BMJ Open

Is exposure to e-cigarette communications associated with perceived harms of e-cigarette secondhand vapor? Results from a national survey of U.S. adults

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2014-007134
Article Type:	Research
Date Submitted by the Author:	06-Nov-2014
Complete List of Authors:	Tan, Andy; Dana-Farber Cancer Institute, Department of Medical Oncology, Division of Population Sciences, Center for Community-Based Research; Harvard School of Public Health, Department of Social and Behavioral Sciences Bigman, Cabral; University of Illinois at Urbana-Champaign, Department of Communication Mello, Susan; Northeastern University, Department of Communication Studies Sanders-Jackson, Ashley; Stanford University, Stanford Prevention Research Center
Primary Subject Heading:	Smoking and tobacco
Secondary Subject Heading:	Communication, Public health
Keywords:	electronic cigarette, perceived harm, secondhand vapor, public opinion, United States

Is exposure to e-cigarette communications associated with perceived harms of e-cigarette secondhand vapor? Results from a national survey of U.S. adults

Andy SL Tan[1,2], Cabral A. Bigman[3], Susan Mello[4], Ashley Sanders-Jackson[5]

[1] Dana-Farber Cancer Institute, Population Sciences Division, Center for Community Based Research, Boston, USA

[2] Harvard School of Public Health, Department of Social and Behavioral Sciences, Boston, USA

[3] University of Illinois at Urbana-Champaign, Department of Communication, Urbana, USA

[4] Northeastern University, Department of Communication Studies, Boston, USA

[5] Stanford University, Stanford Prevention Research Center, Stanford, USA

Corresponding author:

Andy SL Tan, MBBS, MPH, MBA, PhD
Dana-Farber Cancer Institute, Population Sciences Division, Center for Community Based Research
375 Longwood Avenue, Room 633,
Boston, MA 02215
Email: andy_tan@dfci.harvard.edu
Telephone: 617-582-7643

Keywords: electronic cigarette, perceived harm, secondhand vapor, United States, public opinion

Word count: 3183

References: 46

Tables: 5

Web appendices: 2

ABSTRACT (263 words)

Objectives: Electronic cigarettes or e-cigarettes are frequently advertised and portrayed in the media as less harmful compared with regular cigarettes. Earlier surveys reported public perceptions of harms to people using e-cigarettes, however there is currently a lack of data on public perceptions of harms to being exposed to secondhand vapor (SHV). This study examined associations between self-reported exposure to e-cigarette advertising, media coverage, and interpersonal discussion and perceived harms of SHV.

Design: Observational study.

Setting: National online sample of U.S. adults aged 18 years and older.

Participants: 1449 U.S. adults (mean age 49.5 years), 51.3% female, 76.6% White, 7.5% African-American, 10.0% Hispanic, and 5.9% other races.

Primary and secondary outcome measures: Outcomes were perceived harm measures: (1) harmfulness of SHV to one's health, (2) concern about health impact of breathing SHV, and (3) comparative harm of SHV versus secondhand smoke (SHS). Predictors were self-reported exposure to e-cigarette advertising, media coverage, and interpersonal discussion. Analyses controlled for demographic covariates, tobacco use, and were weighted to the general U.S. adult population.

Results: Exposure to advertising perceived as positive was associated with lower concerns about the health impact of breathing SHV (b=-0.051, 95% CI=-0.098 to -0.005) and with lower perceived comparative harm of SHV versus SHS (b=-0.029, 95% CI=-0.050 to -0.008). Exposure to interpersonal discussion perceived as positive was also negatively associated with all three perceived harm outcomes. Non-advertising media exposure was not a significant predictor of any of the three outcomes.

Conclusions: Exposure to information about e-cigarettes through advertising and interpersonal discussion could have a role in shaping public perceptions of the harmfulness of SHV.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This is the first study to describe public perceptions specifically about the risks of SHV among a national sample of U.S. adults and to obtain population estimates of the perceived harms of SHV and associations with information exposure.
- This study is also strengthened by the inclusion of measures beyond frequency of exposure and the inclusion of perceived valence of the exposure from each of the various sources.
- Due to the cross-sectional nature of the analysis, potential threats include reverse causation and omitted confounders.
- The survey was conducted before the FDA announcement of its proposed deeming rule in April 2014. Therefore, more recent data may be necessary to assess the impact of various forms of mediated and interpersonal information exposure arising from the announcement on public perceptions of harms.
- The social media items (in both the advertising and media exposure measures) potentially overlap with one another. Interpersonal discussion could also occur via social media. Future studies should consider alternate methods of measuring ad, media, and interpersonal discussion to better distinguish these forms of exposure.

INTRODUCTION

Public awareness of e-cigarettes among adults in the U.S. has increased over recent years and is near-universal.[1,2] Most people have either seen or heard about e-cigarettes through another person, in stores, television advertising, online, print ads, or news stories.[3] This emergence of mediated and interpersonal communications about e-cigarettes—the benefits and harms of which are still not completely understood—may have important implications for public health and tobacco control. Prior research found that exposure to tobacco-specific information from ads, media and interpersonal sources could influence beliefs and attitudes of the harms of tobacco use, smoking or cessation behaviors, or support for tobacco control policies.[4–10] For instance, a national survey among U.S. adults found that self-reported exposure to anti-secondhand smoke (SHS) media predicted negative social cognitions about SHS and support for home restrictions to reduce SHS exposure.[10] Similarly, recent studies suggest that exposure to mediated and interpersonal communications about e-cigarettes predicted attitudes, e-cigarette use behaviors, and support for regulations restricting e-cigarettes in public venues.[11–13]

An important set of public perceptions about e-cigarettes is perceived harm regarding this novel product because favorable perceptions could potentially encourage e-cigarette experimentation.[14–16] For instance, population surveys reported that many smokers and e-cigarette users perceived e-cigarettes to be less harmful than regular cigarettes and cited this as one of the main reasons for trying e-cigarettes.[17–20] A higher proportion of current smokers versus non-smokers or former smokers rated e-cigarettes as less harmful than regular cigarettes.[1,17] While these earlier surveys provided crucial data on public perceptions of harms

to people *using* e-cigarettes, there is currently a lack of data on public perceptions of harms to people *exposed to* secondhand vapor (SHV). This study focuses on perceived harms of SHV to address the above research gap.

E-cigarette ads and information from media outlets frequently include claims that vapors emitted from e-cigarettes are harmless.[21–26] For instance, one popular late-night talk show featured a celebrity using an e-cigarette on the show while she claimed that SHV contained only water vapor.[27] In an analysis of e-cigarette retail websites, Grana & Ling reported that 76% of websites stated that e-cigarettes emit only water vapor and are harmless to others.[25] Such claims about the harmlessness of SHV through mediated sources could potentially mislead the public because there is emerging evidence that SHV is not innocuous. There are detectable levels of tobacco-specific pollutants in SHV that could impact indoor air quality, though most are at levels lower than those from combustible cigarette smoke.[28–33] In a recent study, researchers noted that while overall particulate matter emissions from e-cigarettes were lower than combustible cigarettes, emissions of specific heavy metals from e-cigarette exceeded those from combustible cigarettes.[32]

Prior research indicates that risk perceptions about SHS were associated with public support of clean indoor air policies.[34] Correspondingly, risk perceptions about SHV may influence public support for regulation to reduce public exposure to SHV. Currently, regulations to restrict e-cigarette use in public venues are in flux. Over 180 local and 11 state ordinances have been passed to prohibit the use of e-cigarettes in public places where smoking is not permitted.[35] Other cities and states are also considering adopting similar regulations. Yet, the

prevalence of e-cigarette use in public places has steadily increased. A recent survey among U.S. flight attendants reported that almost half of the respondents (46.4%) had seen e-cigarette use in an aircraft or airport.[36] Given the frequent claims about SHV in the media environment and ongoing policy interventions to restrict e-cigarette use in public, surveillance of public risk perceptions about SHV and an examination of whether exposure to e-cigarette communications is associated with risk perceptions are urgently needed.

The objective of this study is two-fold: (1) to describe public risk perceptions of SHV based on a national survey of U.S. adults and (2) to examine whether exposure to e-cigarette communications through advertising, media, and interpersonal sources are associated with perceived risks of SHV. Information from this analysis would contribute to understanding the potential impact of e-cigarette communications and aid in policy considerations to mitigate these effects or in designing public information campaigns to provide accurate information to the public.

METHODS

Study sample and data collection

Data were collected through a survey module focused on e-cigarette communications and public perceptions within the Annenberg National Health Communication Survey (ANHCS) from October through December 2013. The ANHCS is a monthly cross-sectional survey among adults aged 18 years and older in the United States, conducted from 2005 to 2013 by GfK (previously Knowledge Networks). Participants of the ANHCS were invited from

KnowledgePanel, 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/). Further details of the sampling and data collection are described elsewhere.[11] The study sample comprised 1551 respondents. Participants who had never heard of e-cigarettes were excluded (n=102), resulting in an analyzed sample of 1449 respondents (aged 18-94 years). The completion rates for the monthly survey from October to December 2013 were 56%, 51%, and 51%, respectively. Informed consent was implied by completion of the survey. The survey did not collect any personally identifiable data. The institutional review board of the University of Pennsylvania granted the ANHCS exempt status.

Measures

Outcome variables – Perceived harms of SHV

Perceived harms of e-cigarettes was measured using three survey items – two personal risk items and a more general comparative risk measure. 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. These two items were adapted from the CDC National Adult Tobacco Survey which asked about perceived harms of secondhand cigarette smoke.[37] The third 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). This item was adapted from the National Cancer Institute (NCI) 2013 Health Information National Trends Survey.[38]

Predictor Variables – Exposure to advertising, media, and interpersonal discussion

The predictor variables are described in detail elsewhere.[11] Briefly, three survey items measured the frequency of exposure to advertisements promoting electronic cigarettes in the preceding 30 days in (1) convenience stores, liquor stores, or gas stations, (2) television, radio, or newspapers and magazines, (3) social media such as Facebook, Twitter, or YouTube (responses ranged from never (1), once or twice (2), three or four times (3), and five times or more (4)). Responses were averaged into a scale for the frequency of advertising exposure. Participants who reported that they had seen or heard at least one form of advertising in the past 30 days (n=1056) were also asked, "In your opinion, was the information in the **advertisements promoting electronic cigarettes**…?" Responses ranged from 'completely positive' to 'completely negative' on a 5-point scale and were reverse-coded such that higher values indicate more positive valence. A valence-weighted advertising exposure (ranging from 1 to 20) was computed by multiplying the frequency of advertising exposure scale by the perceived valence of the information in advertisements. The valence-weighted exposure represents the amount of information that individuals perceived as favorable about e-cigarettes from advertising.

Respondents' frequency of exposure to e-cigarette information in media other than advertising in the preceding 30 days was measured including (1) news on television, newspapers,

or magazines, (2) television shows other than news (e.g., drama, late night comedy, celebrity talk shows, reality television), and (3) social media. These three items were averaged into a scale for other media exposure and the valence-weighted exposure was computed using the procedure described earlier for those who reported at least some media exposure (n=699).

Interpersonal discussion about e-cigarettes was measured with a single item that asked how often a respondents' close friend or family member talked to them about e-cigarettes. The valence-weighted interpersonal discussion measure was computed with the same procedure as above for respondents who had discussed e-cigarettes with others (n=305).

Covariates

Covariates included age, gender, race/ethnicity, household income, education, health status, smoking status (non-smoker, former smoker, or current) and prior use of e-cigarettes (never, ever used e-cigarettes but not in the past 3 months, or used e-cigarettes in the past 3 months). Analyses also adjusted for how often respondents saw other people use e-cigarettes in the preceding 30 days in four venues: (1) indoors at their workplace, (2) indoors at restaurants, (3) indoors at bars/casinos/clubs, and (4) at parks (responses ranged from never (1), once or twice (2), three or four times (3), and five times or more (4)). These responses were averaged into a scale for observing others using e-cigarettes.

Data Analysis

Data analysis was completed in June 2014. After examining descriptive statistics, bivariate correlations (Spearman's rho) of the frequency of exposure measures, valence-weighted

exposures, and the three perceived harm outcome measures were examined. Next, multiple regression was utilized to assess associations between each perceived harm outcome measure and all three frequency of exposure measures (from ads, media other than ads, and interpersonal). The amount of missing data across all variables was minimal (2.4%) and listwise deletion was utilized for handling missing values in these regression analyses. The analyzed sample included all 1449 respondents who were aware of e-cigarettes (see Web-only Supplemental Figure 1 for flow diagram of the analyzed sample).

Separate regression models examined the associations between perceived harm outcomes using each valence-weighted exposure measure at a time. This enabled the examination of unique effects of each channel (i.e., ads, media, or interpersonal discussion) that were perceived as favorable. The analyzed samples for these models were restricted to respondents who had reported at least some exposure to advertisements (n=1056), other media (n=699), or interpersonal discussion (n=305) because those who had no exposure to these forms of e-cigarette communications were not asked the valence questions (Figure 1; online supplemental file).

All regression models adjusted for demographic and tobacco use variables; the Stata 13 SVY program was used to weight the analysis sample to the most recent data from the Current Population Survey (CPS).[39]

RESULTS

Sample characteristics

The mean age of the sample was 49.5 years, 51.3% were female, 76.6% were non-Hispanic white, and 35.5% completed college education or higher. Other characteristics of the sample and weighted distributions (matching the CPS data) are summarized in Table 1.

Table 1 – Analyzed 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)[a]	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
Tried e-cigarettes at least once				
No		87.9		86.4
Yes but not in the past 3 months		8.1		9.2
Yes and in the past 3 months		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)	

Note. [a]6 missing cases.

Descriptive statistics of perceived harm and exposure variables

Participants reported moderate perceived harms associated with SHV. Mean (SD) of perceived harmfulness of SHV to one's health was 3.63 (1.93) while mean of concern about health impact of breathing SHV was 3.94 (2.06) on scales ranging from 1 to 7. Overall, respondents viewed inhaling SHV as less harmful than inhaling SHS; mean (SD) of the comparative harm of SHV versus SHS was 2.03 (0.80) on a scale ranging from 1 to 5.

Exposure to e-cigarette communications in the preceding 30 days was infrequent among participants. Mean (SD) frequency of exposure to advertising, other media, and interpersonal discussion was 1.6 (0.6), 1.4 (0.5), and 1.3 (0.6) respectively on scales ranging from 1 (never) to 4 (five times or more). Mean valence-weighted exposure to advertising, other media, and interpersonal discussion was 7.2 (3.1), 6.2 (2.6), and 8.3 (3.4) respectively on scales ranging from 1 to 20.

Spearman correlations between frequency of exposure and valence-weighted exposure with perceived harm items

Higher frequency of exposures to e-cigarette advertising and interpersonal discussion were negatively correlated with all three perceived harm variables (Spearman's rho ranged from -0.086 to -0.187, all p-values<0.01) (Web-only Supplemental Table 1). Frequency of exposure to other media was not significantly associated with the perceived harm measures. Valence-weighted exposures to advertising, other media, and interpersonal discussion were also negatively associated with lower perceived harm outcomes (Spearman's rho ranged from -0.142 to -0.350, all p-values<0.05).

Multiple regression analyses predicting perceived harms of SHV

Table 2 summarizes the regression models predicting each of the perceived harm outcome measures with the frequency of exposure to ads, other media, and interpersonal discussion. Controlling for covariates, higher frequency of exposure to interpersonal discussion was negatively correlated with two of the perceived harm variables—perceived harmfulness of vapor to one's health (b=-0.245, 95% CI=-0.476 to -0.015) and comparative harm of SHV versus SHS (b=-0.134, 95% CI=-0.246 to -0.022). Frequency of exposure to ads and media were not significantly associated with the perceived harm outcomes (Table 2). Younger respondents, being white (compared with African-American or other race/ethnic group), former and current smokers (compared with non-smokers), and past use of e-cigarettes (compared with never users) were associated with lower ratings of harm for one or more of these outcomes.

Table 2 – Multivariate analyses predicting perceived harm measures with self-reported frequency of exposure measures (N=1449)

	Breathing vapor is harmful to health	Concern about health impact of vapor	Breathing vapor is more harmful compared to breathing smoke
Independent variables	**b (95% CI)**	**b (95% CI)**	**b (95% CI)**
Ad exposure	0.124[-0.102,0.350]	0.049[-0.184,0.283]	-0.028[-0.135,0.079]
Other media exposure	0.019[-0.263,0.302]	0.036[-0.265,0.337]	0.068[-0.067,0.203]
Interpersonal discussion	-0.245*[-0.476,-0.015]	-0.173[-0.423,0.076]	-0.134*[-0.246,-0.022]
Age (years)	0.007[-0.001,0.015]	0.012**[0.004,0.020]	0.001[-0.002,0.004]
Sex – Female	0.145[-0.088,0.379]	0.211[-0.035,0.456]	-0.001[-0.107,0.106]
Race/Ethnicity (White is referent)			
African-American	0.267[-0.200,0.735]	0.283[-0.212,0.778]	0.212*[0.014,0.411]
Hispanic	0.301[-0.093,0.696]	0.357[-0.047,0.760]	0.175[-0.016,0.366]
Other[a]	0.301[-0.176,0.778]	0.246[-0.242,0.735]	0.344**[0.097,0.590]
Education (High school or below is referent)			
Some college	-0.048[-0.341,0.244]	-0.145[-0.451,0.160]	-0.075[-0.204,0.055]
College graduate or higher	0.17[-0.140,0.480]	0.147[-0.173,0.468]	-0.007[-0.135,0.122]
Annual household income (<$25,000 is referent)			
$25,000-49,999	0.097[-0.308,0.502]	0.029[-0.399,0.457]	-0.043[-0.223,0.136]
≥$50,000	0.214[-0.163,0.591]	0.177[-0.216,0.571]	-0.049[-0.220,0.122]
Health Status	0.024[-0.111,0.158]	0.055[-0.086,0.196]	-0.012[-0.075,0.050]
Smoking Status (Non-smoker is referent)			
Former	-0.487***[-0.769,-0.205]	-0.372*[-0.669,-0.075]	-0.104[-0.219,0.010]
Current	-1.119***[-1.516,-0.722]	-0.992***[-1.424,-0.559]	-0.133[-0.321,0.055]
Tried e-cigarettes at least once (Never is referent)			
Yes but not in the past 3 months	-0.623**[-1.074,-0.171]	-0.981***[-1.450,-0.511]	-0.297**[-0.521,-0.073]
Yes in the past 3 months	-0.850**[-1.404,-0.297]	-1.088***[-1.712,-0.465]	-0.462**[-0.765,-0.158]
Observed others vaping	-0.113[-0.396,0.171]	-0.047[-0.362,0.269]	-0.032[-0.196,0.132]
Constant	3.467	3.343	2.298
R-squared	0.125	0.129	0.080

Note. Cell entries are unstandardized coefficients from multivariate regressions adjusting for all variables in the table. Self-reported exposure measures are frequency of exposure on scale with a maximum value of 4. *p<.05, **p<.01, ***p<.0005.

Tables 3 to 5 summarize the regression models predicting each of the perceived harm measures with the valence-weighted exposure to ads, other media, and interpersonal discussion. Controlling for covariates, reporting more exposure to advertising perceived as positive was associated with lower perceived harm of the health impact of breathing SHV (b=-0.051, 95% CI=-0.098,-0.005) (Table 4; Model 2a) and lower comparative harms about SHV versus SHS (b=-0.029, 95% CI=-0.050,-0.008) (Table 4; Model 3a). Exposure to interpersonal discussion perceived as positive was also associated with lower perceptions of harm across all three outcomes (Tables 3 to 5; Models 1c, 2c, and 3c). Valence-weighted exposure to other media was not a significant predictor of any of the three perceived harm outcomes.

Table 3 – Multivariate analyses predicting perceived harmfulness of breathing vapor from other people's e-cigarettes with valence-weighted exposure measures

	Model 1a (N=1056)	Model 1b (N=699)	Model 1c (N=305)
Independent variables	**b (95% CI)**	**b (95% CI)**	**b (95% CI)**
Valence-weighted ad exposure	-0.032[-0.076,0.013]	-	-
Valence-weighted other media exposure	-	-0.022[-0.098,0.054]	-
Valence-weighted interpersonal discussion	-	-	-0.122***[-0.188,-0.055]
Age (years)	0.007[-0.002,0.016]	0.017**[0.006,0.028]	0.005[-0.010,0.019]
Sex – Female	0.065[-0.202,0.332]	0.094[-0.227,0.415]	-0.04[-0.547,0.466]
Race/Ethnicity (White is referent)			
African-American	0.115[-0.359,0.589]	0.181[-0.421,0.783]	-0.003[-1.018,1.013]
Hispanic	0.219[-0.196,0.634]	0.052[-0.461,0.565]	-0.084[-0.733,0.565]
Other[a]	0.519[-0.096,1.134]	0.664[-0.060,1.388]	-0.386[-1.178,0.406]
Education (High school or below is referent)			
Some college	-0.036[-0.360,0.287]	-0.139[-0.530,0.251]	0.105[-0.400,0.610]
College graduate or higher	0.131[-0.220,0.482]	-0.13[-0.545,0.284]	0.45[-0.270,1.170]
Annual household income (<$25,000 is referent)			
$25,000-49,999	-0.145[-0.592,0.303]	0.164[-0.374,0.702]	0.001[-0.664,0.666]
≥$50,000	-0.077[-0.497,0.343]	0.246[-0.267,0.759]	-0.284[-0.848,0.280]
Health Status	0.056[-0.087,0.199]	0.196*[0.017,0.374]	0.054[-0.229,0.337]
Smoking Status (Non-smoker is referent)			
Former	-0.469**[-0.780,-0.158]	-0.708***[-1.067,-0.349]	-0.395[-0.945,0.155]
Current	-1.156***[-1.556,-0.756]	-1.409***[-1.866,-0.952]	-1.145**[-1.898,-0.392]
Tried e-cigarettes at least once (Never is referent)			
Yes but not in the past 3 months	-0.533*[-0.990,-0.075]	-0.616*[-1.161,-0.072]	-0.256[-0.920,0.407]
Yes in the past 3 months	-0.917***[-1.427,-0.408]	-0.807**[-1.377,-0.236]	-0.496[-1.195,0.202]
Observed others vaping	-0.116[-0.398,0.167]	-0.080[-0.391,0.231]	0.273[-0.187,0.732]
Constant	3.751	2.503	3.826
R-squared	0.133	0.188	0.180

Note. Cell entries are unstandardized coefficients from multivariate regressions adjusting for all variables in the table. Self-reported exposure measures are frequency of exposure on scale with a maximum value of 4. *p<.05, **p<.01, ***p<.0005.

Table 4 – Multivariate analyses predicting concern about health impact of vapor with valence-weighted exposure measures

	Model 2a (N=1056)	Model 2b (N=699)	Model 2c (N=305)
Independent variables	**b (95% CI)**	**b (95% CI)**	**b (95% CI)**
Valence-weighted ad exposure	-0.051*[-0.098,-0.005]	-	-
Valence-weighted other media exposure	-	-0.064[-0.141,0.013]	-
Valence-weighted interpersonal discussion	-	-	-0.136***[-0.215,-0.057]
Age (years)	0.011*[0.002,0.021]	0.021***[0.009,0.033]	0.006[-0.011,0.023]
Sex – Female	0.14[-0.146,0.425]	0.075[-0.261,0.410]	-0.02[-0.601,0.560]
Race/Ethnicity (White is referent)			
African-American	0.239[-0.282,0.760]	0.227[-0.410,0.863]	0.237[-0.846,1.321]
Hispanic	0.263[-0.175,0.701]	0.291[-0.248,0.831]	0.36[-0.476,1.197]
Other[a]	0.357[-0.288,1.003]	0.508[-0.236,1.253]	-0.313[-1.139,0.513]
Education (High school or below is referent)			
Some college	-0.191[-0.535,0.153]	-0.219[-0.630,0.192]	0.11[-0.487,0.708]
College graduate or higher	0.084[-0.289,0.458]	-0.16[-0.603,0.284]	0.27[-0.511,1.051]
Annual household income (<$25,000 is referent)			
$25,000-49,999	-0.181[-0.662,0.301]	0.217[-0.344,0.778]	-0.231[-1.012,0.549]
≥$50,000	-0.146[-0.584,0.291]	0.313[-0.222,0.848]	-0.414[-1.111,0.282]
Health Status	0.075[-0.084,0.235]	0.209*[0.024,0.393]	0.178[-0.142,0.497]
Smoking Status (Non-smoker is referent)			
Former	-0.391*[-0.728,-0.053]	-0.528**[-0.918,-0.139]	-0.329[-0.966,0.309]
Current	-0.977***[-1.437,-0.517]	-1.146***[-1.659,-0.634]	-0.900*[-1.798,-0.002]
Tried e-cigarettes at least once (Never is referent)			
Yes but not in the past 3 months	-0.894***[-1.377,-0.412]	-0.925**[-1.502,-0.347]	-0.994**[-1.735,-0.253]
Yes in the past 3 months	-1.148***[-1.737,-0.559]	-1.084***[-1.722,-0.445]	-0.944*[-1.794,-0.093]
Observed others vaping	-0.015[-0.328,0.299]	-0.003[-0.324,0.319]	0.404[-0.077,0.885]
Constant	3.806	2.592	3.613
R-squared	0.135	0.185	0.203

Note. Cell entries are unstandardized coefficients from multivariate regressions adjusting for all variables in the table. Self-reported exposure measures are frequency of exposure on scale with a maximum value of 4. *p<.05, **p<.01, ***p<.0005.

Table 5 – Multivariate analyses predicting perceived harm of breathing vapor compared to breathing smoke with valence-weighted exposure measures

	Model 3a (N=1056)	Model 3b (N=699)	Model 3c (N=305)
Independent variables	**b (95% CI)**	**b (95% CI)**	**b (95% CI)**
Valence-weighted ad exposure	-0.029**[-0.050,-0.008]	-	-
Valence-weighted other media exposure	-	-0.009[-0.038,0.021]	-
Valence-weighted interpersonal discussion	-	-	-0.060***[-0.087,-0.032]
Age (years)	0.000[-0.004,0.004]	0.004[-0.001,0.009]	-0.003[-0.009,0.004]
Sex – Female	-0.001[-0.120,0.118]	0.058[-0.081,0.196]	0.005[-0.212,0.222]
Race/Ethnicity (White is referent)			
African-American	0.14[-0.067,0.346]	0.198[-0.046,0.442]	0.075[-0.360,0.511]
Hispanic	0.08[-0.104,0.265]	0.127[-0.101,0.354]	0.114[-0.223,0.451]
Other[a]	0.385*[0.071,0.699]	0.442*[0.069,0.816]	0.172[-0.131,0.475]
Education (High school or below is referent)			
Some college	-0.039[-0.185,0.106]	-0.043[-0.223,0.136]	0.085[-0.157,0.327]
College graduate or higher	0.028[-0.111,0.167]	-0.002[-0.171,0.167]	0.202[-0.110,0.513]
Annual household income (<$25,000 is referent)			
$25,000-49,999	-0.078[-0.279,0.122]	0.039[-0.199,0.278]	0.065[-0.257,0.386]
≥$50,000	-0.103[-0.288,0.082]	-0.01[-0.242,0.223]	-0.052[-0.370,0.267]
Health Status	-0.01[-0.070,0.049]	0.021[-0.047,0.089]	-0.046[-0.161,0.069]
Smoking Status (Non-smoker is referent)			
Former	-0.111[-0.235,0.014]	-0.185*[-0.339,-0.031]	-0.131[-0.378,0.116]
Current	-0.134[-0.331,0.063]	-0.217[-0.451,0.016]	-0.223[-0.574,0.128]
Tried e-cigarettes at least once (Never is referent)			
Yes but not in the past 3 months	-0.288*[-0.522,-0.055]	-0.129[-0.446,0.188]	-0.28[-0.572,0.012]
Yes in the past 3 months	-0.564***[-0.870,-0.258]	-0.566***[-0.891,-0.241]	-0.35[-0.728,0.027]
Observed others vaping	-0.033[-0.190,0.124]	-0.043[-0.193,0.107]	0.121[-0.081,0.324]
Constant	2.460	1.855	2.502
R-squared	0.092	0.102	0.158

Note. Cell entries are unstandardized coefficients from multivariate regressions adjusting for all variables in the table. Self-reported exposure measures are frequency of exposure on scale with a maximum value of 4. *p<.05, **p<.01, ***p<.0005.

DISCUSSION

To our knowledge, this is the first study to describe public perceptions specifically about the risks of SHV among a national sample of U.S. adults. Importantly, the analysis found that respondents perceived SHV as causing moderate levels of harm to one's health and were moderately concerned about the health impact of breathing in SHV. On average, participants rated inhaling SHV as less harmful than SHS. These findings should be qualified as representing a snapshot of normative perceptions of SHV harms among U.S. adults. The ratings on perceived harms do not represent objective knowledge about SHV harms given that definitive evidence of harmful health effects of SHV, if any, may require years of research to reveal. The results from this study would serve as important baseline data for the surveillance of public risk perceptions of SHV as the information environment surrounding e-cigarettes and SHV evolves.

This analysis further indicated that ads and interpersonal discussion perceived as positive were associated with lower perceived harms about e-cigarettes. The associations between ad exposure and lower perceived harms about SHV could have implications for public policy and research related to e-cigarette advertising claims. Specifically, further research is needed to examine whether specific claims about vapor being harmless in ads are causally related to lower public risk perceptions of SHV using longitudinal and/or experimental designs. From a legislative standpoint, the results could provide important data to inform regulatory considerations to monitor and restrict the presence of inaccurate claims about the harmlessness of SHV in marketing materials. Public education may also be necessary to counter public misperceptions about the constituents present in SHV.

There were differences in the association between e-cigarette communications and perceived harms depending on the channel of communication. The most consistent associations were between exposure to interpersonal discussion about e-cigarettes and the perceived harm outcomes. Valence-weighted exposure to ads was associated with two of the three perceived harm outcomes. In contrast, there was no significant association between frequency of media exposure or valence-weighted media exposure and the three perceived harm measures. Prior research in the context of other forms of health risk information suggest that interpersonal and mediated information can have differential effects on evaluation of personal and societal risk (although these differences are not necessarily consistent).[40–44] In the context of public support for tobacco control policies, Blake and colleagues reported that exposure to news coverage about tobacco issues, anti-tobacco advertising, and pro-tobacco advertising were differentially associated with support for five proposed policies to reduce movie portrayals of smoking.[9] It is also possible that interpersonal discussions about e-cigarettes tend to be more persuasive and credible compared with advertising and media content.[45,46] This could explain the channel differences observed in the current study; however, these hypotheses are not explicitly tested here. More research into the nature of interpersonal discussions about e-cigarettes would offer insight into how and why such discussions relate to lower perceptions about harms from SHV.

This study is strengthened by the inclusion of measures beyond frequency of exposure and the inclusion of perceived valence of the exposure from each of the various sources. The survey also involved a nationally representative sample of U.S. adults and sampling weights that enabled us to obtain population estimates of the perceived harms of SHV and associations with information exposure. However, the study has a few limitations. Due to the cross-sectional

nature of the analysis, potential threats include reverse causation and omitted confounders. The survey was conducted before the FDA announcement of its proposed deeming rule in April 2014. Therefore, more recent data may be necessary to assess the impact of various forms of mediated and interpersonal information exposure arising from the announcement on public perceptions of harms. Finally, the social media items (in both the advertising and media exposure measures) potentially overlap with one another. Interpersonal discussion could also occur via social media. Future studies should consider alternate methods of measuring ad, media, and interpersonal discussion to better distinguish these forms of exposure.

To conclude, this study found that exposure to information about e-cigarettes through advertising and interpersonal discussion are associated with public perceptions of the harmfulness of SHV. These findings may play a role in guiding public education efforts to increase public understanding of the chemical constituents in SHV and policies to restrict potentially misleading claims in marketing materials.

ACKNOWLEDGEMENTS AND FUNDING STATEMENT

Data for this research came from the Annenberg National Health Communication Survey, supported by the Annenberg School at the University of Pennsylvania and the University of Southern California. Andy Tan conducted this work while a postdoctoral fellow at the Center of Excellence in Cancer Communication Research at the University of Pennsylvania and later an assistant professor at the Dana-Farber Cancer Institute and Harvard School of Public Health. Cabral Bigman conducted this work while an assistant professor at the University of Illinois at Urbana-Champaign. Susan Mello conducted this work while an assistant professor at Northeastern University. Ashley Sanders-Jackson conducted this work while a postdoctoral fellow at Stanford Prevention Research Center. No financial disclosures were reported by the authors of this paper. This work was supported by National Heart, Lung, and Blood Institute grant number T32HL007034 and National Cancer Institute grant number P20CA095856. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

COMPETING INTERESTS STATEMENT

No, there are no competing interests.

AUTHORS' CONTRIBUTORSHIP STATEMENT

AT and CB designed the study and survey questionnaire. AT conducted the data analyses. AT, CB, SM, and AS interpreted the results and drafted the paper. AT is responsible for the overall content as guarantor.

DATA SHARING STATEMENT

Dataset may be accessed through the Annenberg National Health Communication Survey (http://anhcs.asc.upenn.edu/). Survey measures, technical appendix, and statistical code available from the corresponding author upon request.

REFERENCES

1 Tan ASL, Bigman CA. E-cigarette awareness and perceived harmfulness: prevalence and associations with smoking-cessation outcomes. *Am J Prev Med* 2014;47:141–9. doi:10.1016/j.amepre.2014.02.011

2 Pepper JK, Brewer NT. Electronic nicotine delivery system (electronic cigarette) awareness, use, reactions and beliefs: a systematic review. *Tob Control* 2013;:tobaccocontrol – 2013–051122. doi:10.1136/tobaccocontrol-2013-051122

3 Pepper JK, Emery SL, Ribisl KM, *et al.* How U.S. adults find out about electronic cigarettes: Implications for public health messages. *Nicotine Tob Res* 2014;:ntu060. doi:10.1093/ntr/ntu060

4 Wakefield M, Flay B, Nichter M, *et al.* Role of the media in influencing trajectories of youth smoking. *Addict Abingdon Engl* 2003;98 Suppl 1:79–103.

5 Durkin S, Brennan E, Wakefield M. Mass media campaigns to promote smoking cessation among adults: an integrative review. *Tob Control* 2012;21:127–38. doi:10.1136/tobaccocontrol-2011-050345

6 Southwell BG, Yzer MC. When (and why) interpersonal talk matters for campaigns. *Commun Theory* 2009;19:1–8. doi:10.1111/j.1468-2885.2008.01329.x

7 Van den Putte B, Yzer M, Southwell BG, *et al.* Interpersonal communication as an indirect pathway for the effect of antismoking media content on smoking cessation. *J Health Commun* 2011;16:470–85. doi:10.1080/10810730.2010.546487

8 Blake KD, Viswanath K, Blendon RJ, *et al.* The role of tobacco-specific media exposure, knowledge, and smoking status on selected attitudes toward tobacco control. *Nicotine Tob Res* 2009;:ntp184. doi:10.1093/ntr/ntp184

9 Blake KD, Viswanath K, Blendon RJ, *et al.* The role of reported tobacco-specific media exposure on adult attitudes toward proposed policies to limit the portrayal of smoking in movies. *Tob Control* 2009;:tc.2009.031260. doi:10.1136/tc.2009.031260

10 Douglas Evans W, Crankshaw E, Nimsch C, *et al.* Media and secondhand smoke exposure: results from a national survey. *Am J Health Behav* 2006;30:62–71. doi:10.5993/AJHB.30.1.6

11 Tan ASL, Bigman CA, Sanders-Jackson A. Sociodemographic correlates of self-reported exposure to e-cigarette communications and its association with public support for smoke-free and vape-free policies: results from a national survey of US adults. *Tob Control* 2014;:tobaccocontrol – 2014–051685. doi:10.1136/tobaccocontrol-2014-051685

12 Pepper JK, Emery SL, Ribisl KM, *et al.* Effects of advertisements on smokers' interest in trying e-cigarettes: the roles of product comparison and visual cues. *Tob Control* 2014;23:iii31–6. doi:10.1136/tobaccocontrol-2014-051718

13 Kelly BJ, Hornik R, Romantan A, *et al.* Cancer information scanning and seeking in the general population. *J Health Commun* 2010;15:734–53. doi:10.1080/10810730.2010.514029

14 Choi K, Fabian L, Mottey N, *et al.* Young adults' favorable perceptions of snus, dissolvable tobacco products, and electronic cigarettes: findings from a focus group study. *Am J Public Health* 2012;102:2088–93. doi:10.2105/AJPH.2011.300525

15 Choi K, Forster J. Characteristics associated with awareness, perceptions, and use of electronic nicotine delivery systems among young US Midwestern adults. *Am J Public Health* 2013;103:556–61. doi:10.2105/AJPH.2012.300947

16 Amrock SM, Zakhar J, Zhou S, *et al.* Perception of e-cigarettes' harm and its correlation with use among US adolescents. *Nicotine Tob Res* 2014;:ntu156. doi:10.1093/ntr/ntu156

17 Pearson JL, Richardson A, Niaura RS, *et al.* E-cigarette awareness, use, and harm perceptions in US adults. *Am J Public Health* 2012;102:1758–66. doi:10.2105/AJPH.2011.300526

18 Richardson A, Pearson J, Xiao H, *et al.* Prevalence, harm perceptions, and reasons for using noncombustible tobacco products among current and former smokers. *Am J Public Health* 2014;104:1437–44. doi:10.2105/AJPH.2013.301804

19 Etter JF. Electronic cigarettes: a survey of users. *BMC Public Health* 2010;10:231. doi:10.1186/1471-2458-10-231

20 Adkison SE, O'Connor RJ, Bansal-Travers M, *et al.* Electronic nicotine delivery systems: International Tobacco Control Four-Country Survey. *Am J Prev Med* 2013;44:207–15. doi:10.1016/j.amepre.2012.10.018

21 Rooke C, Amos A. News media representations of electronic cigarettes: an analysis of newspaper coverage in the UK and Scotland. *Tob Control* 2013;:tobaccocontrol – 2013–051043. doi:10.1136/tobaccocontrol-2013-051043

22 Paek H-J, Kim S, Hove T, *et al.* Reduced harm or another gateway to smoking? Source, message, and information characteristics of e-cigarette videos on Youtube. *J Health Commun* 2013;In press. doi:10.1080/10810730.2013.821560

23 Richardson A, Ganz O, Stalgaitis C, *et al.* Noncombustible tobacco product advertising: how companies are selling the new face of tobacco. *Nicotine Tob Res* 2013;:ntt200. doi:10.1093/ntr/ntt200

24 Richardson A, Ganz O, Vallone D. Tobacco on the web: surveillance and characterisation of online tobacco and e-cigarette advertising. *Tob Control* 2014;:tobaccocontrol – 2013–051246. doi:10.1136/tobaccocontrol-2013-051246

25 Grana RA, Ling PM. 'Smoking Revolution': a content analysis of electronic cigarette retail websites. *Am J Prev Med* 2014;46:395–403. doi:10.1016/j.amepre.2013.12.010

26 Huang J, Kornfield R, Szczypka G, *et al.* A cross-sectional examination of marketing of electronic cigarettes on Twitter. *Tob Control* 2014;23:iii26–30. doi:10.1136/tobaccocontrol-2014-051551

27 Katherine Heigl smokes an Electronic Cigarette live on the David Letterman show! 2013. http://www.youtube.com/watch?v=qNIgREJNYxU&feature=youtube_gdata_player (accessed 6 Jan2014).

28 Goniewicz ML, Knysak J, Gawron M, *et al.* Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tob Control* 2013;:tobaccocontrol – 2012–050859. doi:10.1136/tobaccocontrol-2012-050859

29 Czogala J, Goniewicz ML, Fidelus B, *et al.* Secondhand exposure to vapors from electronic cigarettes. *Nicotine Tob Res* Published Online First: 11 December 2013. doi:10.1093/ntr/ntt203

30 Schober W, Szendrei K, Matzen W, *et al.* Use of electronic cigarettes (e-cigarettes) impairs indoor air quality and increases FeNO levels of e-cigarette consumers. *Int J Hyg Environ Health* doi:10.1016/j.ijheh.2013.11.003

31 Schripp T, Markewitz D, Uhde E, *et al.* Does e-cigarette consumption cause passive vaping? *Indoor Air* 2013;23:25–31. doi:10.1111/j.1600-0668.2012.00792.x

32 Saffari A, Daher N, Ruprecht AA, *et al.* Particulate metals and organic compounds from electronic and tobacco-containing cigarettes: Comparison of emission rates and secondhand exposure. *Environ Sci Process Impacts* Published Online First: 22 August 2014. doi:10.1039/C4EM00415A

33 George O, Grieder TE, Cole M, *et al.* Exposure to chronic intermittent nicotine vapor induces nicotine dependence. *Pharmacol Biochem Behav* 2010;96:104–7. doi:10.1016/j.pbb.2010.04.013

34 Quick BL, Bates BR, Romina S. Examining antecedents of clean indoor air policy support: Implications for campaigns promoting clean indoor air. *Health Commun* 2009;24:50–9. doi:10.1080/10410230802606992

35 American Nonsmokers' Rights Foundation. U.S. state and local laws regulating use of electronic cigarettes. 2014.http://www.no-smoke.org/pdf/ecigslaws.pdf (accessed 11 Aug2014).

36 Stillman FA, Soong A, Zheng LY, *et al.* E-cigarette use in air transit: self-reported data from US flight attendants. *Tob Control* 2014;:tobaccocontrol – 2013–051514. doi:10.1136/tobaccocontrol-2013-051514

37 Centers for Disease Control and Prevention. National Adult Tobacco Survey (NATS). 2013.http://www.cdc.gov/tobacco/data_statistics/surveys/nats/ (accessed 24 Jan2014).

38 Westat. Health Information National Trends Survey 4 (HINTS 4) Cycle 2 Methodology Report. Rockville, MD: 2013. http://hints.cancer.gov/docs/HINTS_4_Cycle2_Methods_Report.pdf (accessed 25 Jul2013).

39 U. S. Census Bureau. Current Population Survey (CPS). 2012.https://www.census.gov/cps/data/ (accessed 2 Mar2014).

40 Tyler TR, Cook FL. The mass media and judgments of risk: Distinguishing impact on personal and societal level judgments. *J Pers Soc Psychol* 1984;47:693–708. doi:10.1037/0022-3514.47.4.693

41 Coleman CL. The influence of mass media and interpersonal communication on societal and personal risk judgments. *Commun Res* 1993;20:611–28. doi:10.1177/009365093020004006

42 Snyder LB, Rouse RA. The media can have more than an impersonal impact: the case of AIDS risk perceptions and behavior. *Health Commun* 1995;7:125–45.

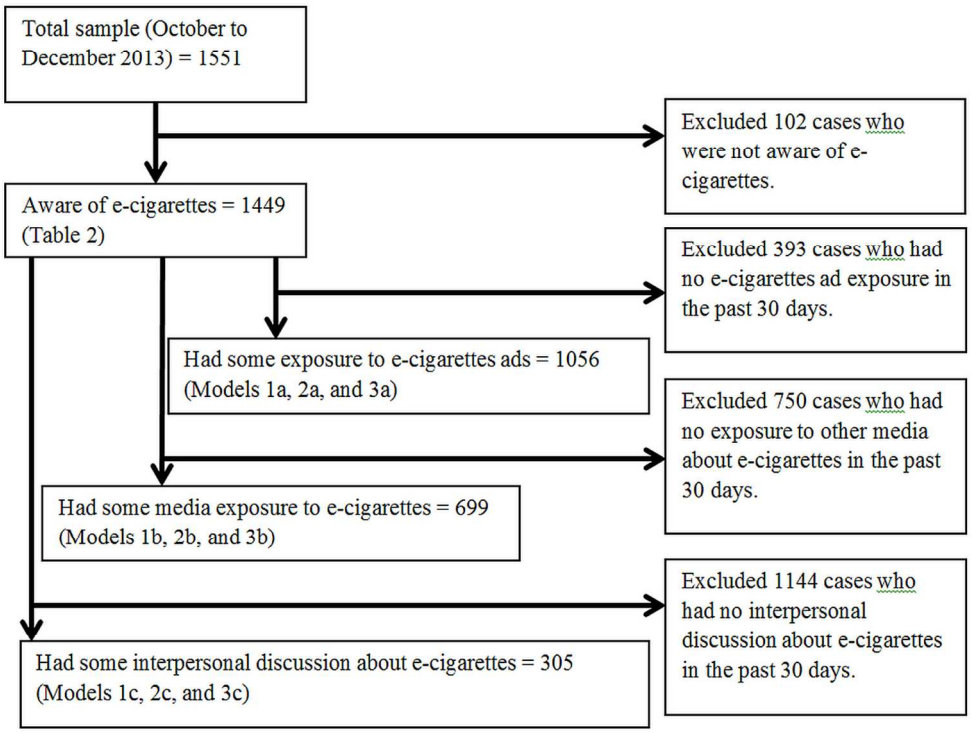
43 Binder AR, Scheufele DA, Brossard D, *et al.* Interpersonal amplification of risk? Citizen discussions and their impact on perceptions of risks and benefits of a biological research facility. *Risk Anal* 2011;31:324–34. doi:10.1111/j.1539-6924.2010.01516.x

44 Han GK, Zhang JM, Chu KR, *et al.* Self–other differences in H1N1 flu risk perception in a global context: A comparative study between the United States and China. *Health Commun* 2013;29:109–23. doi:10.1080/10410236.2012.723267

45 Jones DA. Why Americans don't trust the media a preliminary analysis. *Harv Int J Press* 2004;9:60–75. doi:10.1177/1081180X04263461

46 Lee TT. Why they don't trust the media: An examination of factors predicting trust. *Am Behav Sci* 2010;54:8–21. doi:10.1177/0002764210376308

Supplemental Figure 1 – Flowchart of analyzed sample



Supplemental Figure 1 – Flowchart of analyzed sample

Supplemental Table 1 – Correlations between exposure measures and perceived harm measures

	Harmful to health	Concerned about health impact of vapor	Compared with secondhand smoke
Frequency of ad exposure (n=1443)	-0.086**	-0.0950***	-0.102***
Frequency of media exposure (n=1443)	-0.041	-0.045	-0.034
Frequency of interpersonal discussion (n=1443)	-0.187***	-0.180***	-0.185***
Valence-weighted ad exposure (n=1054)	-0.154***	-0.161***	-0.195***
Valence-weighted media exposure (n=698)	-0.188***	-0.217***	-0.142***
Valence-weighted interpersonal discussion (n=305)	-0.306***	-0.328***	-0.350***

Note. Cell entries are bivariate Spearman's rho estimates. *p<.05, **p<.01, ***p<.0005

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	✓
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	✓
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	✓
Objectives	3	State specific objectives, including any prespecified hypotheses	✓
Methods			
Study design	4	Present key elements of study design early in the paper	✓
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	✓
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	✓
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	✓
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	✓
Bias	9	Describe any efforts to address potential sources of bias	✓
Study size	10	Explain how the study size was arrived at	✓
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	✓
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	✓
		(*b*) Describe any methods used to examine subgroups and interactions	✓
		(*c*) Explain how missing data were addressed	✓
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	✓
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	✓
		(b) Give reasons for non-participation at each stage	✓
		(c) Consider use of a flow diagram	✓
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	✓
		(b) Indicate number of participants with missing data for each variable of interest	✓
Outcome data	15*	Report numbers of outcome events or summary measures	✓
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	✓

		(*b*) Report category boundaries when continuous variables were categorized	✓
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	✓
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	✓
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	✓
Generalisability	21	Discuss the generalisability (external validity) of the study results	✓
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	✓

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Is exposure to e-cigarette communication associated with perceived harms of e-cigarette secondhand vapor? Results from a national survey of U.S. adults

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2014-007134.R1
Article Type:	Research
Date Submitted by the Author:	30-Jan-2015
Complete List of Authors:	Tan, Andy; Dana-Farber Cancer Institute, Department of Medical Oncology, Division of Population Sciences, Center for Community-Based Research; Harvard School of Public Health, Department of Social and Behavioral Sciences Bigman, Cabral; University of Illinois at Urbana-Champaign, Department of Communication Mello, Susan; Northeastern University, Department of Communication Studies Sanders-Jackson, Ashley; Stanford University, Stanford Prevention Research Center
Primary Subject Heading:	Smoking and tobacco
Secondary Subject Heading:	Communication, Public health
Keywords:	electronic cigarette, perceived harm, secondhand vapor, public opinion, United States

Is exposure to e-cigarette communication associated with perceived harms of e-cigarette secondhand vapor? Results from a national survey of U.S. adults

Andy SL Tan[1,2], Cabral A. Bigman[3], Susan Mello[4], Ashley Sanders-Jackson[5]

[1] Dana-Farber Cancer Institute, Population Sciences Division, Center for Community Based Research, Boston, USA

[2] Harvard School of Public Health, Department of Social and Behavioral Sciences, Boston, USA

[3] University of Illinois at Urbana-Champaign, Department of Communication, Urbana, USA

[4] Northeastern University, Department of Communication Studies, Boston, USA

[5] Stanford University, Stanford Prevention Research Center, Stanford, USA

Corresponding author:

Andy SL Tan, MBBS, MPH, MBA, PhD
Dana-Farber Cancer Institute, Population Sciences Division, Center for Community Based Research
375 Longwood Avenue, Room 633,
Boston, MA 02215
Email: andy_tan@dfci.harvard.edu
Telephone: 617-582-7643

Keywords: electronic cigarette, perceived harm, secondhand vapor, United States, public opinion

Word count: 3183

References: 46

Tables: 5

Web appendices: 2

ABSTRACT (300 words)

Objectives: E-cigarettes are frequently advertised and portrayed in the media as less harmful compared with regular cigarettes. Earlier surveys reported public perceptions of harms to people using e-cigarettes; however, public perceptions of harms from exposure to secondhand vapor (SHV) have not been studied. We examined associations between self-reported exposure to e-cigarette advertising, media coverage, and interpersonal discussion and perceived harms of SHV.

Design: Observational study.

Setting: National online sample of U.S. adults aged ≥18 years.

Participants: 1449 U.S. adults (mean age 49.5 years), 51.3% female, 76.6% non-Hispanic White, 7.5% African-American, 10.0% Hispanic, and 5.9% other races.

Outcomes: Perceived harm measures included (1) harmfulness of SHV to one's health, (2) concern about health impact of breathing SHV, and (3) comparative harm of SHV versus secondhand smoke (SHS). Predictors were (1) self-reported frequency of exposure to e-cigarette advertising, media coverage, and interpersonal discussion (close friends or family) and (2) perceived valence of exposure from each source. Covariates were demographic characteristics, cigarette smoking status, and e-cigarette use, and were weighted to the general U.S. adult population.

Results: More frequent interpersonal discussion was associated with lower perceived harmfulness of SHV to one's health and lower perceived comparative harm of SHV versus SHS. Frequency of e-cigarette ad and other media exposure were not significant predictors. Perceived negative valence of ad exposure and interpersonal discussion (versus no exposure) was associated with higher perceived harm across all three outcomes while negative valence of media coverage was associated with higher concern about health impact of breathing SHV. Perceived

positive valence (versus no exposure) of interpersonal discussion was associated with lower perceived harm across all three outcomes about health impact of breathing SHV.

Conclusions: Exposure to information about e-cigarettes through advertising, media coverage, and interpersonal discussion could play a role in shaping public perceptions of the harmfulness of SHV.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This is the first study to describe public perceptions specifically about the harms of SHV among a national sample of U.S. adults and to obtain population estimates of the perceived harms of SHV and associations with information exposure.
- This study is also strengthened by the inclusion of measures beyond frequency of exposure and the inclusion of perceived valence of the exposure from each of the various sources.
- Due to the cross-sectional nature of the analysis, potential threats include reverse causation and omitted confounders.
- The survey was conducted before the FDA announcement of its proposed deeming rule in April 2014. Therefore, more recent data may be necessary to assess the impact of various forms of mediated and interpersonal information exposure arising from the announcement on public perceptions of harms.
- The social media items (in both the advertising and media exposure measures) potentially overlap with one another. Interpersonal discussion could also occur via social media. Future studies should consider alternate methods of measuring ad, media, and interpersonal discussion to better distinguish these forms of exposure.

INTRODUCTION

Public awareness of e-cigarettes among adults in the U.S. has increased over recent years and is near-universal.[1,2] Most people have either seen or heard about e-cigarettes through another person, in stores, television advertising, online, print ads, or news stories.[3] This emergence of mediated and interpersonal communication about e-cigarettes—the benefits and harms of which are still not completely understood—may have important implications for public health and tobacco control. Prior research found that exposure to tobacco-specific information from ads, media and interpersonal sources could influence beliefs and attitudes of the harms of tobacco use, smoking or cessation behaviors, or support for tobacco control policies.[4–11] For example, Depue and colleagues reported that exposure to depictions of tobacco use in social media predicted increased smoking behavior at follow-up among a longitudinal panel of young adults.[11] On the other hand, a national survey among U.S. adults found that self-reported exposure to anti-secondhand smoke (SHS) media predicted negative social cognitions about SHS and support for home restrictions to reduce SHS exposure.[10] Similarly, recent studies suggest that exposure to mediated and interpersonal communication about e-cigarettes predicted attitudes, e-cigarette use behaviors, and support for regulations restricting e-cigarettes in public venues.[12–14]

An important set of public perceptions about e-cigarettes is perceived harm regarding this novel product because favorable perceptions could potentially encourage e-cigarette experimentation.[15–18] For instance, population surveys reported that many smokers and e-cigarette users perceived e-cigarettes to be less harmful than regular cigarettes and cited this as

one of the main reasons for trying e-cigarettes.[19–22] A higher proportion of current smokers versus non-smokers or former smokers rated e-cigarettes as less harmful than regular cigarettes.[1,19] While these earlier surveys provided crucial data on public perceptions of harms to people *using* e-cigarettes, there is currently a lack of data on public perceptions of harms to people *exposed to* secondhand vapor (SHV). This study focuses on perceived harms of SHV to address the above research gap.

E-cigarette ads and information from media outlets frequently include claims that vapors emitted from e-cigarettes are harmless.[23–28] For instance, one popular late-night talk show featured a celebrity using an e-cigarette on the show while she claimed that SHV contained only water vapor.[29] In an analysis of e-cigarette retail websites, Grana and Ling reported that 76% of websites stated that e-cigarettes emit only water vapor and are harmless to others.[27] Such claims about the constituents and harmlessness of SHV through mediated sources could potentially mislead the public because there is emerging evidence that SHV is not innocuous. There are detectable levels of tobacco-specific pollutants in SHV that could impact indoor air quality, though most are at levels lower than those from combustible cigarette smoke.[30–35] In a recent study, researchers noted that while overall particulate matter emissions from e-cigarettes were lower than combustible cigarettes, emissions of specific heavy metals from e-cigarettes exceeded those from combustible cigarettes.[34]

Prior research indicates that harm perceptions about SHS were associated with public support of clean indoor air policies.[36] Correspondingly, harm perceptions about SHV may influence public support for regulation to reduce public exposure to SHV. Currently, regulations

to restrict e-cigarette use in public venues are in flux. Over 180 local and 11 state ordinances have been passed to prohibit the use of e-cigarettes in public places where smoking is not permitted.[37] Other cities and states are also considering adopting similar regulations. Yet, the prevalence of e-cigarette use in public places has steadily increased; a recent survey among U.S. flight attendants reported that almost half of the respondents (46.4%) had seen e-cigarette use in an aircraft or airport.[38] Given the frequent claims about the safety and harmlessness of SHV in the media environment and ongoing policy interventions to restrict e-cigarette use in public, surveillance of public harm perceptions about SHV and an examination of whether exposure to e-cigarette communication is associated with reduced harm perceptions are urgently needed.

The objectives of this study are two-fold: (1) to describe the perceived harms of SHV based on a national survey of U.S. adults and (2) to examine whether exposure to e-cigarette communication through advertising, media, and interpersonal sources is associated with perceived harms of SHV. Information from this analysis would contribute to understanding the potential impact of e-cigarette communication and aid in policy considerations to mitigate these effects or in designing information campaigns to provide accurate information to the public.

METHODS

Study sample and data collection

Data were collected through a survey module, designed by two of the authors (Bigman & Tan), which focused on e-cigarette communication and public perceptions. The survey module was embedded within the Annenberg National Health Communication Survey (ANHCS) from

October through December 2013. The ANHCS is a monthly cross-sectional survey among adults aged 18 years and older in the United States, conducted from 2005 to 2013 by GfK (previously Knowledge Networks) through a university contract. Participants of the ANHCS were invited from KnowledgePanel, 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/). Further details of the sampling and data collection are described elsewhere.[12] The study sample comprised 1551 respondents. Participants who had never heard of e-cigarettes were excluded (n=102), resulting in an analyzed sample of 1449 respondents (aged 18-94 years). The completion rates for the monthly survey from October to December 2013 were 56%, 51%, and 51%, respectively (out of 940 adults in October, 998 adults in November, and 1000 adults in December who were contacted). Informed consent was implied by completion of the survey. The survey did not collect any personally identifiable data. The institutional review board of the University of Pennsylvania granted the ANHCS exempt status.

Measures

Outcome variables – Perceived harms of SHV

Perceived harms of e-cigarettes were measured using three survey items – two personal harm items and a more general comparative harm measure. 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. These two items were adapted from the CDC National Adult Tobacco Survey which asked about perceived harms of secondhand cigarette smoke.[39] The third 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). This item was adapted from the National Cancer Institute (NCI) 2013 Health Information National Trends Survey.[40] All respondents were asked the above three questions.

Predictor Variables – Exposure to advertising, media, and interpersonal discussion

The predictor variables are described in detail elsewhere and the exact phrasing of survey measures is available in the Web-only Supplemental Table 1.[12] Briefly, three survey items measured the frequency of exposure to advertisements promoting electronic cigarettes in the preceding 30 days in (1) convenience stores, liquor stores, or gas stations, (2) television, radio, or newspapers and magazines, and (3) social media such as Facebook, Twitter, or YouTube (responses ranged from never (1), once or twice (2), three or four times (3), and five times or more (4)). Responses were averaged into a scale for the frequency of advertising exposure.

Participants who reported that they had seen or heard at least one form of advertising in the past 30 days were also asked how they perceived the valence of the information in ads. Valence is defined here as whether the information was perceived as positive or negative. Respondents were asked, "In your opinion, was the information in the advertisements promoting electronic cigarettes…?" Response options were 'completely positive', 'mostly positive', 'a mix

of positive and negative', 'mostly negative, and 'completely negative' on a 5-point scale. Based on whether respondents reported exposure to ads and their perceived valence of the exposure, we categorized respondents into four groups: (1) no exposure in the past 30 days, (2) negative valence, (3) mix of positive and negative, and (4) positive valence.[1]

Respondents' frequency of exposure to e-cigarette information in media other than advertising in the preceding 30 days was measured including (1) news on television, newspapers, or magazines, (2) television shows other than news (e.g., drama, late night comedy, celebrity talk shows, reality television), and (3) social media. These three items were averaged into a scale for other media exposure. The perceived valence of media other than ads was obtained using the procedure described earlier.

Interpersonal discussion about e-cigarettes was measured with a single item that asked how often a respondents' close friend or family member talked to them about e-cigarettes. The perceived valence of interpersonal discussion was obtained with the same procedure above.

Covariates

Covariates included age, gender, race/ethnicity, household income, education, and health status. Smoking status was defined based on standard survey questions on amount and recency of cigarette smoking and categorized as: (1) non-smoker (less than 100 cigarettes in their lifetime), (2) former smoker (at least 100 cigarettes in their lifetime but not smoking at all currently), or (3)

[1] We originally conducted analyses using the perceived valence measure only among respondents who had at least some exposure to each of the sources (ads, other media, and interpersonal discussion). Based on suggestions from two of the reviewers, we revised the analytic approach to include the entire analyzed sample by including those who did not have exposure in the past 30 days to e-cigarette communication in a separate category. Substantive findings were similar and detailed results of the original analyses are available from the authors upon request.

current smoker (at least 100 cigarettes in their lifetime and smoking on some days or every day).[39] Ever use of e-cigarettes was categorized as (1) never, (2) ever used e-cigarettes but not in the past 30 days, or (3) used e-cigarettes in the past 30 days. Analyses also adjusted for how often respondents saw other people use e-cigarettes in the preceding 30 days in four venues: (1) indoors at their workplace, (2) indoors at restaurants, (3) indoors at bars/casinos/clubs, and (4) at parks (responses ranged from never (1), once or twice (2), three or four times (3), and five times or more (4)). These responses were averaged into a scale for observing others using e-cigarettes.

Data Analysis

Data analysis was completed in June 2014. After examining descriptive statistics, bivariate correlations (Spearman's rho) of the frequency of exposure measures, valence-weighted exposures, and the three perceived harm outcome measures were examined. Next, multiple regression was utilized to assess associations between each perceived harm outcome measure and all three frequency of exposure measures (from ads, media other than ads, and interpersonal). The amount of missing data across all variables was minimal (2.4%) and listwise deletion was utilized for handling missing values in these regression analyses. The analyzed sample included all 1449 respondents who reported awareness of e-cigarettes.

Separate regression models examined the associations between perceived harm outcomes using the perceived valence of ads, media coverage other than ads, and interpersonal discussion. This enabled the examination of the combined effects of information from each channel (i.e., ads, media, or interpersonal discussion) that were perceived as favorable or unfavorable versus having no exposure to these channels.

All regression models adjusted for demographic variables, smoking status, and e-cigarette use; the Stata 13 SVY program was used to weight the analysis sample to the most recent data from the Current Population Survey (CPS).[41]

RESULTS

Sample characteristics

The mean age of the sample was 49.5 years, 51.3% were female, 76.6% were non-Hispanic white, and 35.5% completed college education or higher. Other characteristics of the sample and weighted distributions (matching the CPS data) are summarized in Table 1.

Table 1 – Study population 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)[a]	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
Tried e-cigarettes at least once				
No		87.9		86.4
Yes but not in the past 30 days		8.1		9.2
Yes and in the past 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)	

Note. [a]6 missing cases.

Descriptive statistics of perceived harm and exposure variables

Participants reported moderate perceived harms associated with SHV. Mean (SD) of perceived harmfulness of SHV to one's health was 3.63 (1.93) while mean of concern about health impact of breathing SHV was 3.94 (2.06) on scales ranging from 1 to 7. Overall, respondents viewed inhaling SHV as less harmful than inhaling SHS; mean (SD) of the comparative harm of SHV versus SHS was 2.03 (0.80) on a scale ranging from 1 to 5.

Exposure to e-cigarette communication in the preceding 30 days was infrequent among participants. Mean (SD) frequency of exposure to advertising, other media, and interpersonal discussion was 1.6 (0.6), 1.4 (0.5), and 1.3 (0.6) respectively on scales ranging from 1 (never) to 4 (five times or more). Significant correlates of higher frequency of exposure to advertising (being a current smoker versus non-smoker and observed others vaping), other media (older age and observed others vaping), and interpersonal discussion (being female, having ever tried e-cigarettes, observed others vaping, and identifying with being a Democrat) were described in detail in a separate analysis available elsewhere.[12] The distributions of the perceived valence measures are summarized in Table 2. The majority of respondents who reported exposure to each of the three channels of e-cigarette information perceived the valence of the information as positive.

Table 2 – Distribution of perceived valence of e-cigarette communication (ads, other media, and interpersonal discussion) (N=1449)

Perceived valence	Communication Channel		
	Advertising	Other Media	Interpersonal Discussion
No exposure	27.1	51.8	79.0
Negative	3.2	3.7	1.3
Mixed	22.2	20.2	8.5
Positive	47.5	24.4	11.3

Spearman correlations between frequency of exposure and valence-weighted exposure with perceived harm items

Higher frequency of exposures to e-cigarette advertising and interpersonal discussion were negatively correlated with all three perceived harm variables (Spearman's rho ranged from -0.086 to -0.187, all p-values<0.01) (Web-only Supplemental Table 2). Frequency of exposure to other media was not significantly associated with the perceived harm measures. Valence-weighted exposures to advertising, other media, and interpersonal discussion were also negatively associated with lower perceived harm outcomes (Spearman's rho ranged from -0.142 to -0.350, all p-values<0.05).

Multiple regression analyses predicting perceived harms of SHV

Table 3 summarizes the regression models predicting each of the perceived harm outcome measures with the frequency of exposure to ads, other media, and interpersonal discussion. Controlling for covariates, higher frequency of exposure to interpersonal discussion was negatively correlated with two of the perceived harm variables—perceived harmfulness of vapor to one's health (b=-0.245, 95% CI=-0.476 to -0.015) and comparative harm of SHV versus SHS (b=-0.134, 95% CI=-0.246 to -0.022). Frequency of exposure to ads and media were not significantly associated with the perceived harm outcomes (Table 3). Younger respondents, being non-Hispanic White (compared with African-American or other race/ethnic group), former and current smokers (compared with non-smokers), and past use of e-cigarettes (compared with never users) were associated with lower ratings of harm for one or more of these outcomes.

Table 3 – Multivariate analyses predicting perceived harm measures with self-reported frequency of exposure measures (N=1449)

	Breathing vapor is harmful to health	Concern about health impact of vapor	Breathing vapor is more harmful compared to breathing smoke
Independent variables	**B (95% CI)**	**B (95% CI)**	**B (95% CI)**
Ad exposure	0.124[-0.102,0.350]	0.049[-0.184,0.283]	-0.028[-0.135,0.079]
Other media exposure	0.019[-0.263,0.302]	0.036[-0.265,0.337]	0.068[-0.067,0.203]
Interpersonal discussion	-0.245*[-0.476,-0.015]	-0.173[-0.423,0.076]	-0.134*[-0.246,-0.022]
Age (years)	0.007[-0.001,0.015]	0.012**[0.004,0.020]	0.001[-0.002,0.004]
Sex – Female	0.145[-0.088,0.379]	0.211[-0.035,0.456]	-0.001[-0.107,0.106]
Race/Ethnicity (White is referent)			
African-American	0.267[-0.200,0.735]	0.283[-0.212,0.778]	0.212*[0.014,0.411]
Hispanic	0.301[-0.093,0.696]	0.357[-0.047,0.760]	0.175[-0.016,0.366]
Other[a]	0.301[-0.176,0.778]	0.246[-0.242,0.735]	0.344**[0.097,0.590]
Education (High school or below is referent)			
Some college	-0.048[-0.341,0.244]	-0.145[-0.451,0.160]	-0.075[-0.204,0.055]
College graduate or higher	0.17[-0.140,0.480]	0.147[-0.173,0.468]	-0.007[-0.135,0.122]
Annual household income (<$25,000 is referent)			
$25,000-49,999	0.097[-0.308,0.502]	0.029[-0.399,0.457]	-0.043[-0.223,0.136]
≥$50,000	0.214[-0.163,0.591]	0.177[-0.216,0.571]	-0.049[-0.220,0.122]
Health Status	0.024[-0.111,0.158]	0.055[-0.086,0.196]	-0.012[-0.075,0.050]
Smoking Status (Non-smoker is referent)			
Former	-0.487***[-0.769,-0.205]	-0.372*[-0.669,-0.075]	-0.104[-0.219,0.010]
Current	-1.119***[-1.516,-0.722]	-0.992***[-1.424,-0.559]	-0.133[-0.321,0.055]
Tried e-cigarettes at least once (Never is referent)			
Yes but not in the past 30 days	-0.623**[-1.074,-0.171]	-0.981***[-1.450,-0.511]	-0.297**[-0.521,-0.073]
Yes in the past 30 days	-0.850**[-1.404,-0.297]	-1.088***[-1.712,-0.465]	-0.462**[-0.765,-0.158]
Observed others vaping	-0.113[-0.396,0.171]	-0.047[-0.362,0.269]	-0.032[-0.196,0.132]
Constant	3.467	3.343	2.298
R-squared	0.125	0.129	0.080

Note. Cell entries are unstandardized coefficients from multivariate regressions adjusting for all variables in the table. Self-reported exposure measures are frequency of exposure on scale with a maximum value of 4. *p<.05, **p<.01, ***p<.0005. As suggested by one reviewer, we

performed a sensitivity analysis to group news and late-night TV together and analyzed information from social media as a separate predictor. The substantive results were identical to what we reported here. Frequency of interpersonal discussion was associated with reduced perceptions that breathing vapor is harmful to health and reduced perceptions of breathing vapor being more harmful than smoke. Frequency of exposure to e-cigarette information from social media was not a significant predictor for the three perceived harm outcomes. As suggested by another reviewer, we also performed a sensitivity analysis to obtain the bootstrapped standard errors because of non-normality of the outcome variables and found that the substantive conclusions were very similar to the above analysis with the exception of one additional significant finding—frequency of other media exposure was associated with higher perceived comparative harm of SHV. These sensitivity analyses are available from the authors upon request.

Table 4 summarizes the regression models predicting each of the perceived harm measures with the perceived valence of exposure to ads, other media, and interpersonal discussion. Perceived negative valence of ad exposure and interpersonal discussion (versus no exposure) was associated with higher perceived harm across all three outcomes (all *P*s<.05). Perceived negative valence of other media (versus no exposure) was associated with higher concerns of the health impact of breathing SHV (*P*<.0005) and was not associated with the other two outcomes. Perceived positive valence of interpersonal discussion (versus no exposure) was associated with lower perceived harm across all three outcomes (all *Ps*<.01). Perceived positive valence of ads and other media (versus no exposure) was not significantly associated with the perceived harm outcomes.

In parallel analyses, we refitted the above models using negative valence as the referent category (not shown here) and noted that perceived positive valence of ad exposure and interpersonal discussion (versus negative valence) was associated with lower perceived harm across all three outcomes (all *P*s<.05). In addition, perceived positive valence of other media (versus negative valence) was associated with lower concerns about health impact of breathing SHV (*P*<.0005) and was not significantly associated with the other two outcomes.

Table 4 – Multivariate analyses predicting perceived harm measures with perceived valence of exposure from ads, other media, and interpersonal discussion (N=1449)

	Breathing vapor is harmful to health	Concern about health impact of vapor	Breathing vapor is more harmful compared to breathing smoke
Independent variables	**B (95% CI)**	**B (95% CI)**	**B (95% CI)**
Valence of ad exposure (referent is no exposure)			
Negative	0.931**[0.261,1.601]	0.856**[0.205,1.506]	0.501*[0.031,0.972]
Mixed	0.010[-0.373,0.393]	0.021[-0.382,0.424]	-0.008[-0.171,0.155]
Positive	-0.127[-0.447,0.193]	-0.209[-0.529,0.111]	-0.098[-0.231,0.036]
Valence of other media exposure (referent is no exposure)			
Negative	0.515[-0.171,1.202]	0.952***[0.393,1.511]	0.030[-0.294,0.354]
Mixed	0.067[-0.252,0.386]	0.005[-0.332,0.343]	0.001[-0.138,0.140]
Positive	-0.144[-0.444,0.155]	-0.228[-0.548,0.092]	-0.099[-0.223,0.024]
Valence of interpersonal discussion (referent is no exposure)			
Negative	1.704***[0.838,2.569]	1.895***[1.080,2.710]	0.731***[0.328,1.134]
Mixed	-0.221[-0.634,0.191]	0.055[-0.414,0.523]	-0.122[-0.320,0.075]
Positive	-0.674***[-1.044,-0.303]	-0.673**[-1.076,-0.270]	-0.414***[-0.570,-0.259]
Age (years)	0.007[-0.001,0.015]	0.011**[0.003,0.019]	0.001[-0.002,0.004]
Sex – Female	0.159[-0.071,0.388]	0.231[-0.007,0.470]	0.013[-0.090,0.117]
Race/Ethnicity (White is referent)			
African-American	0.272[-0.174,0.717]	0.274[-0.194,0.743]	0.222*[0.035,0.409]
Hispanic	0.291[-0.097,0.680]	0.339[-0.051,0.729]	0.188*[0.000,0.377]
Other[a]	0.252[-0.233,0.737]	0.219[-0.280,0.717]	0.317*[0.072,0.562]
Education (High school or below is referent)			
Some college	-0.043[-0.334,0.248]	-0.137[-0.438,0.164]	-0.066[-0.194,0.062]
College graduate or higher	0.235[-0.070,0.540]	0.229[-0.084,0.543]	0.035[-0.091,0.160]
Annual household income			

(<$25,000 is referent)			
$25,000-49,999	0.107[-0.288,0.502]	0.031[-0.378,0.440]	-0.042[-0.213,0.129]
≥$50,000	0.211[-0.161,0.583]	0.172[-0.210,0.555]	-0.054[-0.220,0.112]
Health Status	0.025[-0.103,0.153]	0.049[-0.087,0.184]	-0.014[-0.074,0.046]
Smoking Status (Non-smoker is referent)			
Former	-0.424**[-0.702,-0.146]	-0.297*[-0.586,-0.008]	-0.079[-0.191,0.033]
Current	-0.957***[-1.356,-0.557]	-0.842***[-1.258,-0.425]	-0.061[-0.240,0.119]
Tried e-cigarettes at least once (Never is referent)			
Yes but not in the past 30 days	-0.591*[-1.045,-0.136]	-0.906***[-1.368,-0.444]	-0.277*[-0.495,-0.059]
Yes in the past 30 days	-0.690**[-1.208,-0.172]	-0.873**[-1.449,-0.298]	-0.367*[-0.648,-0.087]
Observed others vaping	-0.104[-0.409,0.202]	-0.044[-0.366,0.277]	-0.024[-0.183,0.135]
Constant	3.416	3.343	2.228
R-squared	0.163	0.181	0.139

Note. Cell entries are unstandardized coefficients from multivariate regressions adjusting for all variables in the table. Self-reported exposure measures are frequency of exposure on scale with a maximum value of 4. *p<.05, **p<.01, ***p<.0005.

DISCUSSION

To our knowledge, this is the first study to describe public perceptions specifically about the harms of SHV among a national sample of U.S. adults. Importantly, the analysis found that respondents perceived SHV as causing moderate levels of harm to one's health and were moderately concerned about the health impact of breathing in SHV. On average, participants rated inhaling SHV as less harmful than SHS. These findings should be qualified as representing a snapshot of current perceptions of SHV harms among U.S. adults. The ratings on perceived harms do not represent objective knowledge about SHV harms given that definitive evidence of harmful health effects of SHV, if any, may require years of research to reveal. The results from this study would serve as important baseline data for the surveillance of public harm perceptions of SHV as the information environment surrounding e-cigarettes and SHV evolves.

This analysis further indicated that information from ads and interpersonal discussion (and to a lesser extent media other than advertising) perceived as positive was associated with lower perceived harms about breathing vapor from e-cigarettes. The associations between ad exposure and lower perceived harms about SHV could have implications for public policy and research related to e-cigarette advertising claims. Specifically, further research is needed to examine whether exposure to specific claims about vapor being harmless in ads are causally related to lower public harm perceptions of SHV using longitudinal and/or experimental designs. From a legislative standpoint, the results could provide important data to inform regulatory considerations to monitor and restrict the presence of unfounded or inaccurate claims about the harmlessness of SHV in marketing materials.

There were differences in the association between e-cigarette communication and perceived harms depending on the channel of communication. The most consistent associations were between frequency of interpersonal discussion and two of the perceived harm outcomes while perceived valence of interpersonal discussion was associated with all three perceived harm outcomes. In comparison, frequency of ad and other media exposure were not significantly associated with the perceived harm measures. Perceived valence of ad exposure was associated with all three perceived harm outcomes and perceived valence of other media exposure was associated with one of the outcomes. Prior research in the context of other forms of health risk information suggest that interpersonal and different types of mediated information can have differential effects on evaluation of personal and societal harm (although these differences are not necessarily consistent).[42–46] Generally, there was a more consistent effect of negative valence, a less consistent effect of positive valence, and no significant effect of mixed valence across the three channels in this study. This is in keeping with the literature on resource allocation, which suggests that aversive information may be more memorable than positive information at low levels of arousal.[47] In the context of public support for tobacco control policies, Blake and colleagues reported that exposure to news coverage about tobacco issues, anti-tobacco advertising, and pro-tobacco advertising were differentially associated with support for five proposed policies to reduce movie portrayals of smoking[2].[9]

It is also possible that interpersonal discussions about e-cigarettes tend to be more persuasive and credible compared with advertising and media content.[48,49] Psychosocial

[2] The five proposed policies in the study were (1) requiring anti-smoking PSAs before movies that show smoking, (2) requiring anti-smoking PSAs before televised movie trailers that show smoking, (3) regulating producers' and actors' acceptance of money for portrayals of smoking in movies, (4) limiting the appearance of tobacco brands and logos in movies, and (5) requiring movies that show smoking to be rated 'R'.

constructs including observational learning, social modeling, and injunctive or descriptive norms are potential mechanisms through which interpersonal communication could influence perceived harms about e-cigarette vapors.[50,51] This could explain the channel differences observed in the current study; however, these hypotheses are not explicitly tested here. More research into the nature of interpersonal discussions about e-cigarettes and potential pathways would offer richer insight into how and why such discussions relate to lower perceptions of harm from SHV.

In this study population, we reported in an earlier paper that women, those who have tried e-cigarettes, observed others vaping, and who identified as being Democrat were more likely to have discussed e-cigarettes with others.[12] Southwell has suggested that disparities in sharing or receiving health information through one's social networks could exacerbate health disparities, including tobacco-related health disparities.[52] More research will be necessary to investigate who is sharing (or not sharing) e-cigarette information and the extent to which interpersonal discussion affects tobacco-related health disparities.

This study is strengthened by the inclusion of measures beyond frequency of exposure and the inclusion of perceived valence of the exposure from each of the various sources. The survey also involved a nationally representative sample of U.S. adults and sampling weights that enabled us to obtain population estimates of the perceived harms of SHV and associations with information exposure. However, the study has a few limitations. While the KnowledgePanel strove to include a nationally representative sample of U.S. adults, we observed that certain subgroups were under-represented (e.g., race/ethnic minorities and those with lower education). This could be due to the survey being conducted online. Further replication using alternate modes of data collection (e.g., through face-to-face interviews) would be helpful to ensure that

the findings are robust across a variety of approaches. The perceived valence measures were limited because they do not capture in detail what specific information within these sources respondents found to be positive or negative. Future qualitative work could be helpful to explore this dimension of e-cigarette-related information. Due to the cross-sectional nature of the analysis, potential threats include reverse causation and omitted confounders. The survey was conducted before the FDA announcement of its proposed deeming rule in April 2014. Therefore, more recent data may be necessary to assess the impact of various forms of mediated and interpersonal information exposure arising from the announcement on public perceptions of harms. Finally, the social media items (in both the advertising and media exposure measures) potentially overlap with one another. Interpersonal discussion could also occur via social media. Future studies should consider alternate methods of measuring ad, media, and interpersonal discussion to better distinguish these forms of exposure.

To conclude, this study found that exposure to information about e-cigarettes through advertising and interpersonal discussion are associated with public perceptions of the harmfulness of SHV. These findings may play a role in guiding public education efforts to increase public understanding of the chemical constituents in SHV and policies to restrict potentially misleading claims in marketing materials.

ACKNOWLEDGEMENTS AND FUNDING STATEMENT

Data for this research came from the Annenberg National Health Communication Survey, supported by the Annenberg School at the University of Pennsylvania and the University of Southern California. Andy Tan conducted this work while a postdoctoral fellow at the Center of Excellence in Cancer Communication Research at the University of Pennsylvania and later an assistant professor at the Dana-Farber Cancer Institute and Harvard School of Public Health. Cabral Bigman conducted this work while an assistant professor at the University of Illinois at Urbana-Champaign. Susan Mello conducted this work while an assistant professor at Northeastern University. Ashley Sanders-Jackson conducted this work while a postdoctoral fellow at Stanford Prevention Research Center. No financial disclosures were reported by the authors of this paper. This work was supported by National Heart, Lung, and Blood Institute grant number T32HL007034 and National Cancer Institute grant number P20CA095856. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

COMPETING INTERESTS STATEMENT

No, there are no competing interests.

AUTHORS' CONTRIBUTORSHIP STATEMENT

AT and CB designed the study and survey questionnaire. AT conducted the data analyses. AT, CB, SM, and AS interpreted the results and drafted the paper. AT is responsible for the overall content as guarantor.

DATA SHARING STATEMENT

Dataset may be accessed through the Annenberg National Health Communication Survey (http://anhcs.asc.upenn.edu/). Survey measures, technical appendix, and statistical code available from the corresponding author upon request.

REFERENCES

1 Tan ASL, Bigman CA. E-cigarette awareness and perceived harmfulness: prevalence and associations with smoking-cessation outcomes. *Am J Prev Med* 2014;**47**:141–9. doi:10.1016/j.amepre.2014.02.011

2 Pepper JK, Brewer NT. Electronic nicotine delivery system (electronic cigarette) awareness, use, reactions and beliefs: a systematic review. *Tob Control* 2013;:tobaccocontrol – 2013–051122. doi:10.1136/tobaccocontrol-2013-051122

3 Pepper JK, Emery SL, Ribisl KM, *et al.* How U.S. adults find out about electronic cigarettes: Implications for public health messages. *Nicotine Tob Res* 2014;:ntu060. doi:10.1093/ntr/ntu060

4 Wakefield M, Flay B, Nichter M, *et al.* Role of the media in influencing trajectories of youth smoking. *Addict Abingdon Engl* 2003;**98 Suppl 1**:79–103.

5 Durkin S, Brennan E, Wakefield M. Mass media campaigns to promote smoking cessation among adults: an integrative review. *Tob Control* 2012;**21**:127–38. doi:10.1136/tobaccocontrol-2011-050345

6 Southwell BG, Yzer MC. When (and why) interpersonal talk matters for campaigns. *Commun Theory* 2009;**19**:1–8. doi:10.1111/j.1468-2885.2008.01329.x

7 Van den Putte B, Yzer M, Southwell BG, *et al.* Interpersonal communication as an indirect pathway for the effect of antismoking media content on smoking cessation. *J Health Commun* 2011;**16**:470–85. doi:10.1080/10810730.2010.546487

8 Blake KD, Viswanath K, Blendon RJ, *et al.* The role of tobacco-specific media exposure, knowledge, and smoking status on selected attitudes toward tobacco control. *Nicotine Tob Res* 2009;:ntp184. doi:10.1093/ntr/ntp184

9 Blake KD, Viswanath K, Blendon RJ, *et al.* The role of reported tobacco-specific media exposure on adult attitudes toward proposed policies to limit the portrayal of smoking in movies. *Tob Control* 2009;:tc.2009.031260. doi:10.1136/tc.2009.031260

10 Douglas Evans W, Crankshaw E, Nimsch C, *et al.* Media and secondhand smoke exposure: results from a national survey. *Am J Health Behav* 2006;**30**:62–71. doi:10.5993/AJHB.30.1.6

11 Depue JB, Southwell BG, Betzner AE, *et al.* Encoded Exposure to Tobacco Use in Social Media Predicts Subsequent Smoking Behavior. *Am J Health Promot* Published Online First: 2014. doi:10.4278/ajhp.130214-ARB-69

12 Tan ASL, Bigman CA, Sanders-Jackson A. Sociodemographic correlates of self-reported exposure to e-cigarette communications and its association with public support for smoke-free and vape-free policies: results from a national survey of US adults. *Tob Control* 2014;:tobaccocontrol – 2014–051685. doi:10.1136/tobaccocontrol-2014-051685

13 Pepper JK, Emery SL, Ribisl KM, *et al.* Effects of advertisements on smokers' interest in trying e-cigarettes: the roles of product comparison and visual cues. *Tob Control* 2014;**23**:iii31–6. doi:10.1136/tobaccocontrol-2014-051718

14 Kelly BJ, Hornik R, Romantan A, *et al.* Cancer information scanning and seeking in the general population. *J Health Commun* 2010;**15**:734–53. doi:10.1080/10810730.2010.514029

15 Choi K, Fabian L, Mottey N, *et al.* Young adults' favorable perceptions of snus, dissolvable tobacco products, and electronic cigarettes: findings from a focus group study. *Am J Public Health* 2012;**102**:2088–93. doi:10.2105/AJPH.2011.300525

16 Choi K, Forster J. Characteristics associated with awareness, perceptions, and use of electronic nicotine delivery systems among young US Midwestern adults. *Am J Public Health* 2013;**103**:556–61. doi:10.2105/AJPH.2012.300947

17 Amrock SM, Zakhar J, Zhou S, *et al.* Perception of e-cigarettes' harm and its correlation with use among US adolescents. *Nicotine Tob Res* 2014;:ntu156. doi:10.1093/ntr/ntu156

18 Choi K, Forster JL. Beliefs and experimentation with electronic cigarettes: a prospective analysis among young adults. *Am J Prev Med* 2014;**46**:175–8. doi:10.1016/j.amepre.2013.10.007

19 Pearson JL, Richardson A, Niaura RS, *et al.* E-cigarette awareness, use, and harm perceptions in US adults. *Am J Public Health* 2012;**102**:1758–66. doi:10.2105/AJPH.2011.300526

20 Richardson A, Pearson J, Xiao H, *et al.* Prevalence, harm perceptions, and reasons for using noncombustible tobacco products among current and former smokers. *Am J Public Health* 2014;**104**:1437–44. doi:10.2105/AJPH.2013.301804

21 Etter JF. Electronic cigarettes: a survey of users. *BMC Public Health* 2010;**10**:231. doi:10.1186/1471-2458-10-231

22 Adkison SE, O'Connor RJ, Bansal-Travers M, *et al.* Electronic nicotine delivery systems: International Tobacco Control Four-Country Survey. *Am J Prev Med* 2013;**44**:207–15. doi:10.1016/j.amepre.2012.10.018

23 Rooke C, Amos A. News media representations of electronic cigarettes: an analysis of newspaper coverage in the UK and Scotland. *Tob Control* 2013;:tobaccocontrol – 2013–051043. doi:10.1136/tobaccocontrol-2013-051043

24 Paek H-J, Kim S, Hove T, *et al.* Reduced harm or another gateway to smoking? Source, message, and information characteristics of e-cigarette videos on YouTube. *J Health Commun* 2013;**In press**. doi:10.1080/10810730.2013.821560

25 Richardson A, Ganz O, Stalgaitis C, *et al.* Noncombustible tobacco product advertising: how companies are selling the new face of tobacco. *Nicotine Tob Res* 2013;:ntt200. doi:10.1093/ntr/ntt200

26 Richardson A, Ganz O, Vallone D. Tobacco on the web: surveillance and characterisation of online tobacco and e-cigarette advertising. *Tob Control* 2014;:tobaccocontrol – 2013–051246. doi:10.1136/tobaccocontrol-2013-051246

27 Grana RA, Ling PM. "Smoking Revolution": a content analysis of electronic cigarette retail websites. *Am J Prev Med* 2014;**46**:395–403. doi:10.1016/j.amepre.2013.12.010

28 Huang J, Kornfield R, Szczypka G, *et al.* A cross-sectional examination of marketing of electronic cigarettes on Twitter. *Tob Control* 2014;**23**:iii26–30. doi:10.1136/tobaccocontrol-2014-051551

29 Katherine Heigl smokes an Electronic Cigarette live on the David Letterman show! 2013. http://www.youtube.com/watch?v=qNIgREJNYxU&feature=youtube_gdata_player (accessed 6 Jan2014).

30 Goniewicz ML, Knysak J, Gawron M, *et al.* Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tob Control* 2013;:tobaccocontrol – 2012–050859. doi:10.1136/tobaccocontrol-2012-050859

31 Czogala J, Goniewicz ML, Fidelus B, *et al.* Secondhand exposure to vapors from electronic cigarettes. *Nicotine Tob Res* Published Online First: 11 December 2013. doi:10.1093/ntr/ntt203

32 Schober W, Szendrei K, Matzen W, *et al.* Use of electronic cigarettes (e-cigarettes) impairs indoor air quality and increases FeNO levels of e-cigarette consumers. *Int J Hyg Environ Health* Published Online First: 2013. doi:10.1016/j.ijheh.2013.11.003

33 Schripp T, Markewitz D, Uhde E, *et al.* Does e-cigarette consumption cause passive vaping? *Indoor Air* 2013;**23**:25–31. doi:10.1111/j.1600-0668.2012.00792.x

34 Saffari A, Daher N, Ruprecht AA, *et al.* Particulate metals and organic compounds from electronic and tobacco-containing cigarettes: Comparison of emission rates and secondhand exposure. *Environ Sci Process Impacts* Published Online First: 22 August 2014. doi:10.1039/C4EM00415A

35 George O, Grieder TE, Cole M, *et al.* Exposure to chronic intermittent nicotine vapor induces nicotine dependence. *Pharmacol Biochem Behav* 2010;**96**:104–7. doi:10.1016/j.pbb.2010.04.013

36 Quick BL, Bates BR, Romina S. Examining antecedents of clean indoor air policy support: Implications for campaigns promoting clean indoor air. *Health Commun* 2009;**24**:50–9. doi:10.1080/10410230802606992

37 American Nonsmokers' Rights Foundation. U.S. State and Local Laws Regulating Use of Electronic Cigarettes. 2014.http://www.no-smoke.org/pdf/ecigslaws.pdf (accessed 11 Aug2014).

38 Stillman FA, Soong A, Zheng LY, *et al.* E-cigarette use in air transit: self-reported data from US flight attendants. *Tob Control* 2014;:tobaccocontrol – 2013–051514. doi:10.1136/tobaccocontrol-2013-051514

39 Centers for Disease Control and Prevention. National Adult Tobacco Survey (NATS). 2013.http://www.cdc.gov/tobacco/data_statistics/surveys/nats/ (accessed 24 Jan2014).

40 Westat. Health Information National Trends Survey 4 (HINTS 4) Cycle 2 Methodology Report. Rockville, MD: 2013. http://hints.cancer.gov/docs/HINTS_4_Cycle2_Methods_Report.pdf (accessed 25 Jul2013).

41 U. S. Census Bureau. Current Population Survey (CPS). 2012.https://www.census.gov/cps/data/ (accessed 2 Mar2014).

42 Tyler TR, Cook FL. The mass media and judgments of risk: Distinguishing impact on personal and societal level judgments. *J Pers Soc Psychol* 1984;**47**:693–708. doi:10.1037/0022-3514.47.4.693

43 Coleman CL. The influence of mass media and interpersonal communication on societal and personal risk judgments. *Commun Res* 1993;**20**:611–28. doi:10.1177/009365093020004006

44 Snyder LB, Rouse RA. The media can have more than an impersonal impact: the case of AIDS risk perceptions and behavior. *Health Commun* 1995;**7**:125–45.

45 Binder AR, Scheufele DA, Brossard D, *et al.* Interpersonal amplification of risk? Citizen discussions and their impact on perceptions of risks and benefits of a biological research facility. *Risk Anal* 2011;**31**:324–34. doi:10.1111/j.1539-6924.2010.01516.x

46 Han GK, Zhang JM, Chu KR, *et al.* Self–other differences in H1N1 flu risk perception in a global context: A comparative study between the United States and China. *Health Commun* 2013;**29**:109–23. doi:10.1080/10410236.2012.723267

47 Lang A. Using the Limited Capacity Model of Motivated Mediated Message Processing to Design Effective Cancer Communication Messages. *J Commun* 2006;**56**:S57–80. doi:10.1111/j.1460-2466.2006.00283.x

48 Jones DA. Why Americans don't trust the media a preliminary analysis. *Harv Int J Press* 2004;**9**:60–75. doi:10.1177/1081180X04263461

49 Lee TT. Why they don't trust the media: An examination of factors predicting trust. *Am Behav Sci* 2010;**54**:8–21. doi:10.1177/0002764210376308

50 Bandura A. *Social foundations of thought and action: a social cognitive theory*. Prentice-Hall 1986.

51 Fishbein M, Ajzen I. *Predicting and changing behavior: the reasoned action approach*. New York: : Psychology Press 2010.

52 Southwell BG. *Social Networks and Popular Understanding of Science and Health: Sharing Disparities*. Baltimore, MD : Research Triangle Park, NC: : Johns Hopkins University Press 2013.

Supplemental Table 1 – Survey Measures for Exposure to E-cigarette Information

Ad Exposure measures

Next, we're going to ask you some questions about the information that you are exposed to in your environment.

In the past 30 days, how often did you see or hear **advertisements promoting electronic cigarettes**…

Variable name		Never	Once or twice	Three or four times	Five times or more
ecigadstore	when you went to a convenience store, liquor store, or gas station?	1	2	3	4
ecigadtvradioprint	when you watched tv, listened to the radio, or read newspapers/magazines?	1	2	3	4
ecigadsocialmedia	when you used social media such as Facebook, Twitter, or Youtube?	1	2	3	4

[PROGRAMMING INSTRUCTION: If ecigadstore OR ecigadtvradioprint OR ecigadsocialmedia=2,3,4, GO TO **ecigadvalence**.

If ecigadstore AND ecigadtvradioprint AND ecigadsocialmedia=1, GO TO **ecignews**.]

ecigadvalence: In your opinion, was the information in the **advertisements promoting electronic cigarettes** …

1. Completely positive
2. Mostly positive
3. A mix of positive and negative
4. Mostly negative
5. Completely negative

Media Exposure (other than ads) measures

In the past 30 days, how often did you see or hear about electronic cigarettes **from sources other than advertisements**…

Variable name		Never	Once or twice	Three or four times	Five times or more
ecignews	when you watched news on tv or read about news on newspapers/magazines?	1	2	3	4
ecigtvshows	when you watched tv shows other than news (e.g., drama, late night comedy, celebrity talk shows, reality television)?	1	2	3	4
ecigsocialmedia	when you used social media such as Facebook, Twitter, or Youtube?	1	2	3	4

[PROGRAMMING INSTRUCTION: If ecignews OR ecigtvshows OR ecigsocialmedia =2,3,4, GO TO **ecigmedvalence**.

If ecignews AND ecigtvshows AND ecigsocialmedia =1, GO TO **eciginterpersonal**.]

ecigmedvalence: In your opinion, was the information about electronic cigarettes **from sources other than advertisements** (i.e., news, TV shows, or social media) …

1. Completely positive
2. Mostly positive
3. A mix of positive and negative
4. Mostly negative
5. Completely negative

Interpersonal communication about e-cigarettes

eciginterpersonal: In the past 30 days, how often did a close friend or family member talk to you about electronic cigarettes?

1. Never
2. Once or twice
3. Three or four times
4. Five times or more

[PROGRAMMING INSTRUCTION: If **eciginterpersonal** =2,3,4, GO TO **ecigipvalence**. If **eciginterpersonal** =1, GO TO **ecigsmkfree**.]

ecigipvalence: In your opinion, was the information your close friends or family members shared about electronic cigarettes …

1. Completely positive
2. Mostly positive
3. A mix of positive and negative
4. Mostly negative
5. Completely negative

Supplemental Table 2 – Correlations between exposure measures and perceived harm measures

	Harmful to health	Concerned about health impact of vapor	Compared with secondhand smoke
Frequency of ad exposure (n=1443)	-0.086**	-0.0950***	-0.102***
Frequency of media exposure (n=1443)	-0.041	-0.045	-0.034
Frequency of interpersonal discussion (n=1443)	-0.187***	-0.180***	-0.185***
Valence-weighted ad exposure (n=1054)	-0.154***	-0.161***	-0.195***
Valence-weighted media exposure (n=698)	-0.188***	-0.217***	-0.142***
Valence-weighted interpersonal discussion (n=305)	-0.306***	-0.328***	-0.350***

Note. Cell entries are bivariate Spearman's rho estimates. *p<.05, **p<.01, ***p<.0005

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	✓
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	✓
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	✓
Objectives	3	State specific objectives, including any prespecified hypotheses	✓
Methods			
Study design	4	Present key elements of study design early in the paper	✓
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	✓
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	✓
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	✓
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	✓
Bias	9	Describe any efforts to address potential sources of bias	✓
Study size	10	Explain how the study size was arrived at	✓
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	✓
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	✓
		(*b*) Describe any methods used to examine subgroups and interactions	✓
		(*c*) Explain how missing data were addressed	✓
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	✓
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	✓
		(b) Give reasons for non-participation at each stage	✓
		(c) Consider use of a flow diagram	✓
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	✓
		(b) Indicate number of participants with missing data for each variable of interest	✓
Outcome data	15*	Report numbers of outcome events or summary measures	✓
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	✓

		(*b*) Report category boundaries when continuous variables were categorized	✓
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	✓
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	✓
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	✓
Generalisability	21	Discuss the generalisability (external validity) of the study results	✓
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	✓

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.