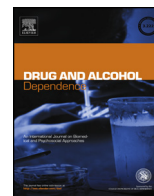




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Comparison of beliefs about e-cigarettes' harms and benefits among never users and ever users of e-cigarettes


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ABSTRACT

Introduction: E-cigarette use is rapidly increasing, especially among youth and young adults. We need to learn what factors are associated with uptake in e-cigarettes. One important set of predictors is beliefs about e-cigarettes' potential harms and benefits.

Methods: Online survey data were collected in July, 2014 from 527 U.S. adults from a nationally representative online panel (KnowledgePanel) who reported being aware of e-cigarettes. Participants were asked to rate 7 statements related to e-cigarettes harms or benefits (e.g., breathing vapors from other people's e-cigarettes is harmful to my health; vaping or using e-cigarettes can help people quit smoking regular cigarettes completely). Responses were categorized into agree, disagree, or no opinion. We compared the proportions of agreement between respondents who ever used e-cigarettes and those who had never used. Multinomial logistic regression was used to predict agree or no opinion versus disagree (base outcome) for each belief. Relative risk ratios (RRRs) are reported. The analyses were completed in December, 2014 and were weighted to match the general U.S. adult population.

Results: Agreement across the 7 beliefs ranged from 33% (vaping can help people quit smoking) to 56% (e-cigarettes make smoking look more acceptable to youth). Ever use of e-cigarettes was associated with lower relative risk of agreeing with statements about potential harms and higher relative risk of agreeing with statements about benefits (versus disagreeing) compared with never users.

Discussion: These findings provide timely data on beliefs about e-cigarettes between e-cigarette users and non-users to inform potential message topics for health campaign interventions.

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1. Introduction

E-cigarette use is rapidly increasing in the U.S. population, especially among youth and young adults (Amrock et al., 2014; Bunnell et al., 2015; Carroll Chapman and Wu, 2014; Krishnan-Sarin et al., 2014; Pearson et al., 2012; Regan et al., 2013). The long-term impacts of e-cigarette use on health outcomes at the individual and population levels are still unknown. Current evidence suggests that e-cigarette emissions generally contain lower levels of tobacco-specific pollutants compared with cigarette smoke (Goniewicz et al., 2013; Grana et al., 2014). However, certain toxicants known to have harmful health effects are found at elevated levels in e-cigarette emissions compared with cigarette smoke.

These include hemiacetals (formaldehyde-releasing agents), metal, and silicate particles (Jensen et al., 2015; Williams et al., 2013). There is also concern in the public health community that as e-cigarettes gain popularity among youth, this could lead to increased nicotine dependence and other tobacco use (Fairchild et al., 2014; Leventhal et al., 2015; Office of Senator Richard J. Durbin, 2014; Paek et al., 2014; Primack et al., 2015).

We need to learn what the key factors that influence the increasing uptake of e-cigarettes are. Based on health behavioral theories and empirical research regarding factors influencing smoking regular tobacco cigarettes, beliefs about the harms (e.g., health consequences) and benefits (e.g., social benefits) of smoking stand out as important predictors of smoking or cessation behavior and intention (Brennan et al., 2014; Klesges et al., 1988). Extending from this earlier research, we expect that beliefs about the potential advantages and risks associated with e-cigarette use would also be important factors that influence e-cigarette use behavior.

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Prior surveys have assessed e-cigarette-related beliefs among a variety of study populations in the U.S. and other countries (Adkison et al., 2013). A systematic review categorized beliefs about e-cigarettes and reasons for using e-cigarettes into 11 major themes including beliefs about cost of e-cigarettes, e-cigarettes as a gateway tobacco product, health and safety concerns of e-cigarette use, and e-cigarettes helping people to quit smoking (Pepper and Brewer, 2013). For instance, several population-based surveys in the U.S. have asked participants about their beliefs regarding the relative harms of using e-cigarettes versus smoking regular tobacco cigarettes (Ambrose et al., 2014; Pearson et al., 2012; Pokhrel et al., 2015a; Richardson et al., 2014; Tan and Bigman, 2014), risks of developing health problems from using e-cigarettes (Pepper et al., 2014b), harms of inhaling secondhand e-cigarette emissions (Tan et al., 2015a), whether e-cigarettes help smokers quit (Choi and Forster, 2014), and whether e-cigarettes are less addictive than regular cigarettes (Choi and Forster, 2014). In a longitudinal study among a cohort of Minnesotan young adults, Choi and Forster reported that participants who believed that e-cigarettes can help people to quit smoking and that e-cigarettes are less harmful than cigarettes at baseline were more likely to report experimenting with e-cigarettes at one year's follow-up (Choi and Forster, 2014). These previous studies underscore the importance of eliciting public beliefs about e-cigarettes.

However, many of these prior studies measured a narrow set of e-cigarette-related beliefs. This limitation precludes a comparison of whether certain beliefs about e-cigarettes are more strongly held by the population than others. Another limitation is some of these earlier studies either involved samples that were limited to smokers/former smokers or participants from specific geographic areas instead of a national sample. In addition, due to the rapidly evolving information and regulatory environment surrounding e-cigarettes over the past few years, we need more recent data about public beliefs about e-cigarettes to guide timely interventions and policies.

The purpose of this study is to assess public beliefs about e-cigarettes across a set of seven beliefs about e-cigarettes beyond a narrow set of beliefs that have been reported in earlier surveys (e.g., perceived relative harms versus smoking) in a national sample of US adults. We further compared beliefs about harms and benefits of e-cigarettes between those who had ever used e-cigarettes and non-users. Findings will provide important and timely information about public beliefs about e-cigarettes, identify beliefs that are associated with e-cigarette use, and help to prioritize topics that could be message targets in future public campaign interventions, given that beliefs are key predictors of smoking behavior (Brennan et al., 2014; Klesges et al., 1988).

2. Methods

2.1. Study sample and data collection

The study sample comprised participants who were invited through KnowledgePanel (maintained by GfK), a nationally representative online research panel randomly recruited by probability-based sampling of households using random-digit dial (RDD) and address-based sampling methods (see www.knowledgenetworks.com/knpanel/). In previous validation research, online surveys of probability samples yielded more accurate population estimates than online surveys involving non-probability samples (Chang and Krosnick, 2009; Yeager et al., 2011). Participating households are supplied with hardware and internet service if needed. Participation in the survey was voluntary and consent was implied from completion of the survey. No personally identifiable data was

collected. The institutional review board of the University of Illinois at Urbana-Champaign approved this study.

The data for this analysis were obtained from a longitudinal study that focused on health information exposure among U.S. adults aged 18 years and older. There were three rounds of online surveys among a cohort of adults. In the first two rounds of the survey conducted in January and April, 2014, items related to beliefs about e-cigarette harms and benefits were not included. We added these items in the third round of the study conducted in July 2014. In the first round of the survey (January 2014), 58% ($n = 795$) of invited participants completed the survey. Of these participants, 784 were re-invited for the second survey (April 2014) and 626 completed this survey (completion rate of 80%). For the third round, 748 participants from the first round were re-invited in June, 2014 and 571 completed this third round (completion rate = 76%). Overall, 72% of the first round participants completed the third round. Older adults and those who had higher education were more likely to have completed the third round survey. For the present analysis, participants were excluded if they indicated that they had never heard about e-cigarettes ($n = 44$), resulting in a final analyzed sample of 527 respondents (aged 18–87 years). Those with higher education and former smokers (versus non-smokers) were more likely to have heard about e-cigarettes. These variables were included as covariates in the analyses described below.

2.2. Measures

2.2.1. Outcome variables. Participants were asked if they agreed or disagreed with seven belief items policies with the following question: "How much do you agree or disagree with the following statements?" The seven statements were: (1) breathing vapors from other people's e-cigarettes is harmful to my health, (2) if I vape or use e-cigarettes every day, I will become addicted, (3) e-cigarettes tempt non-smoking youth to start smoking regular cigarettes, (4) e-cigarettes make smoking look more acceptable to youth, (5) if I vape, or use e-cigarettes, it will be less harmful to me than if I smoke regular cigarettes, (6) vaping or using e-cigarettes can help people quit smoking regular cigarettes completely, (7) breathing vapors from other people's e-cigarettes is less harmful to my health than breathing smoke from other people's regular cigarettes. The decision to focus on these seven beliefs was based on prior qualitative research and surveys on salient beliefs associated with e-cigarettes (Choi et al., 2012; Choi and Forster, 2014; Pearson et al., 2012; Pepper and Brewer, 2013; Pokhrel et al., 2015b; Tan et al., 2015a). The first four items about potential harms of e-cigarettes appeared as a block (in random order) followed by the remaining three items about potential benefits as a block on a separate screen (also in random order). Responses options were 'strongly agree', 'agree', 'disagree', 'strongly disagree', or 'no opinion'. We recognized that for some people, e-cigarette use may not be a salient health issue. They may not have formed an opinion one way or the other about harms and benefits. We therefore included the "no opinion" response in order not to have forced choice responses between agree and disagree. These responses were re-categorized into 'agree', 'disagree', or 'no opinion'. Approximately 20–26 cases (3.8–4.9%) were missing on one or more of these items.

2.2.2. Ever used e-cigarettes. Participants were asked about their e-cigarette use with a single item: "Have you ever tried or used electronic cigarettes (e-cigarettes), even just one time?" Responses included: "I have never heard about e-cigarettes/I have never tried them/I have tried them, but not in the past 30 days/I used them at least once in the past 30 days". We excluded 44 respondents who had never heard about e-cigarettes from the analyses. We categorized participants as never users (84.4%) and ever users (comprising

Table 1
Summary of analyzed sample characteristics $n = 527$ (unweighted and weighted).

	Unweighted		Weighted to Current Population Survey	
	Mean (SD)	%	Mean (SE)	%
Age (years)	51.8 (16.4)		47.3 (0.97)	
Sex				
Male		49.9		48.1
Female		50.1		51.9
Race/ethnicity				
White		75.0		68.3
African-American		9.3		11.0
Hispanic		8.9		14.6
Other		6.8		6.1
Education				
Completed high school or below		40.8		39.1
Some college		27.7		30.5
Bachelor's degree or higher		31.5		30.4
Annual household income				
<\$30,000		20.5		21.5
\$30,000–49,999		17.8		18.3
\$50,000–74,999		19.9		19.0
\$75,000–124,999		26.9		26.3
≥125,000		14.8		14.9
Smoking status ^a				
Non-smoker		58.3		62.0
Former		29.0		25.0
Current		12.7		13.0
Ever tried e-cigarettes at least once ^b				
No		84.4		85.7
Yes		12.9		14.3
Health status ^c (scale of 1–5 from poor to excellent)	3.5 (1.0)		3.5 (0.1)	

^a 16 cases missing smoking status.

^b 14 cases missing on ever tried e-cigarettes.

^c 11 cases missing on health status.

those who tried but not in the past 30 days (8.5%) and those who used them in the past 30 days (4.4%). There were 14 respondents who did not complete this item and they were coded as missing.

2.2.3. Demographic variables and tobacco use. Additional correlates included age, gender, race/ethnicity, household income, education, health status, and smoking status (non-smoker, current smoker, or former smoker).

2.3. Data analysis

Data analysis was conducted in December, 2014. We examined descriptive statistics of the belief measures. We compared beliefs between e-cigarette never users and ever users and analyzed beliefs among e-cigarette ever users stratified by their smoking status. We utilized multinomial logistic regression to predict beliefs (base outcome was 'disagree' and the relative risk ratios (RRRs) are reported). The amount of missing data across all variables was minimal (10.1%) and listwise deletion was utilized for handling missing values in these regression analyses. All regression models adjusted for covariates listed above and the Stata 13 SVY program was used to weight the analysis sample to the most recent data from the Current Population Survey (CPS; US Census Bureau, 2012).

3. Results

3.1. Sample characteristics

The mean age of the sample was 51.8 years (SD = 16.4), 50% were female, 75% were non-Hispanic white, 31.5% completed college education or higher, 13% were current cigarette smokers, and 13% have ever tried using e-cigarettes. Of those who have ever tried e-cigarettes, 53% were current smokers, 24% were non-smokers, and 24% were former smokers. Other characteristics of the sample and

weighted distributions (matching the CPS data) are summarized in [Table 1](#).

3.2. Distribution of participants' beliefs about e-cigarettes

The two statements that most participants agreed with were harms related to e-cigarettes making smoking look acceptable to youth (56%) and tempting youth to start smoking (51%) while the two statements that garnered least agreement were benefits related to e-cigarettes helping people quit smoking (32.8%) and being less harmful than smoking (33.8%; [Fig. 1](#)).

3.3. Comparing beliefs about e-cigarettes between never users and ever users of e-cigarettes

[Table 2](#) summarizes the cross-tabulation of agreeing, disagreeing, or having no opinion about each belief between never users and ever users of e-cigarettes. All the bivariate chi-square tests were statistically significant.

Consistently, fewer ever users agreed with the four statements about potential harms of e-cigarettes compared with never users. Between 26% and 39% of ever users agreed with the statements that breathing vapors is harmful, e-cigarette use is addictive, e-cigarettes tempt youth to start smoking, and e-cigarettes make smoking look more acceptable to youth compared with never users (between 43% and 62% agreed with these statements).

In contrast, a higher proportion of ever users agreed with the three statements about potential benefits than never users. Over half of ever users (52–58%) agreed with the statements that using e-cigarettes is less harmful than smoking, using e-cigarettes help people quit smoking, and breathing vapors from e-cigarettes is less harmful than breathing cigarette smoke, compared with about one-third of never users (32–39%) who agreed with these statements.

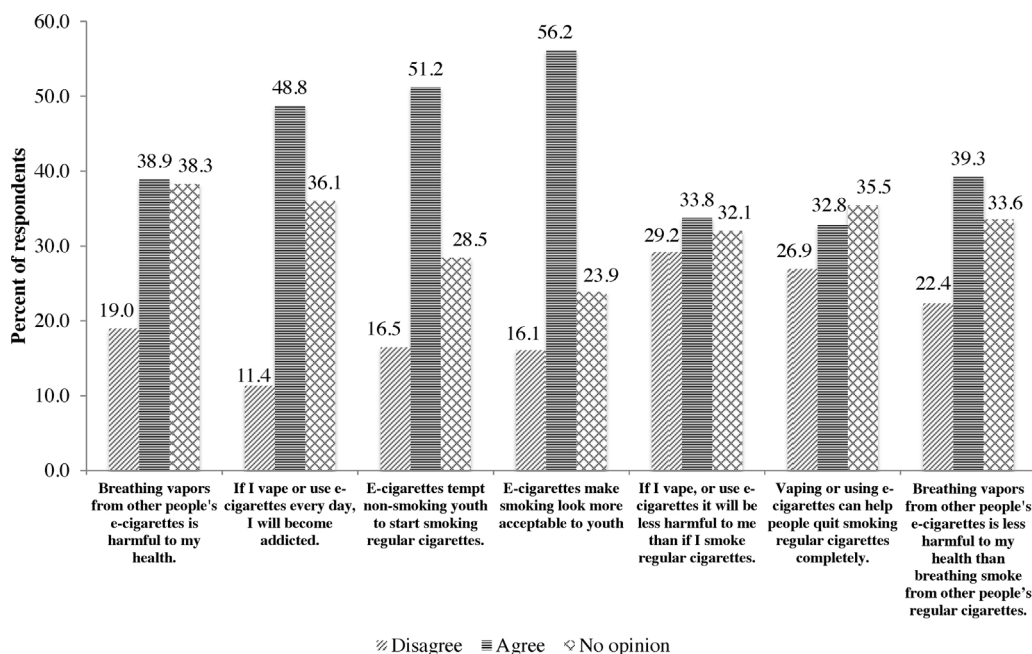


Fig. 1. Distribution of support for individual beliefs across analyzed sample. Notes: Between 20 and 26 cases (3.8–4.9%) had missing values across these seven belief items.

3.4. Comparing beliefs about e-cigarettes among ever users of e-cigarettes, stratified by smoking status

We further stratified ever users of e-cigarettes by their smoking status (non-smoker, former smoker, or current smoker) and analyzed their agreeing, disagreeing, or having no opinion about each belief (Table 3). Due to the small cell sizes, we utilized the

Fisher's exact test for this analysis. We found that beliefs among e-cigarette users about two benefits of e-cigarettes differed significantly by smoking status. More current and former smokers tended to endorse the statement that using e-cigarettes is less harmful than smoking and breathing vapors from e-cigarettes is less harmful than cigarette smoke compared with non-smokers (Fisher's exact tests $p < 0.05$).

Table 2 Agreement with beliefs among never and ever users of e-cigarettes.

Beliefs	Never used e-cigarettes		Ever used e-cigarettes		χ^2 p-value
	N	%	N	%	
Breathing vapors from other people's e-cigarettes is harmful to my health					<0.0001
Disagree	68	15.6	30	46.2	
Agree	187	42.8	17	26.2	
	182	41.6	18	27.7	
If I vape or use e-cigarettes every day, I will become addicted					<0.0001
Disagree	36	8.3	22	33.3	
Agree	229	52.5	27	40.9	
	171	39.2	17	25.8	
E-cigarettes tempt non-smoking youth to start smoking regular cigarettes					0.001
Disagree	63	14.4	22	33.8	
Agree	241	55.1	28	43.1	
	133	30.4	15	23.1	
E-cigarettes make smoking look more acceptable to youth					<0.0001
Disagree	59	13.5	25	38.5	
Agree	269	61.6	25	38.5	
	109	24.9	15	23.1	
If I vape, or use e-cigarettes it will be less harmful to me than if I smoke regular cigarettes					0.001
Disagree	139	32.2	13	20.0	
Agree	140	32.4	37	56.9	
	153	35.4	15	23.1	
Vaping or using e-cigarettes can help people quit smoking regular cigarettes completely					0.005
Disagree	126	29.1	15	23.1	
Agree	138	31.9	34	52.3	
	169	39.0	16	24.6	
Breathing vapors from other people's e-cigarettes is less harmful to my health than breathing smoke from other people's regular cigarettes					0.013
Disagree	103	23.8	13	19.7	
Agree	168	38.9	38	57.6	
	161	37.3	15	22.7	

Notes: Between 20 and 26 cases (3.8–4.9%) were missing values across these seven belief items. Proportions may not add up to 100% due to rounding.

Table 3
Agreement with beliefs among ever users of e-cigarettes by smoking status.

Beliefs	Non-smokers		Former smokers		Current smokers		Fisher's exact test p-value
	N	%	N	%	N	%	
Breathing vapors from other people's e-cigarettes is harmful to my health							0.477
Disagree	4	28.6	6	40.0	20	55.6	
Agree	5	35.7	4	26.7	8	22.2	
No opinion	5	35.7	5	33.3	8	22.2	
If I vape or use e-cigarettes every day, I will become addicted							0.860
Disagree	6	40.0	6	40.0	10	27.8	
Agree	5	33.3	6	40.0	16	44.4	
No opinion	4	26.7	3	20.0	10	27.8	
E-cigarettes tempt non-smoking youth to start smoking regular cigarettes							0.762
Disagree	3	21.4	6	40.0	13	36.1	
Agree	7	50.0	5	33.3	16	44.4	
No opinion	4	28.6	4	26.7	7	19.4	
E-cigarettes make smoking look more acceptable to youth							0.957
Disagree	5	35.7	5	33.3	15	41.7	
Agree	5	35.7	7	46.7	13	36.1	
No opinion	4	28.6	3	20.0	8	22.2	
If I vape, or use e-cigarettes it will be less harmful to me than if I smoke regular cigarettes							0.011
Disagree	5	35.7	4	25.0	4	11.4	
Agree	3	21.4	8	50.0	26	74.3	
No opinion	6	42.9	4	25.0	5	14.3	
Vaping or using e-cigarettes can help people quit smoking regular cigarettes completely							0.201
Disagree	4	28.6	5	31.2	6	17.1	
Agree	4	28.6	8	50.0	22	62.9	
No opinion	6	42.9	3	18.8	7	20.0	
Breathing vapors from other people's e-cigarettes is less harmful to my health than breathing smoke from other people's regular cigarettes							0.020
Disagree	5	33.3	3	18.8	5	14.3	
Agree	4	26.7	8	50.0	26	74.3	
No opinion	6	40.0	5	31.2	4	11.4	

Notes: Between 2 and 3 cases (2.9–4.4%) were missing values across these seven belief items. Proportions may not add up to 100% due to rounding.

3.5. Predicting agreement with beliefs with ever use of e-cigarettes (multinomial logistic regression)

After adjusting for potential confounders, ever users were less likely to endorse all four beliefs about harms compared with never users of e-cigarettes (RRRs range from 0.2 to 0.3, all $ps < 0.05$; Table 4). For two beliefs about benefits (vaping is less harmful than smoking and vaping can help people quit smoking completely), ever users were more likely to agree (RRR = 2.6 and 4.9 respectively, $ps < 0.05$) with each statement compared with never users. Ever users were less likely to have no opinion about the four beliefs on e-cigarette harms than never users (RRRs range from 0.2 to 0.3, $ps < 0.05$). Other significant correlates for various belief items were age, race, education, and health status. Smoking status was not a significant predictor of beliefs about harms and benefits with one exception—former smokers were less likely to report having no opinion that e-cigarettes tempting youth to smoke versus disagreeing with this statement (RRR = 0.4, $p < 0.05$).

4. Discussion

In this national sample of U.S. adults, we found that participants had varying levels of agreement with e-cigarette-related beliefs about harms and benefits. Overall, participants tended to have lower levels of agreement with belief items pertaining to e-cigarette potential benefits (e.g., vaping can help people

quit smoking) and higher levels of agreement with e-cigarette potential harms (e.g., e-cigarettes make smoking look more acceptable to youth). We further found that ever use of e-cigarettes was associated with lower relative risk of agreeing with statements about potential harms and higher relative risk of agreeing with statements about benefits (versus disagreeing) compared with never users.

The findings indicate that participants were particularly concerned about the potential harmful influences of e-cigarettes on youth. More participants agreed with the two statements that e-cigarettes could make smoking look acceptable to youth and tempt youth to start smoking than any of the other statements. This finding is unlikely to be due to older adults in the sample responding that e-cigarettes would influence youth adversely because age was not associated with agreeing with these belief items (versus disagreeing). Rather, the potential risks of e-cigarettes for youth to initiate smoking may stem from broader concerns in the public information environment. For instance, these concerns about e-cigarettes potentially renormalizing smoking among youth are echoed by some in the public health community (Fairchild et al., 2014). Another explanation could be e-cigarette manufacturers have designed products to attract youth and utilized marketing strategies that target youth. Recent evidence highlighted the presence of over 7700 different flavors of e-cigarettes and there are concerns that flavors are particularly appealing to non-smoking youth and young adults (Carpenter et al., 2005; Shiffman

Table 4
Associations between e-cigarette use and agreement with individual beliefs (adjusted RRRs, base outcome is disagree).

	Breathing vapors from other people's e-cigarettes is harmful to my health	If I vape or use e-cigarettes every day, I will become addicted	E-cigarettes tempt non-smoking youth to start smoking regular cigarettes	E-cigarettes make smoking look more acceptable to youth	If I vape, or use e-cigarettes it will be less harmful to me than if I smoke regular cigarettes	Vaping or using e-cigarettes can help people quit smoking regular cigarettes completely	Breathing vapors from other people's e-cigarettes is less harmful to my health than breathing smoke from other people's regular cigarettes
	RRR (CI)	RRR (CI)	RRR (CI)	RRR (CI)	RRR (CI)	RRR (CI)	RRR (CI)
Agree versus disagree							
Never used e-cigarettes (referent)	1	1	1	1	1	1	1
Ever used e-cigarettes	0.313* [0.119, 0.824]	0.220** [0.079, 0.618]	0.356* [0.130, 0.976]	0.319* [0.124, 0.821]	2.595* [1.027, 6.553]	4.858** [1.817, 12.993]	2.354 [0.910, 6.088]
Age (years)	1.005 [0.986, 1.025]	1.007 [0.979, 1.036]	1.018 [0.995, 1.040]	1.01 [0.990, 1.031]	1.006 [0.988, 1.025]	1.020 [1.000, 1.041]	1.000 [0.981, 1.020]
Sex (referent is male)	1	1	1	1	1	1	1
Female	1.309 [0.699, 2.450]	1.372 [0.662, 2.843]	1.293 [0.704, 2.375]	1.341 [0.723, 2.489]	0.868 [0.492, 1.533]	0.817 [0.462, 1.445]	0.607 [0.332, 1.110]
Race/Ethnicity (referent is white)	1	1	1	1	1	1	1
African-American, Hispanic, or other	0.566 [0.268, 1.199]	1.298 [0.586, 2.876]	0.413* [0.179, 0.952]	0.950 [0.456, 1.979]	1.652 [0.832, 3.281]	1.561 [0.778, 3.133]	2.468* [1.236, 4.927]
Education (referent is completed high school or below)	1	1	1	1	1	1	1
Some college	1.032 [0.482, 2.213]	1.462 [0.581, 3.678]	0.852 [0.374, 1.941]	1.466 [0.708, 3.034]	2.138* [1.049, 4.357]	1.110 [0.554, 2.223]	1.795 [0.881, 3.657]
Bachelor's degree or higher	0.641 [0.282, 1.456]	1.837 [0.640, 5.273]	0.464 [0.179, 1.200]	1.487 [0.660, 3.350]	3.596*** [1.711, 7.556]	0.833 [0.397, 1.747]	3.670*** [1.732, 7.778]
Annual household income	1.040 [0.805, 1.344]	1.232 [0.851, 1.782]	1.126 [0.837, 1.514]	0.920 [0.686, 1.232]	0.859 [0.680, 1.085]	0.903 [0.712, 1.145]	0.832 [0.649, 1.068]
Smoking Status (referent is non-smoker)	1	1	1	1	1	1	1
Former	0.662 [0.324, 1.352]	1.520 [0.620, 3.730]	0.584 [0.275, 1.236]	1.341 [0.647, 2.778]	0.743 [0.389, 1.416]	1.103 [0.573, 2.122]	1.300 [0.671, 2.518]
Current	0.432 [0.147, 1.270]	2.006 [0.614, 6.552]	0.853 [0.281, 2.585]	0.780 [0.288, 2.113]	2.477 [0.836, 7.340]	0.974 [0.350, 2.710]	1.694 [0.585, 4.906]
Health status (scale of 1–5 from poor to excellent)	0.866 [0.600, 1.250]	1.177 [0.810, 1.711]	1.083 [0.736, 1.594]	1.315 [0.937, 1.847]	1.316 [0.922, 1.878]	1.646** [1.166, 2.321]	1.645** [1.130, 2.396]
Constant	6.466	0.576	2.535	0.908	0.178	0.074	0.160
No opinion versus disagree							
Never used e-cigarettes (referent)	1	1	1	1	1	1	1
Ever used e-cigarettes	0.237** [0.093, 0.602]	0.183** [0.061, 0.546]	0.316* [0.103, 0.970]	0.272* [0.099, 0.752]	1.485 [0.499, 4.420]	2.882 [0.972, 8.548]	1.501 [0.517, 4.359]
Age (years)	1.014 [0.995, 1.034]	1.036* [1.006, 1.066]	1.033** [1.009, 1.058]	1.022 [0.998, 1.046]	1.025** [1.007, 1.044]	1.033*** [1.014, 1.052]	1.024* [1.004, 1.043]
Sex (referent is male)	1	1	1	1	1	1	1
Female	1.622 [0.870, 3.024]	1.777 [0.834, 3.787]	1.211 [0.615, 2.385]	1.218 [0.585, 2.540]	0.835 [0.472, 1.479]	0.809 [0.461, 1.420]	0.752 [0.409, 1.383]
Race/ethnicity (referent is white)	1	1	1	1	1	1	1
African-American, Hispanic, or other	0.657 [0.304, 1.421]	0.743 [0.325, 1.695]	0.317* [0.127, 0.791]	0.424* [0.183, 0.987]	1.361 [0.687, 2.694]	1.296 [0.655, 2.564]	1.741 [0.875, 3.463]
Education (referent is completed high school or below)	1	1	1	1	1	1	1
Some college	0.925 [0.432, 1.982]	0.906 [0.349, 2.352]	0.894 [0.370, 2.159]	1.076 [0.462, 2.505]	0.944 [0.481, 1.852]	0.766 [0.386, 1.522]	0.870 [0.425, 1.781]
Bachelor's degree or higher	0.829 [0.354, 1.942]	1.251 [0.421, 3.723]	0.481 [0.172, 1.346]	1.039 [0.406, 2.656]	1.45 [0.700, 3.004]	1.192 [0.588, 2.416]	1.672 [0.760, 3.681]
Annual household income	0.884 [0.678, 1.152]	1.022 [0.700, 1.494]	0.915 [0.665, 1.259]	0.744 [0.532, 1.040]	0.95 [0.759, 1.188]	0.848 [0.685, 1.049]	0.899 [0.702, 1.151]
Smoking status (referent is non-smoker)	1	1	1	1	1	1	1
Former	0.869 [0.410, 1.845]	1.053 [0.404, 2.744]	0.397* [0.161, 0.978]	0.578 [0.222, 1.501]	0.63 [0.315, 1.262]	1.031 [0.508, 2.092]	1.017 [0.499, 2.073]
Current	0.763 [0.284, 2.054]	2.148 [0.607, 7.602]	0.686 [0.196, 2.410]	0.963 [0.329, 2.820]	1.005 [0.311, 3.249]	0.814 [0.283, 2.346]	0.887 [0.295, 2.667]
Health status (scale of 1–5 from poor to excellent)	0.990 [0.695, 1.412]	1.268 [0.864, 1.862]	1.136 [0.759, 1.698]	1.494* [1.021, 2.185]	1.206 [0.884, 1.644]	1.425* [1.064, 1.909]	1.597** [1.123, 2.270]
Constant	2.567	0.253	1.408	0.729	0.163	0.119	0.085

Notes: Multinomial logistic regression models adjusted for age, gender, education, race/ethnicity, annual household income, e-cigarette use, and smoking status. Race/ethnicity was dichotomized to white and others because of small cell sizes that led to estimation issues (quasi-complete separation). The base outcome is "Disagree".

* $p < 0.05$

** $p < 0.01$

*** $p < 0.0001$.

et al., 2015; Zhu et al., 2014). A congressional report concluded that e-cigarette companies are currently targeting youth through sponsorship of youth-oriented events, free product samples, advertising with celebrity spokespersons, and social media (Office of Senator Richard J. Durbin, 2014). Currently, 40 states have imposed age restrictions on sales of e-cigarettes to minors. However, approximately 16 million children aged 18 years and younger can still purchase e-cigarettes legally across 11 states and the District of Columbia (Marynak et al., 2014). In addition, minors are able to access e-cigarettes through online purchases, which are not currently prohibited (Williams et al., 2015). Recent longitudinal surveys support the hypothesis that e-cigarettes serve as a gateway tobacco product for youth and potentially lead to increased youth initiation of cigarette smoking (Leventhal et al., 2015; Primack et al., 2015). For instance, Leventhal et al. (2015) reported that non-smoking high school students (from Los Angeles, CA) who used e-cigarettes at baseline had increased odds of using combustible tobacco products including cigarettes, cigars, and hookah at 6- and 12-month follow-up.

The finding that ever users were more likely to believe that using e-cigarettes will be less harmful than smoking and that e-cigarettes help people to quit smoking suggests that these would be important message themes for public education campaigns to address. These messages are particularly relevant for smokers who also used e-cigarettes; over 60% agreed that the devices help people quit smoking completely. Smokers should be informed that e-cigarettes have not been evaluated for safety or approved for use as cessation devices. Given that the growing variety of e-cigarette products have not undergone rigorous evaluation of their safety and efficacy for helping smokers to quit completely, certain state and local public health departments and the U.S. CDC have launched media campaigns recently to discourage adoption of e-cigarettes and to promote approved cessation treatments among smokers who intend to quit (Alaska Department of Health and Social Services, 2014; Centers for Disease Control and Prevention, 2015; San Francisco Department of Public Health, 2015). Furthermore, regulations would be required to ensure that e-cigarette manufacturers adhere to safety standards and undergo clinical efficacy and effectiveness evaluations before they can be marketed as smoking cessation devices to the public.

In contrast with earlier surveys, we found that smoking status was not associated with most of the beliefs about harms and benefits. This was somewhat surprising given that prior surveys have found that more current and former smokers agreed that using e-cigarettes are less harmful than smoking or that secondhand vapor was not harmful compared with non-smokers (Ambrose et al., 2014; Tan et al., 2015a; Tan and Bigman, 2014). Although we observed significant bivariate associations between smoking status and four of the beliefs (results not shown but are available from authors upon request), these were no longer significant in the multinomial regression analyses after including e-cigarette use. One explanation could be that e-cigarette use is confounding the smoking and e-cigarette beliefs association (e-cigarette users tended to be current and former smokers in this sample). It is possible that smokers' beliefs about e-cigarettes may have shifted to be more similar to non-smokers over time as they encounter more health information from various media sources, interpersonal networks, and their healthcare providers about harms and benefits of e-cigarettes (Pepper et al., 2014a). For instance, Tan and Bigman (2014) found a trend that over time, fewer smokers believed that using e-cigarettes was less harmful than smoking (from 85% in 2010 to 65% in 2013).

Future research is needed to assess the relative importance of these beliefs in influencing uptake of e-cigarettes and how these beliefs are formed in the first place. Specifically, we need

more detailed analyses among susceptible populations including youth and young adults who are targeted by e-cigarette companies (Farrelly et al., 2015; Office of Senator Richard J. Durbin, 2014). In addition, we need more research on how people form these beliefs about e-cigarette harms and benefits and the influence of mass-mediated and interpersonal sources of e-cigarette information through communication channels including social media (Grana et al., 2011; Grana and Ling, 2014; Paek et al., 2014; Rooke and Amos, 2013; Zhu et al., 2014). We also need more research about means to correct misinformation about e-cigarette harms and benefits. One recent longitudinal survey among young adults suggest that exposure to information refuting myths about e-cigarettes was associated with reduced misconceptions about e-cigarette harms compared with smoking at follow-up (Tan et al., 2015b). This evidence will be necessary to formulate better strategies to ensure that e-cigarette use among youth is minimized.

4.1. Limitations

While we included a broader array of beliefs related to e-cigarette potential benefits and harms that were identified as most salient from earlier surveys, this set of beliefs is not exhaustive and could have omitted other important beliefs. The statements about potential harms (shown earlier in the survey) may have impacted participants' perceptions about the statements about potential benefits (shown after the potential harms statements). Unfortunately, we were not able to assess the extent of this threat. We suggest randomizing the order of items on potential harms and benefits in future surveys to compare participants' responses when viewing harms and benefits statements in different orders. We relied on respondents' self-reported use of e-cigarettes, which may be subject to social desirability bias. Due to the correlational nature of this analysis, we were not able to distinguish the causal direction of the association between beliefs about e-cigarettes and adoption of e-cigarettes. For instance, ever users may endorse beliefs about benefits more strongly than beliefs about harms due to motivated reasoning as a way to rationalize their use of e-cigarettes. Longitudinal research would be needed to untangle the temporal order of beliefs about e-cigarettes and adoption. A sizable minority of respondents selected "no opinion" across the belief items (23.9–38.3%). We were not able to distinguish whether respondents selected the "no opinion" response because they truly had not formed an opinion or if they were unsure or did not know about individual harms and benefits. The latter response would be understandable given the context of current scientific uncertainty regarding harms and benefits of e-cigarettes. We suggest that future research include separate response options for "don't know", "not sure", and "no opinion" to distinguish between these responses.

5. Conclusion

In sum, these findings provide timely data on public beliefs about e-cigarettes between e-cigarette users and non-users and suggest that certain message topics could be utilized for health campaign interventions.

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Contributors

Chul-joo Lee and Andy SL Tan conceptualized the study and developed the survey instrument. Chul-joo Lee obtained the funding for this research. Andy SL Tan conducted the analyses. Andy SL Tan, Chul-joo Lee, and Cabral A Bigman interpreted the study findings. Andy SL Tan led the manuscript writing. Chul-joo Lee and Cabral A Bigman provided substantial edits for the manuscript. All authors reviewed and approved the final manuscript.

Conflict of interest

No conflict declared.

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