 ***	0.16 ***
Negative Physical Feelings	1.92 (2.26)	2.26 (1.54)	-0.12 ***	0.09 **
Negative Social Impression	2.61 (1.54)	2.90 (1.54)	-0.09 ***	0.10 ***
Addiction	4.19 (1.70)	4.48 (1.59)	-0.09 **	0.10 ***
Craving	4.30 (1.80)	4.45 (1.65)	-0.04	0.08 **
Withdrawal	3.51 (1.83)	3.60 (1.79)	-0.02	0.07 *
Cost	2.81 (1.61)	2.89 (1.67)	-0.03	0.01

* $p < .05$,

** $p < .01$,

*** $p < .001$

Note. All expectancies rated on a scale from 1 (“Strongly Disagree”) to 7 (“Strongly Agree”).

¹ Adjusted for all demographic, cigarette smoking, and e-cigarette use variables.