



The association between perceived e-cigarette and nicotine addictiveness, information-seeking, and e-cigarette trial among U.S. adults



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ABSTRACT

Perceptions of harm and addictiveness are associated with smoking combusted cigarettes, but these factors have not been fully explored for e-cigarettes. Specifically, little is known about the perceived harm and addictiveness of e-cigarettes, or whether information-seeking about e-cigarettes is related to trying e-cigarettes. We aimed to determine the relationship between (1) perceived e-cigarette harm and addictiveness and trying e-cigarettes; (2) nicotine perceptions and trying e-cigarettes; and (3) e-cigarette information-seeking, Internet use, and trying e-cigarettes. We used data from the nationally representative 2015 Health Information National Trends Survey-FDA (HINTS-FDA 2015). Weighted multivariable logistic regression models assessed independent associations between perceived e-cigarette harm, perceived e-cigarette addictiveness, nicotine perceptions, e-cigarette information-seeking, personal Internet use, and trying e-cigarettes, among 3195 adults. Compared to people who believed e-cigarettes were equally or more addictive than combusted cigarettes, those who believed e-cigarettes were less addictive had 2.49 times the odds of trying e-cigarettes (95% confidence interval [CI]: 1.30, 4.74). Perceived e-cigarette harm and nicotine perceptions were not associated with trying e-cigarettes. The positive association between e-cigarette addictiveness and trying e-cigarettes coupled with the lack of an association between nicotine perceptions and trying e-cigarettes suggests people do not fully understand that e-cigarettes contain nicotine and therefore could be addictive. People most frequently reported searching for information about potential health effects of e-cigarettes (37.9%), indicating that people are interested in learning about the potential impact of e-cigarette use on their health. People who searched for information about e-cigarettes had 10.23 higher odds of trying e-cigarettes (CI: 5.41, 19.33).

1. Introduction

Among adults, e-cigarettes have become increasingly used in the United States (U.S.) over the past 5 years (King et al., 2015; Schoenborn and Gindi, 2015). In 2017, an estimated 15.4% of all U.S. adults had tried e-cigarettes (QuickStats, 2017). Previous research demonstrates that younger adults and current smokers are more likely to use e-cigarettes than older adults and non-smokers (McMillen et al., 2015). Key questions about these products focus on the health effects of long-term e-cigarette use; the potential influence of e-cigarette use on combusted cigarette uptake, especially among adolescents and young adults; and the potential for tobacco use relapse among former users (Grana et al., 2014a). Developing a better understanding of such factors will help elucidate the potential public health impact of e-cigarettes.

Research on combusted cigarette use suggests psychological factors

such as perceptions of product harm and addictiveness are associated with smoking (Song et al., 2009), but these factors have not been fully explored for e-cigarettes. The belief that e-cigarettes are less harmful and addictive than combusted cigarettes has been cited as a reason for trying e-cigarettes among youth and adults (Amrock et al., 2015, 2016; Ambrose et al., 2014; Choi and Forster, 2013, 2014; Goniewicz et al., 2013a). Tan and colleagues found that people who had tried e-cigarettes were less likely to believe statements about e-cigarette harms than those who had never tried e-cigarettes (Tan et al., 2016). Nonetheless, findings regarding the relationship between beliefs about e-cigarettes and trying e-cigarettes are unclear or mixed (Choi and Forster, 2013, 2014; Waters et al., 2017; Copeland et al., 2017).

E-cigarettes typically contain nicotine (Grana et al., 2014a), yet this knowledge is not universal among users (Sanders-Jackson et al., 2015). Beliefs about the addictive nature of nicotine differ in general (Wagoner

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et al., 2016; Wiseman et al., 2016; Johnson et al., 2017), and by use of non-cigarette products, including e-cigarettes. For example, users of non-cigarette products report more positive beliefs about nicotine, and non-users report more negative beliefs (Wiseman et al., 2016). Nicotine addictiveness perceptions could influence whether people try e-cigarettes, but this relationship has not been explored.

Past research suggests e-cigarette advertising may be an influential source of marketing (Sanders-Jackson et al., 2015; Pepper et al., 2014; Wackowski et al., 2015). Among youth, exposure to e-cigarette advertising, including advertising through the Internet, was associated with trying e-cigarettes (Singh et al., 2016; Mantey et al., 2016). E-cigarette advertising has presented e-cigarettes as a less harmful alternative to combusted cigarette smoking (Richardson et al., 2015), potentially shaping people's perceptions. Further, exposure to e-cigarette advertising has been associated with the belief that e-cigarettes do not contain nicotine (Sanders-Jackson et al., 2015). Online searches for e-cigarette information increased between 2008 and 2015 (Ayers et al., 2011, 2016), and several characteristics (i.e., prior tobacco use, younger age, female gender, higher education, higher income, increased time spent online) are associated with increased odds of searching for e-cigarette information (Emery et al., 2014). Since many e-cigarette advertisements appear online (Centers for Disease Control and Prevention, 2016), time spent online could influence level of exposure to these ads. However, the unique associations between Internet use, e-cigarette information-seeking, and trying e-cigarettes are still unknown.

The objectives of this paper are threefold. First, we explore the associations between perceived e-cigarette harm and addictiveness and trying e-cigarettes. Second, we explore the relationship between perceived nicotine addictiveness and trying e-cigarettes. Third, we explore the relationship between information-seeking, Internet use, and trying e-cigarettes. We hypothesized that people who believed that e-cigarettes were less harmful or less addictive than combusted cigarettes, who had searched for information about e-cigarettes, and who spend more time on the Internet would be more likely to try e-cigarettes. To our knowledge, this is the first analysis of these associations in a large nationally representative U.S. sample.

2. Methods

2.1. Data source

We analyzed data from a supplemental cycle of the 2015 National Cancer Institute (NCI) Health Information National Trends Survey (HINTS), conducted jointly by NCI and the U.S. Food and Drug Administration (FDA) (hereafter referred to as HINTS-FDA 2015) (Westat, 2015; Blake et al., 2016). HINTS-FDA 2015 used a population-based, nationally representative sampling frame, which over-sampled smokers, using county-level smoking rates, to assess topics related to health communication and FDA regulation of tobacco products. The mailed, self-administered survey had a 33% (AAPOR) response rate, which is comparable to previous cycles of HINTS (National Cancer Institute, 2016) and other mailed surveys (Kaplowitz et al., 2004). The National Institutes of Health (NIH) Office of Human Subjects Research determined that the HINTS-FDA 2015 survey was exempt from IRB review in June 2014. Of the 3738 respondents included in the sample, we excluded 543 participants because they did not answer questions about either trying e-cigarettes or smoking status, leaving 3195 respondents as the analytic sample.

2.2. Measures and coding

2.2.1. Trying e-cigarettes

We assessed whether respondents had ever tried e-cigarettes using one question: "Which of the following tobacco products have you ever tried even once?", which then provided a list of tobacco products.

Respondents who indicated they had ever tried e-cigarettes were coded as "Triers," and the remaining were coded as "Non-triers."

2.2.2. Perceived e-cigarette harm

We assessed perceived e-cigarette harm with one item: "New types of cigarettes are now available called electronic cigarettes or e-cigarettes (also known as vape-pens, hookah pens, e-hookahs, or e-vaporizers). These products deliver nicotine through a vapor. Compared to smoking cigarettes, would you say that electronic cigarettes are": [Response options were:] "Much less harmful," "Less harmful," "Just as harmful," "More harmful," "Much more harmful," "I've never heard of electronic cigarettes," and "I don't know enough about these products." We excluded responses of "I've never heard of electronic cigarettes," and the remaining options were recoded as "Much less harmful/Less harmful," "Just as harmful/More harmful/Much more harmful," and "Don't know."

2.2.3. Perceived e-cigarette addictiveness

We assessed perceived e-cigarette addictiveness using one item: "Overall, how addictive do you believe each of the following is?" which then provided the following options: "Cigarette smoking," "Cigar smoking," "Smokeless tobacco use," "Using electronic cigarettes or e-cigarettes (also known as vape-pens, e-hookahs, or e-vaporizers)," "Smoking tobacco in a hookah," "Smoking 'roll your own' cigarettes," and "Smoking a pipe filled with tobacco." Response options were: "Not at all addictive," "Moderately addictive," "Very addictive," and "Don't know." We used responses to the combusted cigarette and e-cigarette questions to create a comparative addictiveness variable. First, any response of "Don't know" for either e-cigarettes or combusted cigarettes was categorized as a separate "Don't know" category. Then, among remaining responses, each combusted cigarette and e-cigarette item was coded from 0 to 2, with a higher score representing greater perceived addictiveness. We subtracted the e-cigarette item from the combusted cigarette item to create a comparison variable. The resulting score was coded as "E-cigarettes are less addictive than combusted cigarettes" or "E-cigarettes are just as/more addictive than combusted cigarettes".

2.2.4. Nicotine perceptions

We assessed nicotine perceptions using two items: "Nicotine is the main substance in tobacco that makes people want to smoke" and "Addiction to nicotine is something that I am concerned about." Response options were: "Strongly agree," "Agree," "Disagree," "Strongly disagree," and "Don't know." Responses were coded as "Strongly agree/Agree," "Disagree/Strongly disagree," and "Don't know."

2.2.5. E-cigarette information-seeking

We assessed e-cigarette information-seeking using one question: "Have you ever looked for information on electronic cigarettes from any source?" We coded responses as "Yes" or "No." For respondents who replied "yes," further descriptive information was obtained about the type of information they had searched for most recently. Response options were: "Health effects," "Using electronic cigarettes to quit or reduce smoking," "List of chemicals in electronic cigarettes," "Cost/coupons," "Instructions/tutorials," "Where to buy," "Reviews/ratings of brands," and "Something else."

2.2.6. Internet use

We assessed Internet use by asking respondents to report the number of hours they used the Internet for personal reasons on both weekdays and weekends. We created a total hours of personal Internet use per week variable and categorized respondents using quartiles as there is no consensus on what level of Internet use constitutes "regular use" (Bélanger et al., 2011) (0–6.4 h per week, 6.5–13.4 h per week, 13.5–27.1 h per week, and ≥ 27.2 h per week).

2.2.7. Covariates

The following covariates were included: smoking status (current smoker or not a current smoker, including former smokers), age (18–39 years, 40–59 years, and 60+ years), education (\leq high school degree, post-high school but no college, some college, college degree, $>$ college degree), race/ethnicity (non-Hispanic white, non-Hispanic other, Hispanic), gender (male, female). Among smokers only, covariates were intention to quit smoking in the next 6 months (yes or no), and level of nicotine addiction (\leq 5 min or $>$ 5 min to first cigarette).

2.3. Data analysis

We analyzed the data using SAS 9.3 and weighted all analyses using jackknife replicate weights from HINTS-FDA 2015. We calculated descriptive statistics and assessed bivariate associations using chi-square tests for each independent variable of interest (*perceived e-cigarette harm, perceived e-cigarette addictiveness, perceived nicotine addictiveness, concern about nicotine addiction, e-cigarette information-seeking, and personal Internet use*), and for each covariate with the dependent variable (trying e-cigarettes). Next, using multivariable logistic regression, we assessed the independent associations between each of the five variables of interest and trying e-cigarettes. After fitting an initial model with all the independent variables of interest and all possible covariates, we used backwards elimination of the covariates to create a parsimonious model using a log likelihood p-value of 0.2 as the cut-off for retaining a covariate in the model (Rothman et al., 2008). We used the final model to estimate odds ratios (ORs) and 95% confidence intervals (CIs).

Given that much of the research surrounding e-cigarette use focused on smokers (Grana et al., 2014a), we wanted to understand the associations between each of the independent variables and trying e-cigarettes among both smokers and non-smokers by creating models stratified by smoking status. However, the small number of current smokers in the sample limited our ability to include all the independent variables of interest among smokers in our model. Thus, a priori, we used the model analyzing the overall sample to identify variables most strongly associated with trying e-cigarettes, using an alpha of 0.05 to denote statistical significance. We performed an exploratory analysis by creating two models that included only those independent variables found to be associated with trying e-cigarettes—one for smokers and one for non-smokers. These models included the covariates: age (re-categorized as 18–39 and 40+ years), education (re-categorized as \leq some college and \geq college degree), and, among smokers, intention to quit smoking in the next 6 months and nicotine addiction.

3. Results

The majority of respondents were non-Hispanic whites (67.2%) 18–59 years of age (75.4%) with at least some college education (62.5%) (Table 1). Overall, 21.4% had tried e-cigarettes. People who had tried e-cigarettes were more likely to report that e-cigarettes were less harmful or less addictive than combusted cigarettes and to disagree that they were concerned about nicotine addiction. Just over half (51.2%) of those who had tried e-cigarettes were current smokers. Half of those who had tried e-cigarettes (50.3%) reported having searched for information about e-cigarettes. Potential health effects (37.9%), use of e-cigarettes for smoking cessation (20.1%), and where to buy the product (10.3%) were the topics most frequently searched by people who had searched for information about e-cigarettes (Table 2).

People who believed that e-cigarettes were less addictive than combusted cigarettes had 2.49 times the odds of trying e-cigarettes than those who believed that e-cigarettes were just as or more addictive than combusted cigarettes (95% CI: 1.30, 4.74) (Table 3). People who had searched for information about e-cigarettes had 10.23 times the odds of trying e-cigarettes than those who had not searched for information

Table 1
Descriptive frequencies. HINTS-FDA 2015.

Variable	Total (n = 3195)	Tried e-cigarettes		p-Value
		Yes (n = 483, 21.4%) n (weighted %)	No (n = 2712, 78.6%) n (weighted %)	
E-cigarette harm ^a				
Less harmful than combusted cigarettes	801 (28.4)	242 (51.6)	559 (22.1)	< 0.0001
Just as or more harmful than combusted cigarettes	1198 (39.5)	133 (32.2)	1065 (41.4)	
Don't know	1100 (32.1)	93 (16.2)	1007 (36.5)	
E-cigarette addictiveness ^a				
Less addictive than combusted cigarettes	703 (24.2)	217 (47.6)	486 (17.9)	< 0.0001
Just as or more addictive than combusted cigarettes	1040 (37.4)	137 (30.6)	903 (39.2)	
Don't know	1390 (38.4)	121 (21.8)	1269 (42.9)	
Nicotine makes people want to smoke ^a				
Strongly agree/ agree	2707 (85.2)	418 (87.2)	2289 (84.7)	< 0.0001
Strongly disagree/ disagree	141 (4.6)	42 (9.3)	99 (3.3)	
Don't know	320 (10.2)	21 (3.5)	299 (12.0)	
Concern about nicotine addiction ^a				
Strongly agree/ agree	1622 (51.5)	321 (60.6)	1301 (49.0)	0.0122
Strongly disagree/ disagree	1020 (34.0)	123 (30.2)	897 (35.1)	
Don't know	467 (14.5)	36 (9.2)	431 (15.9)	
Has looked up information about e-cigarettes ^a				
Yes	438 (16.8)	276 (50.3)	162 (7.7)	< 0.0001
No	2738 (83.2)	206 (49.7)	2532 (92.3)	
Hours of personal internet use per week ^a				
1st quartile ^b	826 (19.9)	102 (13.6)	724 (21.6)	0.0147
2nd quartile ^c	833 (25.8)	106 (22.8)	727 (26.6)	
3rd quartile ^d	780 (28.4)	131 (32.7)	649 (27.2)	
4th quartile ^e	593 (25.9)	121 (30.9)	472 (24.6)	
Current smoker				
Yes	477 (16.7)	283 (51.2)	194 (7.3)	< 0.0001
No	2718 (83.3)	200 (48.8)	2518 (92.7)	
Age ^a				
18–39 years	613 (40.5)	179 (63.1)	434 (34.2)	< 0.0001
40–59 years	1129 (34.9)	191 (27.4)	938 (37.0)	
60+ years	1378 (24.6)	106 (9.5)	1272 (28.8)	
Education ^a				
\leq high school degree	741 (28.4)	150 (32.6)	591 (27.2)	< 0.0001
Post high school but no college	265 (9.1)	46 (10.4)	219 (8.8)	
Some college	721 (26.0)	135 (36.8)	586 (23.0)	
College degree	814 (20.6)	100 (13.3)	714 (22.6)	
$>$ college degree	617 (15.9)	47 (6.9)	570 (18.4)	
Race/ethnicity ^a				
Non-Hispanic white	2348 (67.2)	358 (73.9)	1990 (65.3)	0.0581
Non-Hispanic other	395 (17.4)	59 (10.8)	336 (19.2)	
Hispanic	192 (15.4)	34 (15.3)	158 (15.5)	
Gender ^a				
Male	1296 (49.9)	191 (54.5)	1105 (48.6)	0.1119
Female	1737 (50.1)	266 (45.5)	1471 (51.4)	

^a Sum does not add to total due to missing values.

^b 0 to 6.4 h per week.

^c 6.5 to 13.4 h per week.

^d 13.5 to 27.1 h per week.

^e $>$ 27.2 h per week.

Table 2
Most recent type of e-cigarette information searched.^a

E-cigarette topics sought (n = 372)	Frequency (weighted %)
Health effects	155 (37.9)
Using electronic cigarettes to quit or reduce smoking	76 (20.1)
Where to buy	25 (10.3)
Cost/coupons	33 (8.7)
Reviews/ratings of brands	27 (7.5)
List of chemicals in electronic cigarettes	27 (7.5)
Something else	23 (4.1)
Instructions/tutorials	6 (3.9)

^a Only asked of people who indicated that they had previously searched for information about e-cigarettes.

Table 3
Associations between perceived e-cigarette harm, perceived e-cigarette addictiveness, perceived nicotine addictiveness, information-seeking, Internet use, and trying e-cigarettes. HINTS-FDA 2015 (n = 2791).

Variable	OR (95% CI)
E-cigarette harm	
Less harmful than combusted cigarettes	1.97 (0.99, 3.94)
Just as or more harmful than combusted cigarettes	1 (ref)
Don't know	0.66 (0.30, 1.45)
E-cigarette addictiveness	
Less addictive than combusted cigarettes	2.49 (1.30, 4.74)
Just as or more addictive than combusted cigarettes	1 (ref)
Don't know	0.83 (0.37, 1.87)
Nicotine makes people want to smoke	
Strongly disagree/disagree	2.65 (0.73, 9.67)
Strongly agree/agree	1 (ref)
Don't know	0.39 (0.08, 1.92)
Concern about nicotine addiction	
Strongly disagree/disagree	1.16 (0.54, 2.47)
Strongly agree/agree	1 (ref)
Don't know	0.83 (0.29, 2.39)
Has looked up information about e-cigarettes	
Yes	10.23 (5.41, 19.33)
No	1 (ref)
Hours of personal internet use per week	
1st quartile ^a	1 (ref)
2nd quartile ^b	0.90 (0.46, 1.77)
3rd quartile ^c	1.52 (0.74, 3.09)
4th quartile ^d	1.19 (0.50, 2.85)
Current smoker	
Yes	17.49 (10.23, 29.91)
No	1 (ref)
Age	
18–39 years	6.25 (3.59, 10.87)
40–59 years	1.43 (0.86, 2.37)
60+ years	1 (ref)
Education	
≤ high school degree	4.07 (1.80, 9.22)
Post high school but no college	3.84 (1.39, 10.61)
Some college	7.03 (3.54, 13.96)
College degree	2.68 (1.32, 5.47)
> college degree	1 (ref)

OR = odds ratio, 95% CI = 95% confidence interval, each association adjusted for all other variables included in the table.

- ^a 0 to 6.4 h per week.
- ^b 6.5 to 13.4 h per week.
- ^c 13.5 to 27.1 h per week.
- ^d > 27.2 h per week.

(95% CI: 5.41, 19.33). Perceived e-cigarette harm and amount of personal Internet use were not associated with trying e-cigarettes. Among the covariates, current smokers and 18- to 39-year-olds had higher odds of trying e-cigarettes. People with education below a college degree had higher odds of trying e-cigarettes compared to those with a college degree.

In exploratory models stratified by smoking status, people who believed e-cigarettes were less addictive than combusted cigarettes,

Table 4
Association between perceived e-cigarette addictiveness, information-seeking, and trying e-cigarettes among smokers and non-smokers. HINTS-FDA 2015.

Variable	Smokers (n = 428)	Non-smokers (n = 2587)
	OR (95% CI)	OR (95% CI)
E-cigarette addictiveness		
Less addictive than combusted cigarettes	4.37 (1.15, 16.56)	2.67 (1.49, 4.79)
Just as or more addictive than combusted al cigarettes	1 (ref)	1 (ref)
Don't know	0.74 (0.25, 2.19)	0.55 (0.22, 1.36)
Looked up information about e-cigarettes		
Yes	33.81 (13.56, 84.30)	8.34 (4.38, 15.85)
No	1 (ref)	1 (ref)
Age		
18–39 years	7.55 (2.79, 20.43)	4.56 (2.59, 8.04)
40+ years	1 (ref)	1 (ref)
Education		
< college degree	1 (ref)	1 (ref)
≥ college	1.22 (0.48, 3.06)	0.32 (0.18, 0.57)
Considering quitting smoking in next 6 months		
Yes	0.65 (0.27, 1.59)	–
No	1 (ref)	–
Time to first daily cigarette		
Within 5 min	1 (ref)	–
After 5 min	0.48 (0.24, 0.96)	–

OR = odds ratio, 95% CI = 95% confidence interval.
“–” = variable not included in model; each association adjusted for all other variables included in the table.

people who had searched for information about e-cigarettes, and younger age groups had higher odds of trying e-cigarettes, regardless of smoking status (Table 4). Non-smokers with at least a college degree had lower odds of trying e-cigarettes compared to those with less than a college degree (OR: 0.32, 95% CI: 0.18, 0.57).

4. Discussion

Our study assessed the independent associations between five constructs of interest—perceived e-cigarette harm, perceived e-cigarette addictiveness, nicotine perceptions, e-cigarette information-seeking, and personal Internet use—and trying e-cigarettes, in a nationally representative sample of U.S. adults. Although reduced-harm and addictiveness perceptions have been studied and are often considered risk factors for using combusted cigarettes and other tobacco products (Eissenberg et al., 2008; Smith et al., 2007; Primack et al., 2008), few studies have examined these associations with e-cigarette use behavior. Of the e-cigarette and nicotine belief items included in this study, only perceived e-cigarette addictiveness was significantly associated with trying e-cigarettes. Specifically, the belief that e-cigarettes are less addictive than combusted cigarettes is associated with trying e-cigarettes.

In contrast to our finding, Choi and colleagues did not find an association between e-cigarette addictiveness beliefs and trying e-cigarettes (Choi and Forster, 2014). This may be due to differences in the sample populations or in measurement of perceived addictiveness. We measured perceived e-cigarette addictiveness through a calculated comparison variable derived from two items asking about the perceived addictiveness of each product separately. Choi and colleagues used one item asking respondents to compare the addictiveness of e-cigarettes to combusted cigarettes directly. These item formats can yield different findings from analyses of the relationship between perceptions and use behavior (Choi and Forster, 2014; Persoskie et al., 2017).

Notably, in our study, around one-third of survey participants responded “Don't know” to the e-cigarette harm and addictiveness questions. This high degree of uncertainty may reflect an actual

knowledge gap about the extent to which e-cigarettes are harmful or addictive. This uncertainty could also be due to the variability in e-cigarette devices and the chemical composition of the liquid they contain, as well as whether they are being used concurrently with other tobacco products. In addition, in many e-cigarettes the amount of nicotine can be set by the user; therefore, e-cigarettes could contain levels of nicotine equal to or higher than combusted cigarettes. Future research could focus on explaining the sources of uncertainty surrounding e-cigarette harm and addictiveness perceptions.

This study did not find a relationship between *nicotine perceptions* and trying e-cigarettes. Despite the fact that nearly all respondents acknowledged being concerned about nicotine addiction and believed that nicotine makes people want to smoke, the lack of relationship between nicotine perceptions and trying e-cigarettes could indicate a lack of awareness that e-cigarettes typically contain nicotine. In this study, knowledge of nicotine levels in e-cigarettes was not assessed, but other research has found that nearly 60% of young adults reported not knowing that e-cigarettes contain nicotine (Sanders-Jackson et al., 2015). Nicotine addiction through e-cigarette use is of particular concern, as it may lead to use of combusted cigarettes and other tobacco products. A meta-analysis of nine longitudinal studies has identified e-cigarette use at baseline as a predictor of subsequent cigarette smoking (Soneji et al., 2017). However, the exact role of e-cigarettes in the progression to other tobacco use is unclear, given study variations in population composition, geographic locations, tobacco use measures, covariates, and confidence intervals. Nicotine addiction through e-cigarette use is also of concern because the implications of sustained e-cigarette use are still unknown, and sustained dual use with other tobacco products puts the user at increased risk for tobacco-related disease and death (US Department of Health and Human Services, 2016; National Academies of Sciences Engineering, and Medicine, 2018). Future research using longitudinal study designs can examine the extent to which perceived e-cigarette harm and addictiveness predict e-cigarette use, particularly dual use with other tobacco products. Such research will clarify use trends and assist in establishing temporal precedence between beliefs and behavior.

Another possible explanation for lack of knowledge about nicotine in e-cigarettes is that people may not currently perceive e-cigarette products as tobacco products and thus may incorrectly assume these products do not contain nicotine. E-cigarette marketing strategies often differentiate e-cigarettes from other tobacco products by using phrases such as “no tobacco” and “no smoke” (Grana et al., 2014b). These factors might have led to different interpretations of the items used in HINTS-FDA 2015 to measure nicotine perceptions, as the items defined nicotine as a substance in tobacco that makes people want to smoke. Moreover, labeled nicotine content is not required for e-cigarette products, and research shows that there is a mismatch between labeled and actual nicotine content, potentially contributing to lack of knowledge about nicotine in e-cigarettes (Goniewicz et al., 2013b). Even for established products like combusted cigarettes, current research suggests that consumers, especially young people, continue to hold misperceptions about addiction, specifically related to the relationship between addiction and the ability to quit (Roditis et al., 2016). Therefore, it would not be surprising if this relationship is less understood for non-cigarette products. Public health practitioners are beginning to craft messages about e-cigarettes to help mitigate confusion surrounding e-cigarette chemical composition, the concept of addiction, and the role that nicotine plays in addiction. FDA recently announced plans to expand its public education campaign, “The Real Cost,” to focus on prevention of youth e-cigarette use (US Food and Drug Administration, 2017) and include messaging on nicotine and addiction. Other strategies to educate the public about e-cigarette constituents and the potential for nicotine addiction may also increase understanding and knowledge about e-cigarettes.

While the association appears strong between *perceived e-cigarette harm* and trying e-cigarettes (1.97, CI: 0.99, 3.94), it did not reach

statistical significance. Thus, our finding may differ from other research, which found that those who perceived e-cigarettes to be less harmful than combusted cigarettes were more likely to use e-cigarettes (Choi and Forster, 2014; Brose et al., 2015). This lack of consistency may reflect sample population differences or the possibility that our study could not adequately assess this association given the relatively small number of respondents who had tried e-cigarettes. Also, because of our a priori modeling decisions, potential differences in the association between perceived harm and trying e-cigarettes by smoking status were not assessed. Research on the potential harm of e-cigarettes is ongoing. As research results become available about e-cigarette health effects, the relationship between perceived e-cigarette harm and trying e-cigarettes may change. Assessing this relationship will continue to be important, especially potential differences in perceived harm between smokers and non-smokers. Also, while much of the research (and the measure included in this study) has focused on perceived e-cigarette harm relative to combusted cigarettes, public health practitioners may consider messaging specifying that a potentially reduced-harm product does not mean that a product poses no potential harm.

Although this analysis found that relatively few people had searched for information about e-cigarettes, there were dramatic differences in *information-seeking* between those who had and had not tried e-cigarettes: People who had searched for information about e-cigarettes had higher odds of trying e-cigarettes. The topics most frequently searched for were cigarettes' potential health effects and the use of e-cigarettes for smoking cessation. Through *searching the Internet*, which is the most utilized source of information about tobacco products (Nguyen et al., 2017), consumers may see e-cigarette advertisements or social media posts by commercial accounts, where in the past, e-cigarettes had been advertised as a means to quit smoking and as a less harmful alternative to combusted smoking (Richardson et al., 2015; Huang et al., 2014). Thus, it is possible that marketing strategies have influenced consumers' information searches. Also, because a large percentage of people who had tried e-cigarettes were smokers, the association between smoking and e-cigarette use could reflect people searching for information about using e-cigarettes for smoking cessation. However, because this study uses data from a cross-sectional survey, we are not able to capture the temporality of the association between information-seeking and trying e-cigarettes. Future studies could continue to examine e-cigarette information-seeking, as well as the influence of advertising on information-seeking patterns, beliefs about e-cigarettes, and use of these products.

Lastly, exploratory models in this study assessed the associations between perceived e-cigarette addictiveness and e-cigarette information seeking with trying e-cigarettes, by smoking status. Similar to previous research (Choi and Forster, 2014), few differences in associations were found by smoking status, suggesting the impact of perceived addictiveness on behavior may be similar for both smokers and non-smokers. However, it appears the association between education and trying e-cigarettes could vary greatly by smoking status. Among smokers, there was no association between education level and trying e-cigarettes; for non-smokers, however, those with at least a college degree had lower odds of trying e-cigarettes than those without a college degree. This finding is consistent with other research that suggests e-cigarette use is most common among those with fewer years of education (Grana et al., 2014b; Regan et al., 2013).

5. Limitations

As this study involved secondary data analysis, not all potential variables of interest could be included. For example, we were not able to examine current daily/regular e-cigarette use. The personal Internet use measure was not designed to measure specific online activities, so we used a broad measure of overall personal Internet use to capture potential exposure to online e-cigarette advertising. Also, while HINTS-FDA 2015 is nationally representative, even with oversampling of

smokers, the number of smokers and people who had tried e-cigarettes was small, which led to less precise confidence intervals around some of our associations of interest. Future researchers interested in examining patterns of trying and using e-cigarettes might consider alternative methods to successfully oversample this subgroup so that more precise comparisons can be made between those who have tried e-cigarettes and those who have not. Further, it is uncertain if our results are generalizable to an adolescent population; understanding the influencers of e-cigarettes use in this population continues to be of interest. Finally, as discussed above, this study used cross-sectional data and as a result, the temporality of associations is unknown.

6. Conclusions

This study is timely for a number of reasons. First is the growing popularity of e-cigarettes: In our study, almost one in five survey respondents have tried e-cigarettes. Second, regulatory oversight of e-cigarettes is expanding. In May 2016, FDA finalized a rule to regulate all products that meet the regulatory definition of a tobacco product, including e-cigarettes (US Food and Drug Administration, 2016). Third, recent research suggests that the e-cigarette market is growing, with one study reporting that between August 2012 and January 2014, an average of 10.5 brands and 242 unique flavors entered the market each month (Zhu et al., 2014). Given these important trends, it is necessary to elucidate the factors associated with trying e-cigarettes as we continue to learn more about this new product. As public health practitioners and researchers learn more about e-cigarettes and their potential long-term benefits and harms, it is imperative to better understand the perceptions and beliefs surrounding e-cigarettes, and how these interrelated beliefs are influencing use. This analysis assessed how a variety of potentially important perceptions and behaviors are associated with trying e-cigarettes. The results of this study shed light on a potential difference in how the population perceives e-cigarette addictiveness compared to nicotine addictiveness. Future research may lead to a better understanding of the foundations for these different perceptions and the impact of marketing on product beliefs and use.

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Conflicts of interest

None.

Disclaimer statement

The findings, conclusions and views expressed in this publication are solely those of the authors and do not represent FDA/CTP or NIH positions or policies.

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