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Is exposure to e-cigarette communication associated with perceived harms of e-cigarette secondhand vapour? Results from a national survey of US adults

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ABSTRACT

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 vapour (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 US adults aged ≥18 years.

Participants: 1449 US adults (mean age 49.5 years), 51.3% female, 76.6% non-Hispanic Caucasian, 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 US 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 (vs 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 (vs 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 secondhand vapour (SHV) among a national sample of US 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.
- Owing to the cross-sectional nature of the analysis, potential threats include reverse causation and omitted confounders.
- The survey was conducted before the Food and Drug Administration (FDA) announcement of its proposed deeming rule in April 2014. Therefore, 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 USA 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 behaviours, or support for tobacco control policies.[4–11] For example, Depue *et al*[11] reported that exposure to depictions of tobacco use in social media predicted increased smoking behaviour at follow-up among a longitudinal panel of young adults. On the other hand, a national survey among US adults found that self-reported exposure to antisecondhand 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 behaviours 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 favourable 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 vapour (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 vapours 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 vapour.[29] In an analysis of e-cigarette retail websites, Grana and Ling[27] reported that 76% of websites stated that e-cigarettes emit only water vapour and are harmless to others. 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 US 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 twofold: (1) to describe the perceived harms of SHV based on a national survey of US 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 (CAB and ASLT), 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 USA, 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 and address-based sampling methods (see http://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 analysed 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.

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 seven-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 seven-point Likert-like scale. These two items were adapted from the U.S. Centers for Disease Control and Prevention (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 online supplementary table S1.[12] Briefly, three survey items measured the frequency of exposure to advertisements promoting e-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 five-point scale. Based on whether respondents reported exposure to ads and their perceived valence of the exposure, we categorised 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.[i]

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 (eg, 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 categorised 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) current smoker (at least 100 cigarettes in their lifetime and smoking on some days or every day).[39] Ever use of e-cigarettes was categorised 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 r) of the frequency of exposure measures, valence-weighted

[i]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 analysed 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 on request.

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				
Non-Hispanic Caucasian		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)*	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 1–4 from never to five times or more in the past 30 days)	1.2 (0.4)		1.3 (0.0)	

*Six missing cases.

exposures and the three perceived harm outcome measures were examined. Next, multiple regression was utilised to assess associations between each perceived harm outcome measure and all three frequency of exposure measures (from ads, media other than ads and interpersonal discussion). The amount of missing data across all variables was minimal (2.4%) and listwise deletion was utilised for handling missing values in these regression analyses. The analysed 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 (ie, ads, media or interpersonal discussion) that were perceived as favourable or unfavourable versus having no exposure to these channels.

All regression models adjusted for demographic variables, smoking status and e-cigarette use; the Stata V.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 Caucasian and 35.5% completed college education or higher. Other characteristics of the sample and weighted distributions (matching the CPS data) are summarised in table 1.

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)

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

to 4 (five times or more). Significant correlates of higher frequency of exposure to advertising (being a current smoker vs 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 summarised 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.

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 was negatively correlated with all three perceived harm variables (Spearman's r ranged from −0.086 to −0.187, all p<0.01; see online supplementary table S2). 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 r ranged from −0.142 to −0.350, all p<0.05).

Multiple regression analyses predicting perceived harms of SHV

Table 3 summarises 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 vapour 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 was not significantly associated with the perceived harm outcomes (table 3). Younger respondents, being non-Hispanic Caucasian (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 4 summarises 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<0.05). Perceived negative valence of other media (vs no exposure) was associated with higher concerns of the health impact of breathing SHV (p<0.0005) and was not associated with the other two outcomes. Perceived positive valence of interpersonal discussion (vs no exposure) was associated with lower perceived harm across all three outcomes (all p<0.01). Perceived positive valence of ads and other media (vs 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 (vs negative valence) was associated with lower perceived harm across all three outcomes (all p<0.05). In addition, perceived positive valence of other media (vs negative valence) was associated with lower concerns about health impact of breathing SHV (p<0.0005) and was not significantly associated with the other two outcomes.

DISCUSSION

To our knowledge, this is the first study to describe public perceptions specifically about the harms of SHV among a national sample of US 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 US 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 vapour 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 vapour being harmless in ads are

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

Independent variables	Breathing vapour is harmful to health B (95% CI)	Concern about health impact of vapour B (95% CI)	Breathing vapour is more harmful compared with breathing smoke B (95% CI)
Ad exposure	0.124 (−0.102 to 0.350)	0.049 (−0.184 to 0.283)	−0.028 (−0.135 to 0.079)
Other media exposure	0.019 (−0.263 to 0.302)	0.036 (−0.265 to 0.337)	0.068 (−0.067 to 0.203)
Interpersonal discussion	−0.245* (−0.476 to −0.015)	−0.173 (−0.423 to 0.076)	−0.134* (−0.246 to −0.022)
Age (years)	0.007 (−0.001 to 0.015)	0.012** (0.004 to 0.020)	0.001 (−0.002 to 0.004)
Sex			
Female	0.145 (−0.088 to 0.379)	0.211 (−0.035 to 0.456)	−0.001 (−0.107 to 0.106)
Race/ethnicity (non-Hispanic Caucasian is referent)			
African-American	0.267 (−0.200 to 0.735)	0.283 (−0.212 to 0.778)	0.212* (0.014 to 0.411)
Hispanic	0.301 (−0.093 to 0.696)	0.357 (−0.047 to 0.760)	0.175 (−0.016 to 0.366)
Other	0.301 (−0.176 to 0.778)	0.246 (−0.242 to 0.735)	0.344** (0.097 to 0.590)
Education (high school or below is referent)			
Some college	−0.048 (−0.341 to 0.244)	−0.145 (−0.451 to 0.160)	−0.075 (−0.204 to 0.055)
College graduate or higher	0.17 (−0.140 to 0.480)	0.147 (−0.173 to 0.468)	−0.007 (−0.135 to 0.122)
Annual household income (<$25 000 is referent)			
$25 000–$49 999	0.097 (−0.308 to 0.502)	0.029 (−0.399 to 0.457)	−0.043 (−0.223 to 0.136)
≥$50 000	0.214 (−0.163 to 0.591)	0.177 (−0.216 to 0.571)	−0.049 (−0.220 to 0.122)
Health status	0.024 (−0.111 to 0.158)	0.055 (−0.086 to 0.196)	−0.012 (−0.075 to 0.050)
Smoking status (non-smoker is referent)			
Former	−0.487*** (−0.769 to −0.205)	−0.372* (−0.669 to −0.075)	−0.104 (−0.219 to 0.010)
Current	−1.119*** (−1.516 to −0.722)	−0.992*** (−1.424 to −0.559)	−0.133 (−0.321 to 0.055)
Tried e-cigarettes at least once (never is referent)			
Yes but not in the past 30 days	−0.623** (−1.074 to −0.171)	−0.981*** (−1.450 to −0.511)	−0.297** (−0.521 to −0.073)
Yes in the past 30 days	−0.850** (−1.404 to −0.297)	−1.088*** (−1.712 to −0.465)	−0.462** (−0.765 to −0.158)
Observed others vaping	−0.113 (−0.396 to 0.171)	−0.047 (−0.362 to 0.269)	−0.032 (−0.196 to 0.132)
Constant	3.467	3.343	2.298
R^2	0.125	0.129	0.080

Cell entries are unstandardised 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.
As suggested by one reviewer, we performed a sensitivity analysis to group news and late-night TV together and analysed 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 vapour is harmful to health and reduced perceptions of breathing vapour 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 SEs 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 on request.
*p<0.05, **p<0.01, ***p<0.0005.

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 was 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

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

Independent variables	Breathing vapour is harmful to health B (95% CI)	Concern about health impact of vapour B (95% CI)	Breathing vapour is more harmful compared with breathing smoke B (95% CI)
Valence of ad exposure (referent is no exposure)			
Negative	0.931** (0.261 to 1.601)	0.856** (0.205 to 1.506)	0.501* (0.031 to 0.972)
Mixed	0.010 (−0.373 to 0.393)	0.021 (−0.382 to 0.424)	−0.008 (−0.171 to 0.155)
Positive	−0.127 (−0.447 to 0.193)	−0.209 (−0.529 to 0.111)	−0.098 (−0.231 to 0.036)
Valence of other media exposure (referent is no exposure)			
Negative	0.515 (−0.171 to 1.202)	0.952*** (0.393 to 1.511)	0.030 (−0.294 to 0.354)
Mixed	0.067 (−0.252 to 0.386)	0.005 (−0.332 to 0.343)	0.001 (−0.138 to 0.140)
Positive	−0.144 (−0.444 to 0.155)	−0.228 (−0.548 to 0.092)	−0.099 (−0.223 to 0.024)
Valence of interpersonal discussion (referent is no exposure)			
Negative	1.704*** (0.838 to 2.569)	1.895*** (1.080 to 2.710)	0.731*** (0.328 to 1.134)
Mixed	−0.221 (−0.634 to 0.191)	0.055 (−0.414 to 0.523)	−0.122 (−0.320 to 0.075)
Positive	−0.674*** (−1.044 to −0.303)	−0.673** (−1.076 to −0.270)	−0.414*** (−0.570 to −0.259)
Age (years)	0.007 (−0.001 to 0.015)	0.011** (0.003 to 0.019)	0.001 (−0.002 to 0.004)
Sex			
Female	0.159 (−0.071 to 0.388)	0.231 (−0.007 to 0.470)	0.013 (−0.090 to 0.117)
Race/ethnicity (non-Hispanic Caucasian is referent)			
African-American	0.272 (−0.174 to 0.717)	0.274 (−0.194 to 0.743)	0.222* (0.035 to 0.409)
Hispanic	0.291 (−0.097 to 0.680)	0.339 (−0.051 to 0.729)	0.188* (0.000 to 0.377)
Other	0.252 (−0.233 to 0.737)	0.219 (−0.280 to 0.717)	0.317* (0.072 to 0.562)
Education (high school or below is referent)			
Some college	−0.043 (−0.334 to 0.248)	−0.137 (−0.438 to 0.164)	−0.066 (−0.194 to 0.062)
College graduate or higher	0.235 (−0.070 to 0.540)	0.229 (−0.084 to 0.543)	0.035 (−0.091 to 0.160)
Annual household income (<$25 000 is referent)			
$25 000–$49 999	0.107 (−0.288 to 0.502)	0.031 (−0.378 to 0.440)	−0.042 (−0.213 to 0.129)
≥$50 000	0.211 (−0.161 to 0.583)	0.172 (−0.210 to 0.555)	−0.054 (−0.220 to 0.112)
Health status	0.025 (−0.103 to 0.153)	0.049 (−0.087 to 0.184)	−0.014 (−0.074 to 0.046)
Smoking status (non-smoker is referent)			
Former	−0.424** (−0.702 to −0.146)	−0.297* (−0.586 to −0.008)	−0.079 (−0.191 to 0.033)
Current	−0.957*** (−1.356 to −0.557)	−0.842*** (−1.258 to −0.425)	−0.061 (−0.240 to 0.119)
Tried e-cigarettes at least once (never is referent)			
Yes but not in the past 30 days	−0.591* (−1.045 to −0.136)	−0.906*** (−1.368 to −0.444)	−0.277* (−0.495 to −0.059)
Yes in the past 30 days	−0.690** (−1.208 to −0.172)	−0.873** (−1.449 to −0.298)	−0.367* (−0.648 to −0.087)
Observed others vaping	−0.104 (−0.409 to 0.202)	−0.044 (−0.366 to 0.277)	−0.024 (−0.183 to 0.135)
Constant	3.416	3.343	2.228
R^2	0.163	0.181	0.139

Cell entries are unstandardised 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<0.05, **p<0.01, ***p<0.0005.

of public support for tobacco control policies, Blake *et al*[9] reported that exposure to news coverage about tobacco issues, antitobacco advertising and protobacco advertising was differentially associated with support for five proposed policies to reduce movie portrayals of smoking[ii].

[ii]The five proposed policies in the study were (1) requiring antismoking public service announcements (PSAs) before movies that show smoking, (2) requiring antismoking 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'.

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 constructs including observational learning, social modelling, and injunctive or descriptive norms are potential mechanisms through which interpersonal communication could influence perceived harms about e-cigarette vapours.[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[52] has suggested that disparities in sharing or receiving health information through one's social networks could exacerbate health disparities, including tobacco-related health disparities. 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 US 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 US adults, we observed that certain subgroups were under-represented (eg, 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 (eg, 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. Owing to the cross-sectional nature of the analysis, potential threats include reverse causation and omitted confounders. The survey was conducted before the Food and Drug Administration (FDA) announcement of its proposed deeming rule in April 2014. Therefore, 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 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 is 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.

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