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Changing Perceptions of Harm of E-Cigarettes Among U.S. Adults, 2012– 2015

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Abstract

Introduction—Although the impact of long-term use of electronic cigarettes (e-cigarettes) on health is still unknown, current scientific evidence indicates that e-cigarettes are less harmful than combustible cigarettes. The study examined whether perceived relative harm of e-cigarettes and perceived addictiveness have changed during 2012–2015 among U.S. adults.

Methods—Data were from Tobacco Products and Risk Perceptions surveys of probability samples representative of U.S. adults in 2012, 2014, and 2015. Changes over time in perceived harmfulness of e-cigarettes were examined using pairwise comparisons of proportions and multinomial logistic regression analysis. Analyses were conducted in January 2016.

Results—Whereas 11.5% and 1.3% of adults perceived e-cigarettes to have about the same level of harm and to be more harmful than cigarettes, respectively, in 2012, 35.7% and 4.1% did so in 2015. The proportion of adults who thought e-cigarettes were addictive more than doubled during 2012–2015 (32.0% in 2012 vs 67.6% in 2015). Compared with 2012, the odds of perceiving e-cigarettes to be equally or more harmful (than to be less harmful) doubled (95% CI=1.64, 2.41) in 2014, and tripled (95% CI=2.60, 3.81) in 2015.

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Conclusions—There is an increase in the proportion of U.S. adults who misperceive the harm of e-cigarettes and consider them to be as harmful as combustible cigarettes. The study highlights the need to design public health messages that accurately interpret the scientific data on the potential harm of e-cigarettes and clearly differentiate the absolute from the relative harm of e-cigarettes.

Introduction

Breathing smoke from combustible cigarettes is a leading cause of preventable disease and death in the U.S., and causes the majority of tobacco-related death and disease.[1] In the U.S., in addition to the more than 16 million who suffer from smoking-attributable diseases,[2] about 480,000 lives are lost to smoking annually.[1] Therefore, curbing the smoking epidemic is a major public health goal.[1] Recently, the market for tobacco products has entered a period of dramatic transformation where innovative products could lead to the demise of combusted cigarettes.[3–5] For example, electronic cigarettes (e-cigarettes), also known as electronic vapor products, are a novel product that has no tobacco, yet may contain nicotine derived from tobacco. This class of products uses battery power to heat a solution (known as e-juice and may contain nicotine in addition to flavorings and other chemicals) to produce an aerosol for inhalation.[6] Ever and current use of e-cigarettes have steadily increased over the last few years.[7–10] In 2014, nearly 15% of U.S. adults had ever used e-cigarettes, 5% had used e-cigarettes in the past 30 days,[8] and 4% had used them every day or some days.[9]

Although the impact of long-term use of e-cigarettes on health is still unknown, the available scientific evidence indicates that e-cigarettes are less harmful than combustible cigarettes,[6,11,12] and that smokers switching to e-cigarettes could benefit from a decrease in health risks related to smoking combustible cigarettes.[6,13,14] One of the common reasons for e-cigarette use is the belief that e-cigarettes are less harmful than combustible cigarettes.[15–17] Research has shown that cigarette smokers, college students, and young adults tend to perceive e-cigarettes to be less harmful than combustible cigarettes,[18–22] and that this correct perception is predictive of future use of e-cigarettes among never users.[23] Furthermore, the belief that e-cigarettes are less addictive than cigarettes increases the appeal of e-cigarettes, especially to young adults.[24] Users of nicotine-containing e-cigarettes may become dependent on e-cigarettes; yet, compared with the addictiveness of combustible cigarettes, e-cigarettes are typically rated as less addictive.[25,26]

Previous studies have identified how consumers perceive e-cigarette harmfulness and addictiveness.[16,19,25] However, different approaches were used to measure perceptions of e-cigarettes, making findings difficult to compare over time.[27] In this study, data were from three web-based surveys using probability samples representative of non-institutionalized U.S. adults conducted in 2012, 2014, and 2015. Using the same measures to define perceived harmfulness and perceived addictiveness of e-cigarettes in the three surveys allowed for comparisons over time. As the nature of the regulatory environment influences perceptions of e-cigarettes,[28] it was hypothesized that perceptions regarding e-cigarettes may have changed over the past 4 years in response to the changing regulatory environment.[29] The purposes of the current study were to determine whether the perceived harm of e-cigarettes relative to the harm of combustible cigarettes and perceived addictiveness have changed over a 4-year period (2012–2015) among U.S. adults and to

examine factors associated with misperceiving e-cigarettes as equally or more harmful than combustible cigarettes.

Methods

Data Sample

This study used data from the 2012 (August), 2014 (June–November), and 2015 (August–September) Tobacco Products and Risk Perceptions Surveys conducted by the Georgia State University School of Public Health. These surveys were national, cross-sectional surveys of a probability sample drawn from KnowledgePanel, a probability-based online research panel designed to be representative of non-institutionalized U.S. adults. More details on these surveys can be found in previous publications.[7,8,30]

For each survey, a probability sample of U.S. adults from KnowledgePanel (including a representative oversample of cigarette smokers in 2014 and 2015) was selected. A total of 4,170, 5,717, and 6,051 respondents completed the 2012, 2014, and 2015 surveys, respectively, yielding final-stage completion rates of 65.1% in 2012, 74.4% in 2014, and 76.0% in 2015. A study-specific post-stratification weight was computed using an iterative proportional fitting procedure (raking) to adjust for survey non-response as well as for oversampling of smokers. Demographic and geographic distributions from the most recent Current Population Surveys for the respective survey years were employed as benchmarks for adjustment, and included gender, age, race/ethnicity, education, household income, Census region, metropolitan area, and Internet access. For the present study, the sample of interest consisted of 2,808, 5,234, and 5,389 participants in 2012, 2014, and 2015, respectively, who reported prior awareness of e-cigarettes. This study was approved by the IRB at Georgia State University. Key demographic characteristics of the samples are shown in Appendix Table 1.

Measures

Participants who indicated that they have heard about e-cigarettes were considered aware. Ever trying e-cigarettes was assessed by asking participants who had indicated prior awareness of e-cigarettes whether they have ever tried e-cigarettes/electronic vapor products, even just one time. Those who responded *yes* were defined as having ever tried e-cigarettes.

Perceived harmfulness of e-cigarettes relative to combustible cigarettes was assessed using the question: *Is using [e-cigarettes/electronic vapor products] less harmful, about the same level of harm, or more harmful than smoking regular cigarettes?* Participants could also select *I don't know*. Perceived addictiveness of e-cigarettes was measured with the question: *Do you think people can become addicted to [e-cigarettes/electronic vapor products]?* Responses included *yes, no*, and *I don't know*.

Sociodemographic characteristics included in this study were: sex, age, race/ethnicity, educational attainment, annual household income, and U.S. Census region. Current smokers were defined as adults who had smoked at least 100 cigarettes during their lifetime and reported currently smoking *every day* or *some days*. Former smokers were defined as adults who had smoked at least 100 cigarettes and responded *not at all* to the question about current

smoking. Those who had not smoked at least 100 cigarettes in their lifetime were defined as never smokers.

Statistical Analysis

Analyses were conducted in January 2016 using Stata, version13 to obtain design-based (weighted) point estimates and 95% CIs of the response category proportions for the perception items, overall and by smoking status. Pairwise comparisons of the proportions were conducted to test the difference between the proportions across surveys.

The characteristics of participants who responded *about the same* and those who responded *more harmful* were examined and found to be similar. Given that only a small proportion of respondents reported *more harmful* and that they were not fundamentally different from adults who reported *about the same*, the two response categories were grouped into one category representing adults who perceived e-cigarettes as equally or more harmful than combustible cigarettes. Perceived harmfulness of e-cigarettes was analyzed using multinomial logistic regression. To identify characteristics of adults who were misinformed about the relative harm of e-cigarettes, for this analysis, the response category, "less harmful" was used as the ref group of the dependent variable, in alignment with the scientific evidence.[12] The survey year and perceived addictiveness were the independent variables, and ever trying e-cigarettes and demographic characteristics were covariates.

Using the most recent survey data, bivariate tests of associations (chi-square) were conducted to examine differences in the perceived harmfulness of e-cigarettes relative to combustible cigarettes and the perceived addictiveness of e-cigarettes across participant characteristics. For all analyses, p-values <0.05 were considered statistically significant.

Results

Table 1 depicts the perceived harmfulness of e-cigarettes relative to cigarettes and the perceived addictiveness among all participants, current smokers, and former smokers. There was an increase in the proportions of adults who perceived e-cigarettes to have "about the same level of harm" as or to be "more harmful" than cigarettes. Whereas about 12.9% of adults thought e-cigarettes were **equally or more harmful than cigarettes** in 2012, nearly four in ten adults (39.8%) held this perception in 2015 (p<0.001). This increase in the perceived relative harm occurred in tandem with a decline in the proportions of adults who were uncertain (*I don't know*) or perceived e-cigarettes as less harmful than cigarettes. The proportion of adults who were uncertain about the relative harm of e-cigarettes decreased from nearly half (47.8%) in 2012 to 29.5% in 2015. A similar, though less pronounced, decrease was observed in the proportions of adults who perceived e-cigarettes as less harmful than cigarettes (39.4% in 2012 vs 30.7% in 2015). The proportion of adults who perceived e-cigarettes to be addictive more than doubled from 32.0% in 2012 to 67.6% in 2015 (p<0.001).

Regardless of smoking status, the perceptions that e-cigarettes were equally or more harmful and that they were addictive increased during (2012–2015). There was an increase in the proportion of current smokers who perceived e-cigarettes to be equally or more harmful than

cigarettes (11.7% in 2012 vs 35.1% in 2015, $p<0.001$). The proportion of current smokers who believed e-cigarettes to be addictive more than doubled (25.3% in 2012 vs 56.7% in 2015, $p<0.001$).

Bivariate tests revealed that perceived harmfulness of e-cigarettes was associated with demographic characteristics and ever trying e-cigarettes, in 2015 (Table 2). Compared with never users of e-cigarettes, those who ever tried were more likely to perceive e-cigarettes to be less harmful than cigarettes (25.7%, 95% CI=24.1, 27.4 vs 51.2%, 95% CI=47.3, 55.1; $p<0.001$).

Results of the multivariable multinomial logistic regression analysis showed that compared with 2012, the odds of perceiving e-cigarettes to be equally or more harmful (compared with less harmful) doubled (95% CI=1.64, 2.41, $p<0.001$) in 2014, and tripled (95% CI=2.60, 3.81, $p<0.001$) in 2015 (Table 3). Adults who perceived e-cigarettes to be addictive had a 4.30-fold (95% CI=3.22, 5.76, $p<0.001$) higher adjusted odds of perceiving e-cigarettes to be equally or more harmful than cigarettes. Significant differences were observed in perceived harmfulness of e-cigarettes by sex, age, and ever trying e-cigarettes. Compared with never e-cigarette users, adults who ever tried e-cigarettes had 61% reduction in the adjusted odds of perceiving e-cigarettes to be equally harmful or more harmful than cigarettes. Men were less likely than women to perceive e-cigarettes as equally or more harmful than cigarettes. Compared with young adults, those aged ≥25 years had higher odds of perceiving e-cigarettes as equally or more harmful than perceiving them to be less harmful than cigarettes.

No significant differences were observed in perceived addictiveness between men and women (Appendix Table 2). However, the perception that e-cigarettes were non-addictive was more common among adults aged 25–34 years (7.2%, 95% CI=5.3, 9.7), those who were Hispanic (8.0%, 95% CI=5.5, 11.3), and those who had less than high school education (5.5%, 95% CI=3.1, 9.6). Compared with never users of e-cigarettes, those who have ever tried e-cigarettes were more likely to perceive e-cigarettes to be non-addictive (2.5%, 95% CI=1.9, 3.3 vs 8.9%, 95% CI=7.0, 11.2; $p<0.001$).

Discussion

The main goal of the present study was to determine whether the perceived relative harm of e-cigarettes versus combustible cigarettes changed between 2012 and 2015. Over this period, there was an increase in perceiving e-cigarettes to be equally or more harmful than cigarettes. Similarly, the belief that e-cigarettes are addictive increased among U.S. adults in 2012–2015. Adults who perceived e-cigarettes to be addictive, had never used e-cigarettes, were female, or aged 25–34 years were more likely to misperceive the harm of e-cigarettes —to believe that e-cigarettes are equally or more harmful than combustible cigarettes.

The findings of the current study indicate that, over time, U.S. adults, irrespective of smoking history, increasingly believe that e-cigarettes could be as harmful as combustible cigarettes, a result congruent with the literature related to the public perceptions of relative harm of e-cigarettes.[14,20,23] A longitudinal study among British adult smokers documented a

rise in perceiving e-cigarettes to be equally harmful to combustible cigarettes from 9.0% in 2012 to 16.9% in 2014.[23] Previous studies have shown that lower risk perceptions of e-cigarettes relative to combustible cigarettes are associated with ever trying and current use of e-cigarettes among adults,[21,31] future use among never users,[23] and exclusive e-cigarette use among smokers who have completely switched from combustible cigarettes.[32] Higher risk perceptions of e-cigarettes could deter current smokers from using e-cigarettes as a cessation aid of smoking combustible cigarettes and preventing a potential public health benefit. Therefore, the observed trend is of particular importance and warrants further attention.

The finding that the higher percentages of adults, including current smokers, misperceived e-cigarettes to be equally or more harmful than cigarettes between 2012 and 2015 may be stemming from misinformed media stories.[33] Toxicology studies on the biological effects of e-cigarette aerosol on the respiratory, cardiovascular, and immune systems have provided evidence of the risk of e-cigarette use,[6] but the absolute level of exposure to risk is almost always significantly less than the exposure from combusted cigarettes. For example, one study examined the effect of e-cigarettes and combustible cigarettes on serum cotinine and lung function in 15 smokers and 15 non-smokers, and documented that short-term use of e-cigarettes may have a negative effect on lung function, but that the magnitude of the damage is much smaller than that of combustible cigarettes.[34] Another study found that the levels of toxicant and carcinogen metabolites in urine of exclusive e-cigarette users were lower than those in the urine of combustible cigarette smokers,[12] thus supporting the view that e-cigarettes are less harmful than combustible cigarettes.[35] At the same time, exposure to e-cigarette vapor was linked to DNA damage, suggesting that e-cigarette use may raise the risk of cancer.[36] Findings of this study[36] were highlighted in a media article in which e-cigarettes were presumed to be “no safer than smoking.”[33,36] Confusing relative risk with absolute risk of e-cigarettes may contribute to framing bias[37] in risk communication and result in media reports and press releases in which the scientific evidence of absolute harm is highlighted and that of relative harm is overlooked. Objective findings may be obscured by the overall image and tone of the news story,[38] therefore negatively influencing public perceptions of e-cigarettes.

Another explanation for the increasingly high perceived risk of e-cigarettes in comparison with combustible cigarettes could be related to the frequent reports of adverse incidents associated with e-cigarette use. Extensive reporting of adverse events has been shown to contribute to public concerns.[38] Recent media reports linking e-cigarettes and e-liquid to serious injuries,[39,40] exposure to toxicants,[41] development of lung diseases,[42] and other health related problems[43] may have contributed to the increasing trend of equating the harm of e-cigarettes to traditional cigarettes. Lastly, U.S. adults may be partially equating the harm of e-cigarettes to combustible cigarettes owing to other concerns related to the potential of e-juice flavors to lure children into addiction,[44,45] the use of e-cigarettes with illicit drugs,[46] and the concern that their use could renormalize smoking.[47] Future research should examine the role of such issues in shaping individual perceptions about e-cigarettes. The findings underscore the urgent need to convey accurate information to the public, especially adult smokers, about the available scientific evidence of the harm of e-cigarettes compared with combustible cigarettes. Public health messages should strike a balance

between addressing the reduced harm of e-cigarettes compared with combustible cigarettes and presenting an accurate interpretation of the absolute harm of e-cigarette use.

In the current study, the estimated percentages of adults who thought e-cigarettes were less harmful than cigarettes were lower than those documented in previous studies.[14,31,48] This difference may be the result of variation in measures of perceived harm of e-cigarettes and in the characteristics of the study population. A study among a national sample of U.S. adults conducted in 2012–2013 revealed that 51.0% of adults perceived e-cigarettes to be less harmful than cigarettes.[14] In that study, perception of relative harm was measured using a Likert scale question (1, *much less risk*; 5, *much more risk*).[14] In the current study, perceived relative harm was measured using a four-response item (*less harmful*, *about the same*, *more harmful*, *I don't know*). Allowing participants to choose an *I don't know* response may explain the lower percentage of adults who believed that e-cigarettes were less harmful than cigarettes. Furthermore, differences in population characteristics, such as differences in age or smoking status, may explain why the observed percentages of perceiving e-cigarettes to be less harmful were lower than those detected in other studies,[31,48] despite using the same measurement.

Although the current study provides no information on the level of addictiveness of e-cigarettes compared with combustible cigarettes, the data show that U.S. adults hold the correct view about the addictive nature of e-cigarettes. Most e-cigarettes deliver nicotine, an addictive chemical, though with actual nicotine exposure dependent on product design and user behavior.[6] In May 2016, e-cigarettes were deemed to be regulated by the U.S. Food and Drug Administration; under this rule, e-cigarettes with nicotine are required to carry an addiction warning statement.[29] Future research examining how the public perceive the addictive nature of e-cigarettes is warranted to evaluate the effectiveness of the new rule of subjecting e-cigarettes to the addiction warning statement.

Limitations

The use of an online research panel (KnowledgePanel) may raise concerns about generalizability of the results to the U.S. adult population. In addition, the rapid changes of e-cigarettes design, characteristics, and nomenclature make it difficult to identify accurate terminology to develop questions regarding e-cigarettes awareness, use, and perceptions of harm and addictiveness. Whereas in 2012 and 2014 surveys the term “e-cigarette” was used to describe the product, a different wording was used in 2015 survey, “electronic vapor product,” to provide an updated terminology that encompasses newer models. This variation in wording may raise concerns about comparability across years. However, the three surveys assessed perceptions of harm using the same question and the same response categories. Finally, similar to previous studies,[14,20,23] one general question to measure the perceived relative harm was used, which may not capture various aspects of harm.[19]

Conclusions

The results document an increase in the misperception that e-cigarettes are equally or even more harmful than combustible cigarettes. The study highlights the need to design public

health messages that accurately interpret the scientific data on the potential harm of e-cigarette use and clearly differentiate the absolute from the relative harm of e-cigarettes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. U.S. Public Health Service, Office of the Surgeon General, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. The health consequences of smoking—50 years of progress: a report of the Surgeon General. Atlanta, GA: DHHS, CDC, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.
2. Rostron BL, Chang CM, Pechacek TF. Estimation of cigarette smoking-attributable morbidity in the United States. JAMA Intern Med. 2014; 174(12):1922–1928. http://dx.doi.org/10.1001/jamainternmed.2014.5219. [PubMed: 25317719]
3. Abrams DB. Promise and peril of e-cigarettes: Can disruptive technology make cigarettes obsolete? JAMA. 2014; 311(2):135–136. http://dx.doi.org/10.1001/jama.2013.285347. [PubMed: 24399548]
4. Cobb NK, Abrams DB. The FDA, e-cigarettes, and the demise of combusted tobacco. N Engl J Med. 2014; 371(16):1469–1471. http://dx.doi.org/10.1056/NEJMp1408448. [PubMed: 25317866]
5. Fagerstrom K, Etter JF, Unger JB. E-cigarettes: a disruptive technology that revolutionizes our field? Nicotine Tob Res. 2015; 17(2):125–126. http://dx.doi.org/10.1093/ntr/ntu240. [PubMed: 25609846]
6. Breland, A., Soule, E., Lopez, A., et al. Electronic cigarettes: what are they and what do they do?. Ann N Y Acad Sci. In press. Online January 15, 2016. http://dx.doi.org/10.1111/nyas.12977
7. King BA, Patel R, Nguyen KH, Dube SR. Trends in awareness and use of electronic cigarettes among U.S. adults, 2010-2013. Nicotine Tob Res. 2015; 17(2):219–227. http://dx.doi.org/10.1093/ntr/ntu191. [PubMed: 25239961]
8. Weaver SR, Majeed BA, Pechacek TF, et al. Use of electronic nicotine delivery systems and other tobacco products among USA adults, 2014: results from a national survey. Int J Public Health. 2016; 61(2):177–188. http://dx.doi.org/10.1007/s00038-015-0761-0. [PubMed: 26560309]
9. Schoenborn, CA., Gindi, RM. NCHS Data Brief. 2015. Electronic Cigarette Use Among Adults: United States, 2014; p. 1-8.
10. McMillen RC, Gottlieb MA, Shaefer RM, Winickoff JP, Klein JD. Trends in Electronic Cigarette Use Among U.S. Adults: Use is Increasing in Both Smokers and Nonsmokers. Nicotine Tob Res. 2015; 17(10):1195–1202. http://dx.doi.org/10.1093/ntr/ntu213. [PubMed: 25381306]
11. Zeller M. Reflections on the 'endgame' for tobacco control. Tob Control. 2013; 22(suppl 1):i40–i41. http://dx.doi.org/10.1136/tobaccocontrol-2012-050789. [PubMed: 23591507]
12. Hecht SS, Carmella SG, Kotandeniya D, et al. Evaluation of toxicant and carcinogen metabolites in the urine of e-cigarette users versus cigarette smokers. Nicotine Tob Res. 2015; 17(6):704–709. http://dx.doi.org/10.1093/ntr/ntu218. [PubMed: 25335945]

13. McNeill, A., B, L., Calder, R., Hitchman, S., Hajek, P., McRobbie, H. E-cigarettes: An Evidence Update: A Report Commissioned by Public Health England. London, United Kingdom: Public Health England; 2015.
14. Kiviniemi MT, Kozlowski LT. Deficiencies in public understanding about tobacco harm reduction: results from a United States national survey. Harm Reduct J. 2015; 12(1):1–7. http://dx.doi.org/10.1186/s12954-015-0055-0.
15. Farsalinos KE, Romagna G, Tsiapras D, Kyrzopoulos S, Voudris V. Characteristics, perceived side effects and benefits of electronic cigarette use: a worldwide survey of more than 19,000 consumers. Int J Environ Res Public Health. 2014; 11(4):4356–4373. http://dx.doi.org/10.3390/ijerph110404356. [PubMed: 24758891]
16. Rass O, Pacek LR, Johnson PS, Johnson MW. Characterizing use patterns and perceptions of relative harm in dual users of electronic and tobacco cigarettes. Exp Clin Psychopharm. 2015; 23(6):494–503. http://dx.doi.org/10.1037/pha0000050.
17. 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]
18. Pearson JL, Richardson A, Niaura RS, Vallone DM, Abrams DB. e-Cigarette Awareness, Use, and Harm Perceptions in US Adults. Am J Public Health. 2012; 102(9):1758–1766. http://dx.doi.org/10.2105/AJPH.2011.300526. [PubMed: 22813087]
19. Pepper J, Emery S, Ribisl K, Rini C, Brewer N. How risky is it to use e-cigarettes? Smokers' beliefs about their health risks from using novel and traditional tobacco products. J Behav Med. 2015; 38(2):318–326. http://dx.doi.org/10.1007/s10865-014-9605-2. [PubMed: 25348584]
20. Tan ASL, Bigman CA. E-Cigarette Awareness and Perceived Harmfulness. Prevalence and Associations with Smoking-Cessation Outcomes. Am J Prev Med. 2014; 47(2):141–149. http://dx.doi.org/10.1016/j.amepre.2014.02.011. [PubMed: 24794422]
21. Pokhrel P, Fagan P, Kehl L, Herzog TA. Receptivity to E-cigarette Marketing, Harm Perceptions, and E-cigarette Use. Am J Health Behav. 2015; 39(1):121–131. http://dx.doi.org/10.5993/AJHB.39.1.13. [PubMed: 25290604]
22. Choi K, Forster JL. Beliefs and experimentation with electronic cigarettes: a prospective analysis among young adults. Am J Prev Med. 2014; 46(2):175–178. http://dx.doi.org/10.1016/j.amepre.2013.10.007. [PubMed: 24439352]
23. Brose LS, Brown J, Hitchman SC, McNeill A. Perceived relative harm of electronic cigarettes over time and impact on subsequent use. A survey with 1-year and 2-year follow-ups. Drug Alcohol Depend. 2015; 157:106–111. http://dx.doi.org/10.1016/j.drugalcdep.2015.10.014. [PubMed: 26507173]
24. Trumbo CW, Kim SJ. The effect of electronic cigarette advertising on intended use among college students. Addict Behav. 2015; 46:77–81. http://dx.doi.org/10.1016/j.addbeh.2015.03.005. [PubMed: 25827334]
25. Etter JF, Eissenberg T. Dependence levels in users of electronic cigarettes, nicotine gums and tobacco cigarettes. Drug Alcohol Depend. 2015; 147:68–75. http://dx.doi.org/10.1016/j.drugalcdep.2014.12.007. [PubMed: 25561385]
26. Cooper, M., Harrell, MB., Perry, CL. Comparing young adults to older adults in e-cigarette perceptions and motivations for use: implications for health communication. Health Educ Res. In press. Online June 19, 2016. http://dx.doi.org/10.1093/her/cyw030
27. Tan ASL, Lee Cj, Bigman CA. Comparison of beliefs about e-cigarettes' harms and benefits among never users and ever users of e-cigarettes. Drug Alcohol Depend. 2016; 158:67–75. http://dx.doi.org/10.1016/j.drugalcdep.2015.11.003. [PubMed: 26621550]
28. Yong, HH., Borland, R., Balmford, J., et al. Prevalence and Correlates of the Belief That Electronic Cigarettes are a Lot Less Harmful Than Conventional Cigarettes Under the Different Regulatory Environments of Australia and the United Kingdom. Nicotine Tob Res. In press. Online May 17, 2016. http://dx.doi.org/10.1093/ntr/ntw137
29. 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. Final rule. Fed Regist. 2016; 81(90):28973–29106. [PubMed: 27192730]

30. Majeed BA, Dube SR, Sterling K, Whitney C, Eriksen MP. Opinions about electronic cigarette use in smoke-free areas among U.S. Adults, 2012. Nicotine Tob Res. 2015; 17(6):675–681. http://dx.doi.org/10.1093/ntr/ntu235. [PubMed: 25358659]
31. Wackowski OA, Delnevo CD. Young Adults' Risk Perceptions of Various Tobacco Products Relative to Cigarettes: Results From the National Young Adult Health Survey. Health Educ Behav. 2016; 43(3):328–336. http://dx.doi.org/10.1177/1090198115599988. [PubMed: 26304709]
32. Farsalinos KE, Romagna G, Voudris V. Factors associated with dual use of tobacco and electronic cigarettes: A case control study. Int J Drug Policy. 2015; 26(6):595–600. http://dx.doi.org/10.1016/j.drugpo.2015.01.006. [PubMed: 25687714]
33. Knapton, S. [Accessed January 15, 2016] E-cigarettes are no safer than smoking tobacco, scientists warn. The Telegraph. Dec 29. 2015 www.telegraph.co.uk/news/health/news/12073221/E-cigarettes-are-no-safer-than-smoking-tobacco-scientists-warn.html
34. Flouris AD, Chorti MS, Poulianiti KP, et al. Acute impact of active and passive electronic cigarette smoking on serum cotinine and lung function. Inhal Toxicol. 2013; 25(2):91–101. http://dx.doi.org/10.3109/08958378.2012.758197. [PubMed: 23363041]
35. Nutt DJ, Phillips LD, Balfour D, et al. Estimating the harms of nicotine-containing products using the MCDA approach. Eur Addict Res. 2014; 20(5):218–225. http://dx.doi.org/10.1159/000360220. [PubMed: 24714502]
36. Yu V, Rahimy M, Korrapati A, et al. Electronic cigarettes induce DNA strand breaks and cell death independently of nicotine in cell lines. Oral Oncol. 2016; 52:58–65. http://dx.doi.org/10.1016/j.oraloncology.2015.10.018. [PubMed: 26547127]
37. Gordon-Lubitz RJ. Risk communication: problems of presentation and understanding. JAMA. 2003; 289(1):95. http://dx.doi.org/10.1001/jama.289.1.95. [PubMed: 12503988]
38. Slovic, P. The feeling of risk: New perspectives on risk perceptions. New York: earthscan from Routledge; 2010.
39. Mohney, G. [Acessed January 20, 2016] First Child's Death From Liquid Nicotine Reported as ‘Vaping’ Gains Popularity ABC News. Dec 12. 2014 http://abcnews.go.com/Health/childs-death-liquid-nicotine-reported-vaping-gains-popularity/story?id=27563788
40. Ng, A. [Acessed June 1, 2016] E-cigarette explosion breaks Memphis native's neck, almost paralyzes him for life. New York Daily News. Nov 23. 2015 www.nydailynews.com/news/national/e-cigarette-explosion-breaks-man-neck-paralyzes-article-1.2444620
41. Brazier, Y. [Accessed Feruary 15, 2016] E-cigarettes impair immune responses more than tobacco. Medical News Today. Feb 15. 2016 www.medicalnewstoday.com/articles/306444.php
42. Winter, L. [Accessed February 20, 2016] E-Cigarette Vapor Shown To Repress Immune System. Health and Medicine. 2015. www.iflscience.com/health-and-medicine/e-cigarette-vapor-shown-repress-immune-system
43. Colbert, T. [Accessed February 20, 2016] Approach with caution: taking a critical look at vaping and e-cigarette trends. Los Angeles Times. Sep 25. 2015 www.latimes.com/brandpublishing/localplus/ucsandiego/la-ss-ucsd2015-vaping-dto-story.html
44. Cardenas VM, Evans VL, Balamurugan A, et al. Use of electronic nicotine delivery systems and recent initiation of smoking among U.S. youth. Int J Public Health. 2016; 61(2):237–241. http://dx.doi.org/10.1007/s00038-015-0783-7. [PubMed: 26833307]
45. DePinho, RA. [Accessed July 15, 2016] It's time to regulate America's latest addiction. The Huffington Post. Feb 12. 2015 www.huffingtonpost.com/ronald-a-depinho-md/its-time-to-regulate-amer_b_6672008.html
46. Silverman, JR. [Acessed February 20, 2016] E-cigarettes packed with marijuana oil set to boom in Colorado. New York Daily News. Jan 6. 2014 www.nydailynews.com/news/national/pot-boom-e-cigs-sales-set-soar-colo-article-1.1567304
47. Cataldo JK, Petersen AB, Hunter M, Wang J, Sheon N. E-cigarette marketing and older smokers: road to renormalization. Am J Health Behav. 2015; 39(3):361–371. http://dx.doi.org/10.5993/ajhb.39.3.9. [PubMed: 25741681]

48. Brown J, West R, Beard E, et al. Prevalence and characteristics of e-cigarette users in Great Britain: Findings from a general population survey of smokers. Addict Behav. 2014; 39(6):1120–1125. http://dx.doi.org/10.1016/j.addbeh.2014.03.009. [PubMed: 24679611]

Table 1

Perceived Harmfulness and Perceived Addictiveness of E-Cigarettes Among U.S. Adults, Overall and by Smoking Status: 2012–2015

	Overall % (95% CI)			Current smokers % (95% CI)			Former smokers % (95% CI)		
Perceptions	2012 (N=2,808)	2014 (N=5,234)	2015 (N=5,389)	2012	2014	2015	2012	2014	2015
Perceived harmfulness[a]									
Less harmful	39.4 (36.9, 41.9)	35.2 (33.8, 36.7)	30.7 (29.1, 32.3)	44.7 (39.1, 50.5)	39.8 (36.6, 43.0)	36.0 (32.2, 40.0)	35.0 (30.7, 39.5)	33.2 (30.6, 35.9)	28.3 (25.6, 31.2)
About the same	11.5 (10.0, 13.2)	28.4 (27.0, 29.8)	35.7 (34.1, 37.3)	11.0 (8.0, 15.0)	24.1 (21.4, 27.1)	30.8 (27.0, 34.8)	10.8 (8.0, 14.3)	24.7 (22.4, 27.2)	34.1 (31.2, 37.2)
More harmful	1.3 (0.8, 2.2)	2.5 (2.0, 3.0)	4.1 (3.4, 5.0)	0.7 (0.1, 3.7)	2.5 (1.6, 4.0)	4.3 (2.6, 6.9)	1.1 (0.5, 2.3)	2.5 (1.7, 3.6)	4.0 (2.7, 6.0)
I don't know	47.8 (45.3, 50.3)	33.9 (32.5, 35.4)	29.5 (28.0, 31.1)	43.6 (37.9, 49.3)	33.6 (30.5, 36.9)	28.9 (25.3, 32.7)	53.2 (48.6, 57.8)	39.7 (37.0, 42.4)	33.5 (30.7, 36.5)
Perceived addictiveness [b]									
Yes	32.0 (29.7, 34.4)	63.2 (61.8, 64.7)	67.6 (66.0, 69.2)	25.3 (20.7, 30.6)	48.0 (44.7, 51.3)	56.7 (52.6, 60.8)	28.1 (24.2, 32.4)	63.0 (60.2, 65.7)	67.9 (65.0, 70.7)
No	11.3 (9.7, 13.1)	4.6 (3.9, 5.3)	3.8 (3.1, 4.5)	16.0 (12.0, 20.9)	9.5 (7.7, 11.8)	8.8 (6.7, 11.5)	9.6 (7.2, 12.7)	3.6 (2.6, 5.1)	2.7 (1.8, 4.0)
I don't know	56.8 (54.3, 59.3)	32.2 (30.8, 33.6)	28.6 (27.1, 30.2)	58.7 (52.9, 64.3)	42.5 (39.2, 45.8)	34.5 (30.6, 38.5)	62.3 (57.8, 66.6)	33.5 (30.8, 36.2)	29.4 (26.7, 32.3)

Note: All % are weighted column %.

[a]Perceived harmfulness was measured using this question: *Is using e-cigarettes less harmful, about the same level of harm, or more harmful than smoking regular cigarettes?*

[b]Perceived addictiveness was measured using this question: *Can people become addicted to e-cigarettes?*

Table 2

Perceived Harm of E-Cigarettes Relative to Cigarettes by Participant Characteristics Among U.S. Adults: 2015

	Responses			
Compared to cigarettes smoking e-cigarettes are	**Less harmful**	**About the same level of harm**	**More harmful**	**I don't know**
Characteristics	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**
Sex***				
Male	**34.6 (32.4, 36.9)**	33.5 (31.3, 35.8)	3.6 (2.7, 4.7)	28.3 (26.2, 30.5)
Female	**26.9 (24.8, 29.1)**	37.8 (35.4, 40.1)	4.6 (3.5, 6.1)	30.7 (28.5, 33.1)
Age (years) ***				
18-24	**45.5 (38.9, 52.3)**	31.3 (25.3, 38.0)	3.6 (1.6, 7.8)	**19.6 (14.9, 25.4)**
25-34	**36.8 (33.2, 40.5)**	38.1 (34.5, 41.8)	4.5 (3.0, 6.8)	**20.7 (17.5, 24.3)**
35-44	**30.7 (26.9, 34.6)**	38.0 (34.1, 42.1)	6.4 (4.1, 9.9)	**25.0 (21.7, 28.6)**
45-54	**26.9 (23.5, 30.5)**	37.6 (33.5, 41.9)	5.5 (3.7, 7.9)	**30.0 (26.3, 34.0)**
55-64	**27.4 (24.2, 30.9)**	34.2 (30.7, 37.9)	2.5 (1.4, 4.3)	35.9 (32.3, 39.6)
65+	**22.9 (20.2, 25.8)**	32.9 (29.7, 36.2)	2.4 (1.7, 3.5)	**41.9 (38.3, 45.5)**
Race/Ethnicity**				
White, NH	**32.7 (30.9, 34.5)**	34.6 (32.7, 36.5)	3.3 (2.6, 4.1)	29.5 (27.8, 31.3)
Black, NH	**22.3 (18.0, 27.2)**	35.7 (30.3, 41.5)	6.7 (4.1, 10.6)	35.4 (29.9, 41.2)
Other, NH	31.1 (24.5, 38.5)	40.7 (33.3, 48.5)	6.4 (2.9, 13.3)	21.9 (16.3, 28.8)
Hispanic	27.3 (23.2, 31.9)	38.4 (33.9, 43.1)	5.3 (3.2, 8.4)	29.0 (24.8, 33.7)
Education***				
<High school	29.9 (23.9, 36.6)	34.5 (28.3, 41.3)	6.7 (3.9, 11.4)	28.9 (23.3, 35.3)
High school	27.2 (24.6, 29.8)	34.0 (31.3, 36.8)	3.9 (2.7, 5.6)	**35.0 (32.2, 37.8)**
Some college	31.4 (28.5, 34.5)	35.1 (32.0, 38.4)	5.0 (3.6, 7.0)	28.4 (25.5, 31.5)
College degree +	33.5 (31.1, 36.1)	38.2 (35.6, 40.8)	2.6 (1.8, 3.6)	**25.7 (23.3, 28.3)**
Household income**				
<$15K	27.6 (22.8, 32.9)	35.2 (29.8, 41.0)	7.9 (5.0, 12.2)	29.4 (24.4, 34.9)
$15K–$24.9K	**23.6 (18.5, 29.7)**	36.8 (30.3, 43.8)	4.7 (2.0, 10.6)	34.9 (28.7, 41.5)
$25K–$39.9K	27.6 (23.8, 31.8)	38.9 (34.6, 43.4)	4.8 (3.0, 7.4)	28.7 (24.8, 32.9)
$40K–$59.9K	29.5 (26.0, 33.4)	32.7 (29.1, 36.6)	3.4 (2.0, 5.7)	34.3 (30.5, 38.4)
≥$60K	**33.2 (31.1, 35.4)**	35.7 (33.5, 37.9)	3.4 (2.5, 4.5)	27.8 (25.7, 29.9)
U.S. region				
Northeast	32.5 (28.7, 36.5)	36.3 (32.4, 40.4)	3.2 (2.1, 4.8)	28.0 (24.5, 31.9)
Midwest	30.9 (27.9, 34.0)	34.2 (31.0, 37.5)	4.3 (2.9, 6.5)	30.6 (27.7, 33.7)
South	30.4 (27.9, 33.1)	34.0 (31.4, 36.8)	4.1 (2.9, 5.8)	31.5 (28.8, 34.3)
West	29.5 (26.4, 32.8)	39.2 (35.8, 42.6)	4.7 (3.2, 6.8)	26.7 (23.7, 29.8)
E-cigarette use***				

	Responses			
Compared to cigarettes smoking e-cigarettes are	**Less harmful**	**About the same level of harm**	**More harmful**	**I don't know**
Characteristics	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**
Ever tried	**51.2 (47.3, 55.1)**	**25.9 (22.6, 29.4)**	3.8 (2.4, 6.1)	**19.1 (16.3, 22.3)**
Never tried	**25.7 (24.1, 27.4)**	**38.0 (36.2, 39.9)**	4.2 (3.4, 5.2)	**32.0 (30.3, 33.9)**

Note: Boldface indicates statistical significance

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$

p is based on weighted bivariate tests of association (χ^2).

NH, non-Hispanic

Table 3

Factors Associated With Perceived Harmfulness of E-Cigarettes Among U.S. Adults, 2012-2015

	Equally or more harmful [a]	"I don't know" [a]
Independent variables	**AOR (95% CI)**	**AOR (95% CI)**
Survey year		
2012	Ref	Ref
2014	**1.99 (1.64, 2.41)** ***	0.93 (0.81, 1.08)
2015	**3.15 (2.60, 3.81)** ***	1.01 (0.86, 1.17)
Perception of addictiveness		
No	Ref	Ref
Yes	**4.30 (3.22, 5.76)** ***	**2.46 (1.79, 3.40)** ***
I don't know	**1.38 (1.02, 1.88)** *	**6.20 (4.49, 8.55)** ***
E-cigarette use		
Never tried	Ref	Ref
Ever tried	**0.39 (0.33, 0.46)** ***	**0.37 (0.31, 0.45)** ***
Sex		
Male	**0.66 (0.59, 0.73)** ***	**0.75 (0.67, 0.84)** ***
Female	Ref	Ref
Age (year)		
18-24	Ref	Ref
25-34	**1.38 (1.08, 1.75)** **	1.00 (0.78, 1.28)
35-44	**1.37 (1.08, 1.74)** *	**1.38 (1.09, 1.74)** **
45-54	**1.66 (1.30, 2.12)** ***	**1.76 (1.40, 2.22)** ***
55-64	**1.47 (1.15, 1.87)** **	**1.85 (1.47, 2.33)** ***
65+	**1.77 (1.38, 2.26)** ***	**2.24 (1.77, 2.83)** ***
Smoking status		
Current smoker	**1.33 (1.10, 1.60)** **	**1.31 (1.10, 1.56)** **
Former smoker	0.97 (0.84, 1.11)	**1.18 (1.03, 1.34)** *
Never smoker	Ref	Ref

Note: Boldface indicates statistical significance

* $p<0.05$;

** $p<0.01$;

*** $p<0.001$

[a] Analysis was performed using multivariable multinomial logistic regression; the response category 'less harmful' was used as the reference group. All variables in the table were included as covariates.