HHS Public Access

How hearing about harmful chemicals affects smokers' interest in dual use of cigarettes and e-cigarettes

Jessica K. Pepper[a,b,*], **M. Justin Byron**[a,c], **Kurt M. Ribisl**[a,c], and **Noel T. Brewer**[a,c]

[a]Department of Health Behavior, Gillings School of Global Public Health, University of North Carolina, 135 Dauer Drive, Rosenau Hall, CB#7440, Chapel Hill, NC 27599, USA

[b]RTI International, 3040 E. Cornwallis Road, Research Triangle Park, NC 27709, USA

[c]Lineberger Comprehensive Cancer Center, University of North Carolina, 101 Manning Drive, CB#7295, Chapel Hill, NC 27599, USA

Abstract

Substantial harm could result from concurrent cigarette and e-cigarette use (i.e., dual use) were it to undermine smoking cessation. Perceptions of chemical exposure and resulting harms may influence dual use. We conducted a probability-based phone survey of 1164 U.S. adult cigarette smokers in 2014–2015 and analyzed results in 2016. In a between-subjects experiment, smokers heard a hypothetical scenario in which cigarettes and e-cigarettes had the same amount of harmful chemicals or cigarettes had more chemicals than e-cigarettes (10× more, 100× more, or chemicals were present only in cigarettes). Smokers indicated how the scenario would change their interest in dual use and perceived health harms. Few smokers (7%) who heard that the products have the same amount of chemicals were interested in initiating or increasing dual use. However, more smokers were interested when told that cigarettes have 10× more chemicals than e-cigarettes (31%), 100× more chemicals than e-cigarettes (32%), or chemicals were present only in cigarettes (43%) (all $p < .001$). Individuals told that cigarettes have more chemicals were more likely than those in the "same amount" scenario to perceive that cigarettes would be more harmful than e-cigarettes (79% vs. 41%, OR = 5.41, 95% CI = 4.08–7.17). These harm perceptions partially explained the relationship between chemical scenario and dual use interest. Smokers associated higher chemical amounts in cigarettes versus e-cigarettes with greater health harms from cigarettes and thus expressed increased interest in dual use. The findings suggest that disclosing amounts of chemicals in cigarette smoke and e-cigarette aerosol could unintentionally encourage dual use.

Keywords

Smoking; Electronic cigarettes; Tobacco products

*Corresponding author at: RTI International, 3040 E. Cornwallis Road, Research Triangle Park, NC 27709-2194, USA. jpepper@rti.org (J.K. Pepper).

1. Introduction

The toxic constituents (chemicals) in cigarette smoke, including at least 71 carcinogens, directly contribute to the burden of disease caused by cigarette smoking (Talhout et al., 2011). The 2009 Family Smoking Prevention and Tobacco Control Act requires tobacco companies to report to the U.S. Food and Drug Administration (FDA) the quantity of each harmful or potentially harmful smoke constituent for each brand and sub-brand of cigarettes (11th Congress of the United States of America, 2009). FDA must then disclose this information to the public in a way that is "understandable" and not "misleading to a lay person" (U.S. Food and Drug Administration, 2011). U.S. adults have little knowledge of most of the chemicals in cigarette smoke (Hall et al., 2014), and when presented with general information about chemicals and their quantities, most adults have difficulty interpreting this information (Neil et al., 1994). One consideration for FDA in determining how to disclose constituent information in cigarettes may be the impact of this information on use of e-cigarettes, another product that FDA now regulates and will eventually require manufacturers to report the levels of constituents (U.S. Food and Drug Administration, 2016).

One public health concern about disclosing cigarette smoke constituent information to the public is that smokers may respond by initiating or increasing e-cigarette use without quitting cigarette smoking (i.e., engaging in dual use of these products). Although quitting smoking dramatically improves health outcomes, reductions in the amount of cigarette smoking appear to have few or minor benefits unless the reductions are both substantial (down to <50% of baseline use) and sustained over time (Begh et al., 2015; Pisinger and Godtfredsen, 2007). Thus, starting or increasing e-cigarette use, even if accompanied by some reduction in cigarette smoking, is unlikely to lead to improved health outcomes. E-cigarette advertising claims (e.g., that e-cigarettes produce only "harmless water vapor" or contain "no carcinogens") (Grana and Ling, 2014) and positive interpersonal communication from e-cigarette enthusiasts (Pepper et al., 2014) may be encouraging dual use of e-cigarettes and traditional cigarettes. Dual use is potentially problematic because it could maintain smokers' nicotine addiction, making it more difficult to quit using tobacco (Schroeder and Hoffman, 2014). Smokers trying to use e-cigarettes to quit smoking often use a tapering approach to reduce their cigarette smoking over time (Pepper and Brewer, 2014; Rutten et al., 2015), which for some individuals may be a less successful strategy than "quitting cold turkey" for achieving successful cessation (Cheong et al., 2007). Furthermore, e-cigarette use exposes users to aerosolized e-liquid, a mix of unregulated and often unknown chemical ingredients, some of which have been found to be toxic (Barrington-Trimis et al., 2014; Goniewicz et al., 2014).

Understanding smokers' harm perceptions about chemicals in traditional cigarettes and e-cigarettes is important for two reasons. First, it could provide insight into smokers' decisions about dual use. Second, it has regulatory implications. The FDA is currently considering how best to publicly display information on the amounts of harmful chemicals in traditional cigarettes and e-cigarettes and whether certain tobacco products like e-cigarettes could be approved as "modified risk tobacco products" on the basis of their amounts of harmful constituents (U.S. Food and Drug Administration, 2015). Thus, the goal of our study was to

explore the impact of hypothetical scenarios describing the amounts of chemicals in e-cigarettes relative to cigarettes on smokers' interest in initiating or increasing dual use. We further explored the relationship between scenarios and interest in dual use with anticipated perceptions about the health harms caused by cigarettes versus e-cigarettes.

2. Methods

2.1. Sample

From September 2014 to May 2015, we recruited a probability sample of 5014 U.S. adults, including 1164 smokers (Boynton et al., 2016; Brewer et al., 2016). Our paper focuses on an experiment conducted with established cigarette smokers (defined as those who reported smoking "some days" or "every day" and who had smoked at least 100 cigarettes in their lifetime). We identified participants through random-digit-dial landline and cell phone sampling frames with 98% coverage of the U.S. population. We oversampled cell phone numbers and geographic areas with higher rates of poverty and smoking. To be eligible for study participation, adults had to be aged 18 or older and speak English or Spanish. Boynton and colleagues have provided additional details on sampling design, survey methods, and sample characteristics (Boynton et al., 2016). The response rate among adults was 42%, calculated using AAPOR formula 4 (American Association for Public Opinion Research, 2016; Boynton et al., 2016). The University of North Carolina's institutional review board approved the study.

2.2. Procedure and measures

Interviewers obtained verbal consent before starting the interview. Participants heard a broad description of e-cigarettes at the beginning of the interview ("The next few questions are about electronic or e-cigarettes and other vaping devices, such as e-hookah and vape pens. Popular brands include Blu, Vuse, NJOY, and Flavor Vapes."). Later in the interview, before responding to the experimental items, interviewers told participants, "In the next questions, I'll say 'e-cigarettes' to also refer to other vaping devices." Survey software randomized cigarette smokers to 1 of 4 scenarios describing hypothetical amounts of chemicals in cigarettes and e-cigarettes: "What if... [the amount of harmful chemicals in cigarettes was the same as in e-cigarettes; the amount of harmful chemicals in cigarettes was about 10 times higher than in e-cigarettes; the amount of harmful chemicals in cigarettes was about 100 times higher than in e-cigarettes; cigarettes had harmful chemicals, but e-cigarettes did not]." We hereafter refer to these scenarios as "same amount," "10 times more" [in cigarettes compared with e-cigarettes], "100 times more" [in cigarettes compared with e-cigarettes], and "chemicals present" [in cigarettes versus absent in e-cigarettes].

Next, smokers were asked how this scenario would affect their perceptions of harm: "Would this make you think that cigarettes cause more health problems than e-cigarettes?" ("no" coded as 0 and "yes" as 1). For parsimony, we refer to these anticipated perceptions, which represent their imagined response to the scenario, as "harm perceptions" or "perceived harm." Interviewers then asked smokers who were not current e-cigarette users whether learning the information in the scenario would make them start using e-cigarettes. If smokers were already current e-cigarette users, interviewers asked if the information in the scenario

would make them use e-cigarettes less, the same amount, or more. Finally, respondents were asked whether the chemical information described in the scenario would make them stop smoking traditional tobacco cigarettes, smoke less, smoke the same amount, or smoke more. We recoded participants' answers to these items such that a value of "1" corresponded to interest in initiating or increasing dual use of the products. We defined this type of interest as the participant stating that she or he would decrease, continue, or increase cigarette smoking (i.e., any smoking behavior other than quitting) while also starting or increasing e-cigarette use. We coded all other combinations of behaviors as "0."

Demographic measures included sex, age, race, Hispanic/Latino ethnicity, educational attainment (high school or less; some college or associate's degree; bachelor's degree or more), and geographic region. We coded participants as having low socioeconomic status if they had a household income below the federal poverty level, they had less than a high school education (among adults aged 21 or older), or if their mothers had less than a high school education (among adults aged 18 to 20). We coded them as having low numeracy (i.e., difficulty understanding and working with numbers) if they responded "Don't know" or incorrectly to the following survey item: "In general, which of these numbers shows the biggest risk of getting a disease? 1 in 10; 1 in 100; or 1 in 1,000." (Lipkus et al., 2001) Respondents who had never tried e-cigarettes were considered "never users"; among those who had ever tried e-cigarettes, we describe individuals who had used in the past 30 days as "current users" and those who had not used in the past 30 days as "former users."

2.3. Statistical analyses

To check whether random assignment created demographically equivalent groups by experimental condition, we used chi-square tests for categorical demographic variables (sex, race/ethnicity, region, own or mothers' education, e-cigarette use, cigarette smoking, and numeracy) and linear regression for the continuous demographic variable (age). Using logistic regression, we examined the effects of chemical amount scenario on harm perceptions and interest in dual use. The "same amount" scenario was the reference category in these two regressions. Next, we assessed whether perceived harm mediated the relationship between the chemical amount scenario (coded as 0 for "same amount" and 1 for the "10 times more," "100 times more," and "chemicals present" scenarios) and interest in dual use. We used a Sobel test to examine the significance of the mediation effect. To explore the role of numeracy in participants' responses to the scenarios, we also conducted exploratory analyses using the same analytic approaches as described above but stratifying by numeracy. Finally, we examined whether prior use of e-cigarettes changed the relationship between the scenario and interest in dual use (i.e., moderation). The moderation analysis was a logistic regression, which included the chemical amount scenario (0 for "same amount" and 1 for any other scenario), past e-cigarette use (0 for "no" and 1 for "yes"), and their interaction. The moderation analysis was conducted using the full sample, not stratified by numeracy, in order to avoid having small cell sizes with less precise estimates. We used two-tailed statistical tests and conducted analyses in 2016 using Stata version 13. Regression coefficients are presented as odds ratios with 95% confidence intervals (CIs).

3. Results

About half of participants had not attended college (53%) (Table 1). Their mean age was 42 years (SD = 15). The majority of participants were white (68%) and non-Hispanic (93%). A moderate number were low socioeconomic status (36%) or low numeracy (38%). About one-third each smoked 1 pack or more of cigarettes per day (32%), smoked daily but <1 pack of cigarettes per day (38%), or only smoked some days (31%). Most (69%) smokers had tried e-cigarettes, but only 32% had used them in the past 30 days. Participant characteristics did not differ by scenario (all $p > 0.05$).

3.1. Effects of chemical amount scenarios

Compared with the "same amount" scenario (in which 7% were interested in dual use), more smokers were interested in dual use when told that cigarettes have 10 times more chemicals than e-cigarettes (31%, OR = 5.62, 95% CI = 3.41–9.29), 100 times more chemicals than e-cigarettes (32%, OR = 5.89, 95% CI = 3.57–9.74), or chemicals were present in cigarettes but not e-cigarettes (43%, OR = 9.41, 95% CI = 5.76–15.36) (Table 2). Chemical amount scenarios had a similar effect on smokers' perceptions of whether cigarettes cause more health problems than e-cigarettes (see Table 2). While 41% endorsed the belief that cigarettes cause more health problems than e-cigarettes in the "same amount" scenario, 79% (OR = 5.48, 95% CI = 3.79–7.92) endorsed it in response to the "10 times more" scenario, 80% (OR = 5.62, 95% CI = 3.87–8.16) in response to the "100 times more" scenario, and 78% (OR = 5.16, 95% CI = 3.61–7.37) in the "chemicals present only in cigarettes" scenario. After stratification, the low numeracy and high numeracy groups both showed the same pattern of results relative to the full sample.

3.2. Mediation by perceived harm

Perceptions of harm partly explained the relationship between chemical amount scenario and interest in dual use of cigarettes and e-cigarettes (Fig. 1). Smokers were more likely to perceive that cigarettes were more harmful than e-cigarettes when told that the amount of chemicals in cigarettes was higher than in e-cigarettes (79% vs. 41%, OR = 5.41, 95% CI = 4.08–7.17). Perceptions about the greater harm of cigarettes compared with e-cigarettes were associated with more interest in dual use (37% vs. 8%, OR = 5.19, 95% CI = 3.38–7.97). Controlling for perceived harm reduced the association between chemical amount scenario and interest in dual use, and the association remained statistically significant (OR = 4.49, 95% CI = 2.81–7.20), a pattern of findings that indicates partial mediation (Sobel z = 6.88, $p < 0.001$). After stratification, the low numeracy and high numeracy groups both showed the same pattern of mediation as in the full sample.

3.3. Moderating effect of prior e-cigarette use on interest in dual use

Smokers who had used e-cigarettes at least once in their lifetimes responded differently to one of the chemical amount scenarios than those who had not (i.e., moderation by prior e-cigarette use, interaction $p < 0.05$). Specifically, the difference between the "100 times more" and "same amount" scenarios was statistically significant among e-cigarette experienced smokers (36% in the "100 times more" vs. 6% in the "same amount" scenarios were interested in dual use, $p < 0.001$). It was also different among the e-cigarette naïve

smokers (23% in the "100 times more" vs. 10% in the "same amount" scenarios were interested in dual use, $p < 0.05$). However, the difference between scenarios was larger for e-cigarette experienced smokers.

4. Discussion

Hearing information about the amount of chemicals in cigarettes versus e-cigarettes in a hypothetical scenario changed smokers' anticipated interest in changing behavior and their harm perceptions. Scenarios that described cigarettes as containing more chemicals than e-cigarettes increased their anticipated endorsement of the perception that cigarettes are more harmful than e-cigarettes, which in turn increased interest in initiating or escalating dual use. E-cigarette experienced smokers were especially likely to say that they would increase their dual use in one of the scenarios that described reduced chemical exposure compared with e-cigarette naïve smokers.

Chemical amount scenarios did not appear to have a clear dose-response effect on interest in dual use or perceived harm. Respondents may not have distinguished much among the "10 times more," "100 times more," or "chemicals present only in cigarettes" scenarios because individuals often have difficulty interpreting information about magnitude (Hammitt and Graham, 1999; Neil et al., 1994) or felt that 10 times was sufficient, or "good enough," to be interested in dual use and the increases beyond that (100 times or chemicals completely absent in e-cigarettes) were not necessary. Alternatively, as predicted by fuzzy trace theory, some respondents in the "10 times more" and "100 times more" scenarios may have thought of this information as simply "more" rather than noticing the exact amount (Corbin et al., 2015).

The perception that cigarettes were more harmful than e-cigarettes mediated the relationship between chemical amount scenario and interest in dual use. This finding demonstrates that consumers inherently link beliefs about lower levels of constituents with beliefs about reduced health harms. This could have implications for FDA's consideration of modified risk tobacco products. As part of FDA's authority over tobacco products, the agency reviews applications from tobacco companies that want to have their products approved as modified risk tobacco products (O'Connor, 2012). For a product to receive approval, companies must demonstrate that either (a) the product causes fewer health harms or (b) the product contains fewer toxic constituents *but is not misinterpreted by consumers as being necessarily less harmful*. The results of this mediation analysis suggest that an e-cigarette (or likely any other tobacco product) may have difficulty gaining approval as a modified risk product using the latter pathway given that smokers automatically assumed that lower amounts of chemicals meant less harm to health.

Because the experimental manipulation involved numeric comparisons, we explored whether participants' numeracy affected their responses. Our analyses indicated that both low numeracy and high numeracy participants showed the same pattern of results as in the full sample. Regardless of whether they were high or low numeracy, participants were more likely to be interested in dual use when told that cigarettes had more chemicals than e-cigarettes and perceived harm mediated this perception. That the results did not differ

between the groups adds to the potential public health concern: even individuals who have difficulty interpreting numbers in their everyday lives were responsive to messages about chemical amounts in potentially problematic ways.

Personal experience with e-cigarettes changed smokers' responses to one of the chemical amount scenarios. There are multiple reasons why personal experience could change reactions. In past research, e-cigarette users have often reported that e-cigarettes caused less coughing and other unpleasant side effects than cigarettes (Pepper and Brewer, 2014). If smokers had this type of positive experience when they tried e-cigarettes, they might be particularly receptive to scenarios saying that e-cigarettes have fewer chemicals than cigarettes. Alternatively, smokers who were familiar with e-cigarettes may have found the prospect of increasing use of the product less daunting than e-cigarette naïve smokers thinking of initiating use. The significant difference between e-cigarette experienced and e-cigarette naïve smokers appeared in the "100 times more" scenario. This scenario may have seemed the most reasonable to smokers if they saw the "10 times more" scenario as underestimating harm reduction and the other scenarios ("same amount" of chemicals and "chemicals present only in cigarettes") as implausible. Although the research about chemical constituents in e-cigarette aerosol is inconsistent, some studies suggest that the magnitude of difference in amounts of certain chemicals between aerosol and cigarette smoke is roughly in the hundreds (Bhatnagar et al., 2014; Burstyn, 2014; Goniewicz et al., 2014).

4.1. Study limitations

Limitations to this experiment include possible misunderstanding of the description of e-cigarettes despite the interviewers' instructions to think of e-cigarettes as well as "other vaping products" and their mention of the terms "e-hookah" and "vape pens." We were not able to show respondents images of different product types because this was a phone survey. Another limitation is that smokers were describing their perceptions and interest in behavior change in response to a hypothetical situation. Finally, although one could define "dual use" in other ways, we focused on smokers who said they would start or increase their use of e-cigarettes without quitting cigarette smoking. We chose this definition because additional tobacco product use in the absence of quitting smoking is a health concern for the individual in the short-run, although the longer term population-wide effects are still unknown.

5. Conclusion

FDA is required to publicly display information about the quantities of chemicals in cigarettes and cigarette smoke in a way that is not misleading. This information, if paired with information from advertising or FDA disclosures indicating that e-cigarette aerosol contains lower amounts of those same chemicals, could have the unfortunate effect of encouraging smokers to become dual users or increase their existing dual use in lieu of quitting smoking under the mistaken impression that they are significantly reducing their health risks. Although the long-term population-wide effects of widespread dual use are unknown (Kalkhoran and Glantz, 2015; Levy et al., 2016), initiation or escalation of dual use is likely problematic for individual health in the short-run. From a regulatory standpoint, our findings also suggest that e-cigarettes may not be able to be approved as a modified risk

tobacco product on the basis of reduced chemical exposure alone because the public views information about lower chemical amounts as inherently related to reduced health harms. Future research should examine whether information about the amounts of chemicals in cigarettes versus e-cigarettes has a different impact on smokers' beliefs and interest in changing behavior after FDA regulations (including public disclosure of cigarette smoke constituents, manufacturer reporting of ingredients in e-liquid, and public disclosure of constituents in e-cigarette aerosol) are implemented (11th Congress of the United States of America, 2009; U.S. Food and Drug Administration, 2016). Beyond e-cigarettes and similar vaping devices, researchers should examine whether *any* tobacco products can be considered modified risk tobacco products on the basis of reduced chemical exposure or whether that approval pathway is inherently doomed to fail because of its link with perceptions of reduced harm to health.

Acknowledgments

References

11 th Congress of the United States of America, 2009. Family Smoking Prevention and Tobacco Control Act (Public Law 111–31 [H.R. 1256]).

American Association for Public Opinion Research. Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. 9. AAPOR; 2016.

Barrington-Trimis JL, Samet JM, McConnell R. Flavorings in electronic cigarettes: an unrecognized respiratory health hazard? JAMA. 2014; 312(23):2493–2494. http://dx.doi.org/10.1001/jama.2014.14830. [PubMed: 25383564]

Begh R, Lindson-Hawley N, Aveyard P. Does reduced smoking if you can't stop make any difference? BMC Med. 2015; 13:257. http://dx.doi.org/10.1186/s12916-015-0505-2. [PubMed: 26456865]

Bhatnagar A, Whitsel LP, Ribisl KM, et al. Electronic cigarettes: a policy statement from the American Heart Association. Circulation. 2014; 130(16):1418–1436. http://dx.doi.org/10.1161/CIR.0000000000000107. [PubMed: 25156991]

Boynton MH, Agans RP, Bowling JM, et al. Understanding how perceptions of tobacco constituents and the FDA relate to effective and credible tobacco risk messaging: a national phone survey of U.S. adults. BMC Public Health. 2016; 16(1):516. http://dx.doi.org/10.1186/s12889-016-3151-5. [PubMed: 27333921]

Brewer, NT., Morgan, JC., Baig, SA., Mendel, JR., Boynton, MH., Pepper, JK., Byron, MJ., Noar, SM., Agans, RP., Ribisl, KM. Public understanding of cigarette smoke constituents: three US surveys. pii: tobaccocontrol-2015-052897. Tobacco Control. 2016 Dec 6. http://dx.doi.org/10.1136/tobaccocontrol-2015-052897 [Epub ahead of print]

Burstyn I. Peering through the mist: systematic review of what the chemistry of contaminants in electronic cigarettes tells us about health risks. BMC Public Health. 2014; 14:18. http://dx.doi.org/10.1186/1471-2458-14-18. [PubMed: 24406205]

Cheong Y, Yong HH, Borland R. Does how you quit affect success? A comparison between abrupt and gradual methods using data from the International Tobacco Control Policy Evaluation Study. Nicotine Tob Res. 2007; 9(8):801–810. http://dx.doi.org/10.1080/14622200701484961. [PubMed: 17654293]

Corbin JC, Reyna VF, Weldon RB, Brainerd CJ. How reasoning, judgment, and decision making are colored by gist-based intuition: a fuzzy-trace theory approach. J Appl Res Mem Cogn. 2015; 4(4): 344–355. http://dx.doi.org/10.1016/j.jarmac.2015.09.001. [PubMed: 26664820]

Goniewicz ML, Knysak J, Gawron M, et al. Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. Tob Control. 2014; 23(2):133–139. http://dx.doi.org/10.1136/tobaccocontrol-2012-050859. [PubMed: 23467656]

Grana RA, Ling PM. "Smoking revolution": a content analysis of electronic cigarette retail websites. Am J Prev Med. 2014; 46(4):395–403. http://dx.doi.org/10.1016/j.amepre.2013.12.010. [PubMed: 24650842]

Hall MG, Ribisl KM, Brewer NT. Smokers' and nonsmokers' beliefs about harmful tobacco constituents: implications for FDA communication efforts. Nicotine Tob Res. 2014; 16(3):343–350. http://dx.doi.org/10.1093/ntr/ntt158. [PubMed: 24151139]

Hammitt JK, Graham JD. Willingness to pay for health protection: inadequate sensitivity to probability? J Risk Uncertain. 1999; 18(1):33–62.

Kalkhoran S, Glantz SA. Modeling the health effects of expanding e-cigarette sales in the United States and United Kingdom: a Monte Carlo analysis. JAMA Intern Med. 2015; 175(10):1671–1680. http://dx.doi.org/10.1001/jamainternmed.2015.4209. [PubMed: 26322924]

Levy DT, Borland R, Villanti AC, et al. The application of a decision-theoretic model to estimate the public health impact of vaporized nicotine product initiation in the United States. Nicotine Tob Res. 2016; E-pub, July 14. doi: 10.1093/ntr/ntw158

Lipkus IM, Samsa G, Rimer BK. General performance on a numeracy scale among highly educated samples. Med Decis Mak. 2001; 21(1):37–44.

Neil N, Malmfors T, Slovic P. Intuitive toxicology: expert and lay judgments of chemical risks. Toxicol Pathol. 1994; 22(2):198–201. [PubMed: 7973368]

O'Connor RJ. Postmarketing surveillance for "modified-risk" tobacco products. Nicotine Tob Res. 2012; 14(1):29–42. http://dx.doi.org/10.1093/ntr/ntq243. [PubMed: 21330282]

Pepper JK, Brewer NT. Electronic nicotine delivery system (electronic cigarette) awareness, use, reactions and beliefs: a systematic review. Tob Control. 2014; 23(5):375–384. http://dx.doi.org/10.1136/tobaccocontrol-2013-051122. [PubMed: 24259045]

Pepper JK, Emery SL, Ribisl KM, Brewer NT. How U.S. adults find out about electronic cigarettes: implications for public health messages. Nicotine Tob Res. 2014; 16(8):1140–1144. doi: 0.1093/ntr/ntu060. [PubMed: 24755397]

Pisinger C, Godtfredsen NS. Is there a health benefit of reduced tobacco consumption? A systematic review. Nicotine Tob Res. 2007; 9(6):631–646. [PubMed: 17558820]

Rutten LJ, Blake KD, Agunwamba AA, et al. Use of e-cigarettes among current smokers: associations among reasons for use, quit intentions, and current tobacco use. Nicotine Tob Res. 2015; 17(10): 1228–1234. http://dx.doi.org/10.1093/ntr/ntv003. [PubMed: 25589678]

Schroeder MJ, Hoffman AC. Electronic cigarettes and nicotine clinical pharmacology. Tob Control. 2014; 23(Suppl 2):ii30–ii35. http://dx.doi.org/10.1136/tobaccocontrol-2013-051469. [PubMed: 24732160]

Talhout R, Schulz T, Florek E, et al. Hazardous compounds in tobacco smoke. Int J Environ Res Public Health. 2011; 8(2):613–628. http://dx.doi.org/10.3390/ijerph8020613. [PubMed: 21556207]

U.S. Food and Drug Administration. Tobacco Products as Used in Section 904(e) of the Federal Food, Drug, and Cosmetic Act. U.S. Department of Health and Human Services, Food and Drug Administration, Center for Tobacco Products; Rockville, MD: 2011. Guidance for Industry and FDA Staff: "Harmful and Potentially Harmful Constituents".

U.S. Food and Drug Administration. [Accessed June 17, 2016] Section 911 of the Federal Food, Drug, and Cosmetic Act—Modified Risk Tobacco Products. 2015. http://www.fda.gov/TobaccoProducts/Labeling/RulesRegulationsGuidance/ucm262077.htm

U.S. Food and Drug Administration. Deeming tobacco products to be subject to the Federal Food, Drug, and Cosmetic Act, as Amended by the Family Smoking Prevention and Tobacco Control Act; Restrictions on the Sale and Distribution of Tobacco Products and Required Warning Statements for Tobacco Products. Fed Regist. 2016; 21 (CFR Parts 1100, 1140, and 1143).
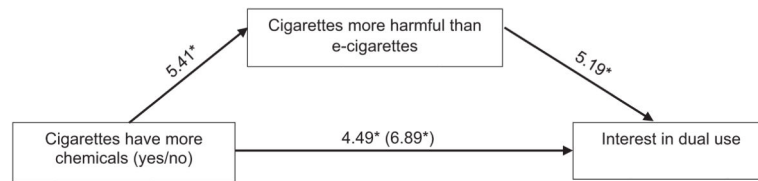
Fig. 1.
Anticipated perceptions of harm mediate the effect of scenario on interest in dual use. Path values are odds ratios. Numbers in parentheses show the association between scenario and interest in dual use before controlling for perceived harm. Study conducted in U.S. in 2014–2015. $*p < 0.001$.

Table 1

Participant characteristics ($n = 1164$).

Characteristic	n	%
Sex		
Female	560	48.1
Male	604	51.9
Age: mean (SD)	42.3 (14.8)	
Race		
White	787	67.6
African American	251	21.6
American Indian or Alaska Native	45	3.9
Asian	13	1.1
Other or missing	68	5.8
Hispanic/Latino	83	7.1
Education		
High school or less	612	52.6
Some college or associate's degree	379	32.6
Bachelor's degree or more	173	14.9
Low socioeconomic status[a]	421	36.2
Low numeracy[b]	446	38.3
Region		
Midwest	257	31.4
Northeast	108	9.3
South	666	57.3
West	132	11.3
Current cigarette smoking		
Smoke some days	357	30.7
Smoke every day, <1 pack per day	438	37.6
Smoke every day, 1 pack per day	369	31.7
E-cigarette use		
Never used	364	31.3
Used but not in past 30 days	432	37.1
Used in past 30 days	368	31.6

Note. Missing values (<0.5% per variable) recoded to mode. SD = standard deviation. Study conducted in U.S. in 2014–2015.

[a] Defined as having less than a high school education or a household income below the federal poverty level.

[b] Defined as an incorrect or "don't know" response to the item, "In general, which of these numbers shows the biggest risk of getting a disease? 1 in 10; 1 in 100; or 1 in 1000."

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 2

Effect of scenario on perceived harm and interest in dual use of cigarettes and e-cigarettes ($n = 1164$).

	Number who are interested in dual use/number in scenario		Association with interest in dual use			Number who perceive that cigarettes are more harmful than e-cigarettes/number in scenario		Association with perceived harm	
	n	(%)	OR	(95% CI)		n	(%)	OR	(95% CI)
Overall	328/1164	(28.2)				807/1164	(69.3)		
Scenario									
Same amount of harmful chemicals in e-cigarettes and cigarettes (Ref)	22/299	(7.4)	1.00	–		123/299	(41.1)	1.00	–
10 times more harmful chemicals in cigarettes than e-cigarettes	88/285	(30.9)	5.62[*]	(3.41, 9.29)		226/285	(79.3)	5.48[*]	(3.79, 7.92)
100 times more harmful chemicals in cigarettes than e-cigarettes	88/276	(31.9)	5.89[*]	(3.57, 9.74)		220/276	(79.7)	5.62[*]	(3.87, 8.16)
Harmful chemicals are present in cigarettes but not e-cigarettes	130/304	(42.8)	9.41[*]	(5.76, 15.36)		238/304	(78.3)	5.16[*]	(3.61, 7.34)

Note. Dual use was defined as reducing, continuing, or increasing smoking while also starting or increasing e-cigarette use. Study conducted in U.S. in 2014–2015.

[*]
$p < 0.001$.