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## Knowledge about chemicals in e-cigarette secondhand vapor and perceived harms of exposure among a national sample of U.S. adults

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### Abstract

Potentially harmful chemicals are detectable in e-cigarette secondhand vapor (hereafter SHV), contrary to advertising and marketing claims that it contains “only water vapor.” We assessed public knowledge about the presence of chemicals in SHV and associations between knowledge and perceived harms of exposure to SHV. We conducted an online survey of a nationally representative sample of 1449 U.S. adults (GfK’s KnowledgePanel) from October-December 2013. Respondents were asked whether e-cigarette vapor contains only water vapor, contains tar, or contains formaldehyde (true/ false/ don’t know). Responses to these three items were recoded (1=incorrect, 2=don’t know, 3=correct) and averaged into a knowledge scale. They were also asked if they perceived breathing SHV to be harmful to one’s health (two-item scale) and comparative harm of breathing SHV versus breathing secondhand smoke (SHS). Multiple regression analyses were weighted to the U.S. adult population and adjusted for potential confounders. Most respondents (58-75%) reported not knowing whether SHV contained only water vapor, if SHV contained tar, and if it contained formaldehyde. African-American respondents (versus white) and current smokers (versus non-smokers) had lower levels of knowledge about chemicals in SHV. Adjusting for covariates, correct knowledge about chemicals in SHV was associated with higher perceived harms about SHV for one’s health and perceived comparative harm of SHV versus SHS. These findings suggest a need to provide accurate information about the presence of chemicals in SHV (e.g., using product ingredient labels or public education).

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## Keywords

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## 1. Introduction

Although e-cigarette marketing claims frequently highlight the absence of chemicals in e-cigarette secondhand vapor (SHV),(1,2) toxicology studies have demonstrated that nicotine, particulate matter, volatile organic compounds, and tobacco-specific chemicals are present in these emissions.(3–9) The public is increasingly relying on media sources for health risk information(10) including information about e-cigarettes. This information comes from a variety of sources including the internet, social media, news coverage, and public health campaigns.(11–18) Conflicting or contradictory information about harms of SHV from marketing and other sources could lead to public confusion, inaccurate knowledge about chemicals, and biased perceptions of risk associated with exposure to SHV.

This paper focuses on public risk perceptions and knowledge about chemicals in SHV for a few reasons. First, we focus on risk perceptions about harmful effects of exposure to SHV because perceived risk could influence e-cigarette use. We know from prior research on perceptions about risks of secondhand cigarette smoke exposure that those who perceived secondhand smoke risks as lower were more likely to intend to smoke and initiate smoking subsequently. (19–21) Second, inaccurate knowledge about the presence of chemicals in SHV may impact e-cigarette uptake in youth and young adult populations. For instance, inaccurate knowledge that SHV is free of any harmful chemicals may encourage uptake of e-cigarette use among youth who might otherwise abstain from tobacco use. Third, risk perceptions may influence attitudes toward regulating e-cigarette use in smoke-free places. Drawing from research on combusted cigarette secondhand smoke (SHS), perceiving SHS as harmful is associated with reduced cigarette smoking behavior, increased enforcement of household rules about smoking, and increased support for public smoke-free policies. (19,20,22–24) Similarly, a recent study found that lower perceptions about health harms of breathing SHV were associated with reduced support for banning e-cigarette use in smoke-free places.(25)

Research in public risk perception suggests that the public is particularly sensitive to risks associated with chemicals in the environment.(26) Compared to experts such as toxicologists, the lay public has greater confidence in animal studies and early research showing links between chemical exposure and carcinogenic effects.(27,28) In addition, people are prone to rely on their intuition(29) and on representativeness heuristics(30) (e.g., extrapolating what they know about the likelihood of harm from SHS exposure to estimate risks associated with SHV) to avoid toxic risks rather than factual evidence of the presence and degree of environmental risks. These trends have led to a growing challenge in educating the public about actual health risks of technological innovations as risks become less perceptible to the basic human senses.(29) Based on the psychometric paradigm described by Slovic and colleagues,(31) in the case of SHV, risk perceptions are likely to be higher among those who believe such emissions contain chemicals because e-cigarettes are

novel products, evolving rapidly in the marketplace, and may pose involuntary risks to bystanders that are unobservable (invisible) and relatively unknown to science.

While recent surveys have focused on beliefs about e-cigarettes helping smokers quit and health consequences of using e-cigarettes,(32–37) no study has yet assessed people's knowledge of chemicals in SHV specifically. In one related study, Sanders-Jackson and colleagues assessed knowledge about e-cigarette constituents based on a national survey among young adults (the survey items asked whether respondents knew if e-cigarettes contained nicotine and any of the toxic chemicals found in combustible cigarettes but did not specify which chemicals). The study found that 37% of respondents did not know whether e-cigarettes contained nicotine and 48% were not aware if e-cigarettes contained toxic chemicals found in combustible cigarettes.(38) However, the study did not measure people's knowledge about specific chemicals (e.g., formaldehyde) in e-cigarette SHV.

Data on public knowledge of chemicals in SHV and perceived harms would provide valuable information for newly announced e-cigarette regulations. In 2014, the U.S. Food and Drug Administration (FDA) issued a proposed deeming rule to extend its regulatory authority over e-cigarettes as tobacco products.(39) The deeming rule was finalized in May 2016.(40) Upon taking effect in August 2016, the deeming rule will enable FDA to require e-cigarette manufacturers to test and report the levels of harmful and potentially harmful constituents (HPHCs), similar to requirements for cigarette, smokeless tobacco, and roll-your-own tobacco manufacturers. FDA is also required by law to publicly display HPHC information of the amounts of each chemical in each brand and sub-brand of tobacco products. Therefore, research on public knowledge about constituents in SHV and perceived harms would be critical for regulatory agencies to identify potential knowledge gaps and inform the development of effective communication strategies to convey information of levels of e-cigarette HPHCs to the public.

The objectives of this study are to: 1) describe public knowledge about chemicals in SHV in a national sample of adults, 2) analyze the correlates of knowledge about chemicals in SHV, and 3) test the hypothesis that knowledge about chemicals in SHV is associated with higher perceived harm of exposure. Findings would help determine the need for disseminating accurate information (e.g., through public education or regulating product ingredient labeling) about the presence or absence of chemicals in SHV and the likelihood of associated health risks.

## 2. Methods

### 2.1. Study sample and data collection

We surveyed U.S. adults, aged 18 years and older, who were members of GfK's KnowledgePanel (previously Knowledge Networks). KnowledgePanel is a nationally representative online research panel randomly recruited by GfK using probability-based random-digit dial (RDD) and address-based sampling of U.S. households (see [www.knowledgenetworks.com/knpanel/](http://www.knowledgenetworks.com/knpanel/)). GfK provides recruited households the hardware and Internet service necessary for participating in online surveys for households that require them.

Data for this study were collected between October and December 2013 as a survey module measuring public attitudes and knowledge about SHV within the Annenberg National Health Communication Survey (ANHCS). The ANHCS was a rolling cross-sectional survey among adults aged 18 years and older and was conducted between 2005 and 2013. The e-cigarette survey module included multiple items measuring public knowledge, risk perceptions, and policy opinions associated with SHV. In the beginning of the survey module, respondents were shown a description of e-cigarettes that included other terms used at that time for vaping products: “New types of cigarettes are now available called electronic cigarettes (also known as e-cigarettes, e-cigs, or personal vaporizers). These products are battery-operated and deliver nicotine through a vapor that is inhaled by the user. Most e-cigarettes look like regular cigarettes, cigars, or pipes. Some resemble everyday items such as pens and USB memory sticks. They can be bought online or in convenience stores as reusable kits with refillable cartridges, or they can be bought as one-time, disposable products. Some electronic cigarette brands include Smoking Everywhere, NJOY, Gamucci, Blu, or Vuse.” Subsequent survey items referred to the term “electronic cigarettes” to keep the items brief.

For the three months (October-December 2013) when the e-cigarette survey module was fielded, the completion rates (proportion of completed surveys over invited panel members) were 56%, 51%, and 51%, respectively. A total of 1551 respondents participated during these three months. We excluded participants who were not aware of e-cigarettes (n=102). The final analyzed sample comprised 1449 respondents (aged 18-94 years).

Participants were informed that taking the survey was voluntary and were free to terminate the survey at any time. The survey did not collect any identifiable information. Informed consent was implied from completion of the survey. Written consent was not collected because this would have been the only identifiable information in the survey. The university's institutional review board approved the study and granted the ANHCS exempt status.

## 2.2. Measures

**2.2.1. Outcome variables – Perceived harms of breathing SHV and Comparative harms of SHV versus SHS**—We measured perceived harms of SHV using three survey items – two personal risk items about harms of breathing SHV and a comparative risk measure of breathing SHV versus SHS. Two measures were adapted from the CDC National Adult Tobacco Survey which asked about perceived harms of exposure to secondhand cigarette smoke.<sup>(41)</sup> The first item asked respondents, “Do you think that breathing vapor from other people's electronic cigarettes is...?” Responses ranged from ‘not at all harmful to my health’ to ‘very harmful to my health’ along a 7-point Likert-like scale. The second item asked respondents, “How concerned would you be about the impact on your health of breathing vapor from other people's electronic cigarettes if you were regularly exposed to secondhand vapor? Would you be...?” The responses to this item ranged from ‘not at all concerned’ to ‘very concerned’ along a 7-point Likert-like scale. Responses from these two items were averaged into a scale for perceived harms of breathing SHV ranging from 1 to 7. The third item measured perceptions of the comparative harms of breathing SHV and SHS (adapted from the National Cancer Institute (NCI) 2013 Health Information

National Trends Survey(42)). This item asked participants, “Compared to breathing smoke from other people's cigarettes, would you say that breathing vapor from other people's electronic cigarettes is...?” The response options were ‘much less harmful’ (1), ‘less harmful’ (2), ‘just as harmful’ (3), ‘more harmful’ (4), and ‘much more harmful’ (5).

**2.2.2. Predictor variable – Correct knowledge of chemicals in SHV—**We asked participants three questions about SHV constituents. The question “Please answer whether the following statements are true or false” was followed by three statements: 1) Vapors from other people's electronic cigarettes contain only water vapor, 2) Secondhand vapors from electronic cigarette users contain tar, which can cause lung cancer, and 3) Vapors from electronic cigarettes contain formaldehyde, which is an ingredient in embalming fluid. Response options were ‘True’, ‘False’, or ‘Don't know’. The correct response for the first two statements was ‘false’ and the correct response for the third item is ‘true’. These three items were recoded (1=incorrect, 2=don't know, 3= correct) and averaged into a scale representing correct knowledge of chemicals in SHV. We selected the first two belief items about water vapor and tar based on content analyses indicating that promotional media for e-cigarettes frequently suggest that SHV constitute only water vapor and did not contain harmful chemicals or tar.(1,2) The third belief item was based on toxicological reports about detectable levels of formaldehyde in SHV.(43–45) The phrasing of the items about tar and formaldehyde were adapted from a previous survey that asked respondents about the presence of harmful ingredients in cigarette smoke paired with a statement about potential health conditions or a statement that the chemical could be found in other products.(46) These belief items about chemicals in SHV appeared after the questions on perceived harms of SHV described above and other survey items on attitudes, perceived norms, and self-efficacy that are not part of this analysis.

**2.2.3. Covariates—**We included demographic variables (age, gender, race/ethnicity, household income, and education), self-reported health status (scale of 1-6 from very poor to excellent), smoking status (non-smoker, former smoker, or current smoker using standard measures of lifetime cigarette use and current use of cigarettes),(41) and e-cigarettes use status (never tried, tried but not in the past 30 days, or used e-cigarettes in the past 30 days) adapted from previous survey measures.(47,48) Furthermore, we adjusted for the frequency of respondents encountering others using e-cigarettes. The survey asked respondents, “In the past 30 days, how often did you see other people use electronic cigarettes...1) indoors at your workplace, 2) indoors in restaurants, 3) indoors in bars, casinos/clubs, and 4) at a park”. These responses ranged from never to five times or more along a four-point scale and were averaged into a scale for observing others vaping (Cronbach's alpha =0.82). These variables were included in the analyses because of prior theory (e.g., Knowledge Gap Hypothesis) and empirical research suggesting that tobacco-related knowledge and risk perceptions may differ based on demographic characteristics, tobacco use behaviors, and norms of tobacco use.(49–52)

### 2.3. Data Analysis

We first performed descriptive analyses of the measures. We then analyzed bivariate associations between knowledge and standardized scores of the perceived harms items using

Spearman's correlations. Next, we performed multiple linear regression analyses to assess the correlates of knowledge about chemicals in SHV using the demographic variables, self-reported health, smoking status, and vaping status. We conducted multiple linear regression analyses predicting the perceived harm measures with the knowledge about chemicals in SHV, adjusting for the above covariates. The amount of missing data across all variables was minimal (0.6 to 0.7%) and listwise deletion was utilized for handling missing values in these regression analyses. The Stata 13 SVY program was used to weight the analysis sample to the most recent data from the Current Population Survey (CPS).<sup>(53)</sup> We used the 'collin' program in Stata 13 to assess the regression models for multi-collinearity by examining the tolerance and variance inflation factor (VIF) values.

### 3. Results

#### 3.1. Sample characteristics

The mean age of the sample was 49.5 years, 51.3% were female, 76.6% were non-Hispanic white, 35.5% completed college education or higher, and 88% had never tried e-cigarettes before. Other characteristics of the sample and weighted distributions (matching the CPS data) are summarized in Table 1.

#### 3.2. Correct knowledge about chemicals in SHV

Most participants stated that they did not know whether SHV contained only water vapor (58%), or whether SHV contained tar (63%) or formaldehyde (75%).<sup>1</sup> The proportions of respondents who were correct for the statements on water vapor, tar, and formaldehyde were respectively 21%, 27%, and 10%. The remainder of respondents was incorrect about SHV containing only water vapor (20%), tar (10%), and formaldehyde (15%). The mean of correct knowledge about chemicals in SHV was 2 (on a scale of 1 to 3, SD=0.3).

#### 3.3. Perceived harms of exposure to SHV

Participants reported moderate perceived harms associated with exposure to SHV (Table 1). Mean (SD) of perceived harmfulness of breathing SHV was 3.8 (1.9) on a scale ranging from 1 to 7. Overall, respondents viewed inhaling SHV as less harmful than inhaling SHS; mean (SD) of the comparative harm measure was 2.0 (0.8) on a scale ranging from 1 to 5.

#### 3.4. Bivariate associations between knowledge of chemicals in SHV and perceived harms

Correct knowledge of chemicals was associated with increased perceived harm of breathing SHV (Spearman's  $\rho=0.27$ ,  $p<0.0001$ ) and with increased comparative harm of breathing SHV versus SHS (Spearman's  $\rho=0.20$ ,  $p<0.0001$ ).

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<sup>1</sup>A small minority of participants responded in a contradictory way that SHV contained only water vapor and that it contained tar and/or formaldehyde (n=40, 2.8% of the analyzed sample). In sensitivity analyses, we had excluded these respondents and this did not change the conclusions of the paper. We therefore presented the analyses including all respondents in the revision.



### 3.5. Multiple linear regression analysis predicting knowledge of chemicals in SHV with sample characteristics

Table 2 shows the weighted multiple regression analysis predicting each belief item with individual characteristics. African-American adults had lower correct knowledge of chemicals in SHV compared with White adults. Current smokers had lower correct knowledge of chemicals in SHV compared with non-smokers.

### 3.6. Multiple linear regression analyses predicting perceived harms with correct knowledge of chemicals in SHV and covariates

Table 3 shows the weighted multiple linear regression analyses predicting perceived harms measures with knowledge of chemicals in SHV and adjusted for covariates. Correct knowledge of chemicals in SHV was associated with both perceived harms outcomes. Older adults had higher perceived harms of breathing SHV. There were differences in perceived harms by race and ethnicity. African-Americans and those of other races reported higher comparative harms of breathing SHV versus SHS than Whites. For both outcomes, Hispanics reported higher perceived harms than Whites. Former and current smokers reported lower perceived harms of breathing SHV than non-smokers. Past and current users of e-cigarettes (in the past 30 days) had lower perceived harms of SHV compared with never users across both perceived harm outcomes. There was no evidence of extreme multicollinearity (i.e., VIF over 2.5 or tolerance below 0.4) in any of the models—all VIF values were below 1.65 and tolerance values were above 0.61.

## 4. Discussion

In this study, we examined the prevalence of correct knowledge about chemicals in SHV, correlates of knowledge, and associations between knowledge and perceived harms of exposure to SHV in a national survey of U.S. adults. We found that most respondents (58-75%) did not know whether SHV contains only water vapor, or if SHV contains tar or formaldehyde. Knowledge that chemicals are present was associated with race and ethnicity and current smoking status. Having used e-cigarettes was not associated with more accurate knowledge about chemicals in SHV compared with never users. One potential explanation is the poor quality of labeling of ingredients on e-cigarettes and other vaping products such that users do not necessarily have better information about what is present in SHV compared with never-users. (54) Another explanation is the scientific uncertainty surrounding these products that may have contributed to lack of knowledge among users and non-users equally. A third reason may be e-cigarette users are exposed to marketing messages that make claims about SHV containing only water vapor or having no harmful chemicals.(1,2) Based on the risk perception literature and the psychometric paradigm, we anticipated that the perceived risk of health harms associated with exposure to SHV would be higher among those who thought SHV contain chemicals compared to those who thought otherwise. Our study findings supported this hypothesis. We found that knowledge of presence of chemicals in SHV was associated with higher perceived harms of breathing SHV and higher comparative harm of SHV versus SHS (Table 3).

It is concerning that a sizable minority of participants inaccurately responded that SHV contains only water vapor (21%), contains tar (10%), or does not contain formaldehyde (15%). Inaccurate knowledge about chemicals in SHV is important because this may impact e-cigarette uptake in youth and adult populations.(19–21) As mentioned earlier, assuming that SHV contains only water vapor could make e-cigarettes more appealing to youth and young adults and lead to increased adoption of e-cigarettes among those who might not have initiated any tobacco use in the first place. More research is needed to examine knowledge about chemicals, risk perceptions, and attitudes toward e-cigarette use among youth and young adults. Targeted messaging for correcting misperceptions about chemicals in SHV may be necessary for these different groups.

The finding that most respondents did not know about the presence or absence of chemicals in SHV deserves further exploration. This may be simply because of the relative novelty of e-cigarettes in the marketplace. In addition, most people had no prior experience using these devices, had never seen someone use e-cigarettes, and may have only modest exposure to information about e-cigarettes to have accurate knowledge about chemicals in SHV.(16) Alternately, people may be unsure about the presence of chemicals because of ongoing scientific uncertainty and controversy based on differing reports about chemicals being present or absent in SHV from tests of various e-cigarette devices.(7,43,55) Scholars in risk communication have argued that “controversies over chemical risks may be fueled as much by limitations of the science of risk assessment and disagreements among experts as by public misconceptions”.(28) This scientific uncertainty stems in part from the lack of policies regulating the levels of chemicals in SHV. Product manufacturing standards and regulations are needed to ensure that e-cigarette use does not lead to chemical emissions that adversely impact indoor air quality and public health. We acknowledge that we were not able to probe whether misperceptions about the presence of chemicals in SHV were the product of having ambiguous risk information or having no information at all. Future research should include more detailed response options to assess lack of knowledge versus uncertainty.

Our survey questions asked about knowledge of the presence or absence of chemicals in SHV and not about whether detected amounts are likely to cause harm. This decision is supported by prior research in the U.S. and Canada demonstrating that the public is “much less sensitive than experts to considerations of dose and exposure”.(27,28) The public has a tendency to view the mere presence of chemicals as either safe or dangerous, and “appear to equate even small exposures to toxic or carcinogenic chemicals with almost certain harm.” (28) An implication for public communication and education efforts is that simply mentioning the presence of chemicals and ignoring information about actual toxicity in news coverage or public health campaigns may have an inadvertent consequence of amplifying public risk perceptions beyond actual risk.(56,57) Risk communicators should be mindful of this lack of dose-response sensitivity and consider the ethical implications of conveying information about the presence and levels of chemicals in SHV to the lay public.

Under the new FDA deeming regulation, the testing and reporting of amounts of harmful and potentially harmful constituents will now be required for e-cigarette manufacturers. Regulating product manufacturing standards and requiring labeling of chemicals on e-



cigarette packaging may be potential approaches to better inform consumers of the chemicals in SHV from individual products. For instance, Borland and Hill found that content labeling on tobacco product packaging increased smokers' knowledge about main constituents of cigarette smoke.(58) However, reporting actual levels of harmful constituents in SHV may have unintended consequences on public health due to consumers' tendency to misunderstand this type of information. In 1966, the Federal Trade Commission encouraged cigarette manufacturers to machine-measure tar and nicotine levels and share this information publicly. Peters and colleagues speculate that the risk assessment itself and its public reporting imbues the resulting values and quantitative information with meaning. People perceive the levels to be useful by the simple fact that their detection and disclosure were required.(59) A recent study in the case of cigarette packaging also found that exposure to packaging with quantitative emission information led to inaccurate beliefs regarding tar delivery and health risks.(60) Because emission values often do not represent the actual amount of human exposure or necessarily correlate with harm, reporting actual levels of harmful constituents may inadvertently confuse consumers.

Another challenge to content labeling may arise because scientists interpret findings about the presence and absence of chemicals in SHV differently. These conflicting interpretations are likely to persist and potentially translate into seemingly contradictory findings when reported in the news media.(61–63) The conflicting reports from scientists about constituents and adverse effects of exposure to SHV could lead to public confusion and backlash such that people may become less supportive of regulations requiring manufacturing standards and labeling of products, similar to what has been observed in the context of conflicting information about nutrition and health effects.(64) In line with this hypothesis, Tan and colleagues reported analyses from a national survey of US adults showing that increased self-reported exposure to media information, including contradictory information about e-cigarettes, was associated with lower support for policies requiring labeling of e-cigarette contents on packaging.(65) At the very least, marketing materials claiming that SHV contain only water vapor should be banned.

#### 4.1. Strengths and Limitations

To our knowledge, this is the first study to have collected data about knowledge of chemicals in SHV and analyzed the associations between knowledge and perceived harms about breathing SHV. This study was strengthened by the diverse probability-based sample of U.S. adults. Analyses adjusted for covariates and weighted the analyses to extrapolate to the general U.S. adult population. However, the survey only asked about two specific chemicals (tar and formaldehyde) and was constrained by survey length from asking about knowledge about the presence of other chemicals. Future research should consider examining public knowledge about other chemicals found in SHV in more recent laboratory studies (e.g., particulate matter and heavy metals).50,51 The statements about tar and formaldehyde included two separate clauses (i.e., the chemical is present in SHV and the chemical causes a health condition or is found in another product). Future work should perform cognitive testing to assess if participants understood these items as intended. Our study was also limited by the cross-sectional nature of the analysis, which is prone to validity threats including reverse causation and unmeasured confounders. Longitudinal surveys and other

research approaches would be necessary to strengthen the causal inferences of the associations between knowledge and perceived harms of SHV.

## 5. Conclusion

In sum, this survey among a national sample of U.S. adults found that most people were not aware about chemicals in SHV and that knowledge about the presence of chemicals was associated with perceived harms of breathing e-cigarette SHV. With the implementation of the deeming rule to extend FDA's authority over e-cigarettes in August 2016, this data provides useful baseline information about public awareness to inform FDA's strategies to provide accurate information about the presence of HPHCs in e-cigarettes.

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**Table I**  
**Study sample characteristics (N=1449)**

	Unweighted		Weighted to Current Population Survey	
	Mean (SD)	%	Mean (SE)	%
Age (years)	49.5 (16.9)		46.6 (0.6)	
Sex				
Male		48.7		49.5
Female		51.3		50.4
Race/Ethnicity				
White		76.6		69.4
African-American		7.5		10.6
Hispanic		10.0		13.9
Other		5.9		6.0
Education				
Completed high school or below		33.7		40.4
Some college		31.9		29.6
College graduate or higher		35.5		30.0
Annual household income				
<\$25,000		15.7		16.4
\$25,000-49,999		23.7		22.9
\$50,000		60.7		60.7
Health Status (scale of 1-6 from very poor to excellent) <sup>a</sup>	4.3 (0.9)		4.3 (0.0)	
Smoking Status				
Non-smoker		55.8		55.9
Former		29.1		27.1
Current		15.1		17.0
E-cigarette use				
Never tried e-cigarettes		87.9		86.4
Tried e-cigarettes but not in the last 30 days		8.1		9.2
Used e-cigarettes in the last 30 days		3.9		4.4
Observed others vaping (scale of 1 to 4 from never to five times of more in the past 30 days)	1.2 (0.4)		1.3 (0.0)	
Perceived harm of breathing vapor to health (two-item scale of 1 to 7 from not at all harmful to very harmful)	3.8 (1.9)		3.8 (0.1)	
Breathing vapor is more harmful compared to breathing smoke <sup>a</sup> (scale of 1 to 5 from much less to much more harmful)	2.0 (0.8)		2.0 (0.0)	
Correct knowledge (3-item scale of 1 to 3 from incorrect to correct) <sup>b</sup>	2.0 (0.3)		2.0 (0.0)	

Notes.

<sup>a</sup> 6 cases missing.

<sup>b</sup> 2 cases missing.



**Table II**  
**Weighted multiple linear regression analysis predicting correct knowledge of chemicals in e-cigarette secondhand vapor (N=1449)**

	Correct knowledge of chemicals in SHV		
	<b>b</b>	<b>CI</b>	<b>p</b>
Age (years)	0.001	[-0.000,0.002]	0.233
Sex – Female (male is referent)	-0.018	[-0.049,0.014]	0.269
Race/Ethnicity (White is referent)			
African-American	-0.059	[-0.114,-0.005]	0.034
Hispanic	-0.041	[-0.091,0.009]	0.108
Other	0.018	[-0.066,0.103]	0.668
Education (High school or below is referent)			
Some college	0.035	[-0.007,0.077]	0.102
College graduate or higher	0.035	[-0.008,0.078]	0.112
Annual household income (<\$25,000 is referent)			
\$25,000-49,999	0.003	[-0.051,0.056]	0.921
\$50,000	0.012	[-0.039,0.063]	0.636
Health Status	0.002	[-0.014,0.019]	0.797
Smoking Status (Non-smoker is referent)			
Former	-0.028	[-0.064,0.009]	0.137
Current	-0.061	[-0.118,-0.004]	0.036
E-cigarette use (Never used is referent)			
Ever used but not in the past 30 days	-0.046	[-0.111,0.019]	0.167
Used in the past 30 days	-0.017	[-0.134,0.100]	0.773
Observed others vaping	0.004	[-0.037,0.046]	0.843
Constant	2.001		
R-squared	0.034		

Notes. Correct knowledge of chemicals in SHV is the mean of responses to three statements about SHV (1=incorrect, 2=don't know, 3= correct). The correct response for the statements that SHV contain only water vapor and SHV contain tar which can cause lung cancer is “false”. The correct response for the statement that SHV contain formaldehyde which is an ingredient in embalming fluid is “true”. The analysis was weighted to match the sample to the US adult population.

**Table III**  
**Weighted multiple regression analysis predicting perceived harm measures with correct knowledge of chemicals in e-cigarette secondhand vapor (N=1449)**

	Perceived harm of breathing vapor to health			Breathing vapor is more harmful compared to breathing smoke		
	<b>b</b>	<b>CI</b>	<b>p</b>	<b>b</b>	<b>CI</b>	<b>p</b>
Correct knowledge of chemicals in SHV	0.791	[0.545,1.037]	<0.001	0.639	[0.376,0.903]	<0.001
Age (years)	0.005	[0.001,0.009]	0.021	0.001	[-0.003,0.006]	0.529
Sex – Female (male is referent)	0.099	[-0.019,0.218]	0.101	0.003	[-0.128,0.135]	0.960
Race/Ethnicity (White is referent)						
African-American	0.196	[-0.026,0.419]	0.084	0.317	[0.084,0.549]	0.008
Hispanic	0.212	[0.019,0.406]	0.032	0.258	[0.019,0.497]	0.034
Other	0.117	[-0.140,0.374]	0.373	0.406	[0.076,0.737]	0.016
Education (High school or below is referent)						
Some college	-0.087	[-0.234,0.060]	0.245	-0.118	[-0.278,0.043]	0.151
College graduate or higher	0.059	[-0.092,0.210]	0.446	-0.017	[-0.174,0.140]	0.835
Annual household income (<\$25,000 is referent)						
\$25,000-49,999	0.044	[-0.162,0.250]	0.675	-0.048	[-0.269,0.172]	0.667
\$50,000	0.103	[-0.085,0.291]	0.283	-0.056	[-0.267,0.154]	0.600
Health Status	0.018	[-0.050,0.087]	0.596	-0.022	[-0.098,0.055]	0.579
Smoking Status (Non-smoker is referent)						
Former	-0.214	[-0.358,-0.070]	0.004	-0.128	[-0.273,0.017]	0.084
Current	-0.502	[-0.702,-0.303]	<0.001	-0.144	[-0.378,0.090]	0.226
E-cigarette use (Never used is referent)						
Ever used but not in the past 30 days	-0.394	[-0.623,-0.164]	0.001	-0.376	[-0.651,-0.100]	0.008
Used in the past 30 days	-0.566	[-0.842,-0.290]	<0.001	-0.698	[-1.073,-0.323]	<0.001
Observed others vaping	-0.06	[-0.202,0.082]	0.409	-0.091	[-0.267,0.085]	0.311
Constant	-1.818			-1.035		
R-squared	0.174			0.098		

Note. The analysis was weighted to match the sample to the US adult population.