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Flavorings and Perceived Harm and Addictiveness of E-cigarettes among Youth

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Abstract

Objectives—Given the increasing trend in use of electronic cigarettes (“e-cigarettes”) among youth, it is crucial to understand how these products are perceived and how these perceptions are associated with their decision whether or not to use them.

Methods—This is a cross-sectional analysis of data from a rapid response surveillance system of 6th, 8th and 10th grade students’ tobacco use behaviors (sample [n] = 3704 from a population of students [N] = 434,601). We used weighted logistic regression models to investigate the relationship between perceptions of harm and addictiveness and e-cigarette use, including the use of flavored and non-flavored e-cigarettes.

Results—Compared to youth who did not use e-cigarettes, ever and current e-cigarette users had higher odds of reporting that e-cigarettes were “not at all harmful” to health and “not at all addictive.” Ever and current e-cigarette users had higher odds of reporting that flavored e-

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Human Subjects Statement

The University of Texas Health Science Center’s Institutional Review Board approved this study (reference number HSC-SPH-13-0377). For participating schools, district and principal approval, and where appropriate, school Institutional Review Board approval, were obtained.

Conflict of Interest Statement

The authors affirm no conflicts of interest.

cigarettes were “less harmful” than non-flavored e-cigarettes, compared to youth who did not use e-cigarettes.

Conclusions—These findings warrant attention given that nicotine is an addictive substance whose effects on the adolescent brain are potentially negative. Youth e-cigarette users perceived lower harm from flavored e-cigarettes, which is worrisome given emerging research documenting harmful constituents in certain e-cigarette flavorings.

Keywords

adolescents; e-cigarettes; risk perceptions

Given the increasing trend in use of electronic cigarettes (“e-cigarettes”) among youth, it is crucial to improve understanding of how these products are perceived by youth and how these perceptions affect their decision to use them or not. Youth e-cigarette ever use and current use has risen significantly between 2011 and 2014 in the United States (US), with the most dramatic increase occurring between 2013 and 2014.¹ In 2014, e-cigarettes surpassed conventional cigarettes as the most commonly used tobacco product among youth.^{1,2} In 2014 in the US, approximately 3.9% of middle school students and 13.4% of high school students used e-cigarettes in the past 30 days.¹ In 2014, Texas-specific estimates of current e-cigarette use were even higher at 7.9% for middle school students and 19.1% for high school students.³

To date, a limited number of studies have investigated risk factors associated with the use of e-cigarettes among youth.^{4–9} Young populations are important to study for various reasons. First, there is emerging evidence that e-cigarette companies are using marketing strategies that appeal to youth. These include sponsorship of youth-oriented events or providing samples at such events; airing of television and radio commercials during events such as the Super Bowl; and marketing of flavors such as grape mint and cherry crush that may be particularly enticing to youth.¹⁰ Other marketing strategies used by e-cigarette companies include celebrity spokesmen and social media promotion, both of which may be used to attract young consumers.

Second, nicotine exposure may affect young populations’ health particularly negatively, and this population also may tend to underestimate the severity of nicotine’s effects. Research has shown that adolescents misjudge the drug’s addictiveness; although conventional cigarette smokers in this age group are more likely than nonsmokers to believe they can quit anytime, only a small minority (about 4%) successfully quit each year.¹¹ Other evidence suggests that the brains of younger individuals are more vulnerable to nicotine than older populations. According to one animal study, the plasticity of the developing brain makes it particularly susceptible to certain drugs, like nicotine.¹² In fact, nicotine exposure during adolescence may be linked to enhanced vulnerability to nicotine addiction, increased impulsivity and mood disorders.¹³

Third, public health researchers speculate about other deleterious consequences of early e-cigarette use, including the possibility of a gateway effect leading to later use of conventional and potentially more harmful tobacco products, like cigarettes. To date, there

are only limited data that support this idea.^{14–17} Whereas the “gateway phenomenon” in reference to e-cigarettes and cigarettes is not yet definitively proven, the biological evidence alone serves to caution against the dangers of youth exposure to nicotine, the highly addictive substance that is found in e-cigarettes.¹⁸

Given the fact that youth are both experimenting with and regularly using e-cigarettes at rapidly growing rates, it is fundamental to understand common beliefs about their use. Currently, there is a significant gap in our understanding of how youth perceive these products and how such perceptions may affect their decision to use them. To date, only a few published studies exist on the topic.^{4,6,9,19} For conventional cigarettes, however, there is consensus that perceptions of harmfulness affect smoking behaviors; as perceived harm decreases, conventional smoking behaviors increase.²⁰ The Theory of Planned Behavior lays the foundation for this association, positing that one’s perceptions predict changes in behavior.²¹ One qualitative study of 47 male e-cigarette users between ages of 15–17 found that 30% used e-cigarettes because they believed they were healthier than cigarettes.⁵ Few studies, however, have explored the perceptions of harm of e-cigarettes in a population-based sample of youth, including users and non-users. One exception are results from the 2012 National Youth Tobacco Survey comparing harm perceptions of e-cigarettes and conventional cigarettes among middle school and high school students (N = 24,658). One in 3 students reported e-cigarettes were less harmful than cigarettes, and boys and white respondents were more likely to hold this perception. In addition, ever e-cigarette use was associated with perceiving e-cigarettes as less harmful. This was consistent regardless of cigarette smoking status.⁴ However, in a study of Canadian youth and young adults, perceptions of e-cigarette harm did vary by smoking history; among former or never smokers, ever users of e-cigarettes held lower perceptions of harm from e-cigarettes than the never e-cigarette users, whereas the opposite pattern was found among current smokers.²²

To our knowledge, no studies to date have assessed perceived addictiveness of e-cigarettes and e-cigarette use in youth. In addition, there is limited literature addressing the role of flavors in youth perceptions of harm, and in fact, according to our review, only one assessed whether the presence of flavoring in an e-cigarette influences an individual’s belief about its harmfulness. A study of adolescents in the United Kingdom found that e-cigarettes flavored as candy and cherry were perceived as being less harmful than e-cigarettes in general, and those flavored like tobacco were perceived as being more harmful than e-cigarettes in general.²³

This study aims to strengthen our understanding of young people’s beliefs about e-cigarettes. The specific aim is to evaluate harm perceptions and perceived addictiveness of e-cigarettes among youth, including perceptions of harm specific to flavored e-cigarettes. We also assess whether these relationships differ in magnitude by sex or race/ ethnicity. The hypothesis is that among youth, perceived harm and addictiveness of e-cigarettes is lower among ever and current users of e-cigarettes as compared to non-users. Given the previous literature,⁴ we hypothesize that this relationship will be greatest among users who are male and white. A second hypothesis is that perceived harm of flavored e-cigarettes is lower than perceived harm of non-flavored e-cigarettes among ever and current users of e-cigarettes as

compared to non-users. We also hypothesize that this relationship will be greatest among male and white users.

METHODS

Study Design

The Texas Adolescent Tobacco and Marketing Surveillance system (TATAMS) is a rapid response surveillance system currently being implemented with 6th, 8th and 10th grade students in the 5 counties that surround the 4 largest cities in Texas—Austin, Houston, San Antonio, and Dallas/Ft. Worth. This study is a cross-sectional analysis of baseline data (Wave 1) from TATAMS, collected during the 2014–2015 academic year.

Data from The Texas Education Agency, the Texas Private School Accreditation Commission, and the National Center for Education Statistics were used to generate a sampling frame of 6th, 8th and 10th grade students enrolled in public, private and charter schools in these 5 counties in Texas (Travis, Harris, Bexar, Dallas/Tarrant Counties) in the 2014–2015 academic year. A complex, multistage, probability-design sample of public schools was taken using probability proportional to the grades' enrollment, and later all private and charter schools were invited to participate. The details of this complex procedure are described in Perez et al.²⁴ Overall, 79 schools agreed to participate.

A point person (eg, teacher, school counselor) was identified at each participating grade level and asked to recruit at least 55 students from each participating grade. This contact person was provided a \$100 incentive to reimburse them for their time and effort. Some 10th grade high school classes had students from 9th grade who were allowed to participate in the study to ease classroom burden. Active parental consent and active student assent were obtained. Students received a \$10 incentive upon completion of the survey. The baseline (ie, Wave 1) survey was administered between October 2014 and June 2015 (Sample [n] = 3907 from a population of students [N] = 461,069) using a computerized form on tablets.

Instrument

Survey questions were developed from a catalogue of valid and reliable measures used in state and national tobacco surveillance, including the Population Assessment of Tobacco and Health (PATH) study currently underway by the US Food and Drug Administration (FDA).^{25–27} A preliminary survey draft was reviewed by a panel of 6 leading experts with extensive experience in tobacco control, measurement, and survey design to establish face validity of the instrument. Additional cognitive interviewing was conducted between April and July 2014 with 27 students, ages 11 to 18, to ensure clear understanding of survey questions and full-color photographs of tobacco and nicotine products. Modifications to the instrument were made based on the expert review and the cognitive interviews.

The final survey instrument includes more than 340 questions specific to demographic factors, tobacco use behaviors (ie, e-cigarettes, cigars and cigarillos, little filtered cigars, smokeless tobacco, hookah, and cigarettes), cognitive and affective factors (eg, perceptions of harm), and self-reported exposure to tobacco marketing (eg, at retail outlets and in magazines and newspapers). Full-color photographs of the products were included to assist

participants with their recognition of tobacco and nicotine products, and skip patterns were programmed into the survey to reduce participant burden where applicable.

Outcome Variables

This manuscript focuses on 3 outcome variables. The first outcome was harm perceptions of e-cigarettes. The survey question, in reference to electronic cigarettes, vape pens or e-hookahs, asked: “How harmful are these products to health?” Participants were asked to choose among 4 categories of responses ranging from “not at all harmful” to “extremely harmful.” Responses were collapsed into 2 categories: “not at all” harmful and any other response was collapsed to represent the “any perceived harm” category. The “any perceived harm” category served as the reference.

The second outcome was harm perceptions of flavored e-cigarettes. To assess this outcome, students were asked: “Compared to non-flavored electronic cigarettes, vape pens or e-hookahs, how harmful are flavored electronic cigarettes, vape pens or e-hookahs to health?” Response categories were: “less harmful,” “about as harmful,” and “more harmful.” Responses “about as harmful” and “more harmful” were collapsed into “same/higher perceived harm” category versus “less harmful.” The “same/higher perceived harm” category served as the reference.

The third outcome of interest was perceived addictiveness of e-cigarettes. Students were asked: “How addictive are electronic cigarettes, vape pens or e-hookah?” Responses included: “not at all addictive,” “somewhat addictive,” and “very addictive.” Responses “somewhat addictive” and “very addictive” were collapsed to represent “any perceived addictiveness” versus “not at all addictive.” The “any perceived addictiveness” category served as the reference. All 3 outcomes were collapsed as described above to avoid large standard errors for the regression estimates associated with small cell size in each category.

Exposure

Current and ever e-cigarette use were the exposures of interest, and both were examined as dichotomous variables. To assess current e-cigarette use, respondents were asked: “During the past 30 days, on how many days did you use an electronic cigarette, vape pen or e-hookah?” By including a variety of commonly-used terms, captured through testing our survey instrument and items with cognitive interviewing with youth, we aimed to measure use and perceptions for all electronic nicotine delivery systems (ENDS). Therefore, findings should be applied to all ENDS broadly. Responses greater than zero days were considered past-30 day use. Respondents who reported they had not used e-cigarettes in the past 30 days represented the non-current user group. To assess ever e-cigarette use, respondents were asked: “Have you ever used an electronic cigarette, vape pen, or e-hookah, even one or two puffs?” Youth who responded “yes” were considered ever e-cigarette users and those who responded “no” were considered never e-cigarette users.

Covariates

Other covariates included: sex, grade, race/ethnicity (Hispanic, non-Hispanic white/other, and non-Hispanic black), socioeconomic status, and current use of tobacco products other

than e-cigarettes. Socioeconomic status was operationalized asking: “In terms of income, what best describes your family’s standard of living in the home where you live most of the time?” and collapsed response categories were: “very well off,” “living comfortably,” and “just getting by/nearly poor/poor.” To assess current use of other tobacco products (cigarettes, little filtered cigars, large cigars or cigarillos, hookah, smokeless tobacco), respondents who indicated they had ever tried any of these products were given separate items that asked: “During the past 30 days, on how many days did you smoke/use cigarettes, little filtered cigars/large cigars or cigarillos/hookah/smokeless tobacco?” For each one of these variables, responses greater than zero days were considered past 30-day use for that tobacco product. These covariates were chosen because they have been found to be associated with risk perceptions of tobacco products and/or e-cigarette use.^{6,28–31}

Statistical Methods

Descriptive statistics were conducted on sex, race/ethnicity, grade, socioeconomic status, e-cigarette user status, other tobacco product use, as well as the 3 outcome variables. All analyses used sampling weights to account for the complex design as well as for the clustering of the students within schools and to generalize to the population of students enrolled in these grades in these 4 Texas cities. Overall, Wave 1 had a sample size (n) of 3907 participants representing (N) 461,069 students in this sampling frame in Texas. Given that there were less than 10% of missing values for any of the variables described before, a complete case analysis³² was conducted on 3704 participants representing 434,601 students in these 4 cities in Texas. A type I error level of 0.05 was considered statistically significant. All data analyses were conducted using Stata 14.1 software package (College Station, TX).

Six separate weighted logistic regression models were used to test the hypothesis that current and ever e-cigarette user status were associated with each of the 3 outcomes each adjusting for the mentioned covariates. Furthermore, sex and race/ethnicity were considered as potential moderators because the perceived risks of e-cigarette use have been shown to vary by sex and race/ethnicity.^{4,6} That is, in the models examining current e-cigarette use, we included 2-way interaction terms between: (1) current e-cigarette use and sex; and (2) current e-cigarette use and race/ethnicity. Also, in the models examining ever e-cigarette use, we included 2-way interaction terms between: (1) ever e-cigarette use and sex; and (2) ever e-cigarette use and race/ethnicity. When no statistically significant moderation was found, we reported models adjusted for all covariates without the interaction (sex, grade, race/ethnicity, socioeconomic status and cigarette or other tobacco product use). We used the Hosmer-Lemeshow goodness-of-fit test for weighted logistic regression to evaluate model fit.³³

RESULTS

Descriptive Statistics

Table 1 provides descriptive statistics. The weighted sample included in this analysis is 49.2% female; 54.6% Hispanic, 28.0% non-Hispanic white/other, 17.4% non-Hispanic black; and 18.5% were from families of lower socioeconomic status. The sample was evenly distributed across 6th (32.1%), 8th (34.5%), and 10th (33.4%) grade levels. An estimated

17.4% of youth reported that e-cigarettes were “not at all” harmful, 27.0% reported that flavored e-cigarettes were “less harmful” than non-flavored e-cigarettes, and 55.5% reported that e-cigarettes were “not at all” addictive. In the past 30 days, 7.1% of youth reported they had used e-cigarettes, and 19.2% reported that they had ever used e-cigarettes. The vast majority of current e-cigarette users (88.4%) reported use of flavored e-cigarettes, which are those that were not tobacco-flavored. In the past 30 days, 6.0% of youth reported using at least one other tobacco product other than an e-cigarette.

Perceived Harm of E-cigarettes

The F-test statistics, associated degrees of freedom, and associated p-values for the interaction terms for race/ethnicity and current e-cigarette use, sex and current e-cigarette use, race/ethnicity and ever e-cigarette use, and sex and ever e-cigarette use were: $F(2,76) = 0.70$ ($p = .50$), $F(1,77) = 1.66$ ($p = .20$), $F(2,76) = 0.40$ ($p = .67$), and $F(1,77) = 0.39$ ($p = .53$), respectively. None of these was statistically significant; therefore, all the models without interactions were used. As Table 2 shows, youth who currently used e-cigarettes had higher odds ($OR = 4.77$, 95% CI: 3.19 – 7.15) of reporting that e-cigarettes were “not at all” harmful to health compared to non-current e-cigarettes users after adjusting for sex, grade, race/ethnicity, socioeconomic status and cigarette or other tobacco product use. Youth who had ever used e-cigarettes also had higher odds ($OR = 3.61$, 95% CI: 2.48 – 5.28) of reporting that e-cigarettes were “not at all” harmful to health compared to never users after adjusting for covariates (Table 3). The Hosmer-Lemeshow goodness-of-fit tests indicated good model fit for the adjusted weighted logistic regression models examining current e-cigarette use ($\chi^2 = 1.43$, $p = .19$) and ever e-cigarette use ($\chi^2 = 0.70$, $p = .71$) on perceived harm of e-cigarettes.

Perceived Harm of Flavored E-cigarettes Compared to Non-flavored E-cigarettes

The F-test statistics, associated degrees of freedom, and associated p-values for the interaction terms for race/ethnicity and current e-cigarette use, sex and current e-cigarette use, race/ethnicity and ever e-cigarette use, and sex and ever e-cigarette use were: $F(2,76) = 0.99$ ($p = .38$), $F(1,77) = 0.12$ ($p = .74$), $F(2,76) = 1.72$ ($p = .19$), and $F(1,77) = 0.05$ ($p = .82$), respectively. None of these was statistically significant; therefore, all the models without interactions were used. As seen in Table 2, youth who currently used e-cigarettes had higher odds ($OR = 2.84$, 95% CI: 1.91 – 4.21) of reporting flavored e-cigarettes as “less harmful” than non-flavored e-cigarettes compared to non-current users after adjusting for covariates. Youth who had ever used e-cigarettes also had higher odds ($OR = 2.88$, 95% CI: 2.42 – 3.42) of reporting that e-cigarettes were “less harmful” than non-flavored products compared to never users after adjusting for covariates (Table 3). The Hosmer-Lemeshow goodness-of-fit tests indicated good model fit for the adjusted weighted logistic regression models examining current e-cigarette use ($\chi^2 = 0.93$, $p = .51$) and ever e-cigarette use ($\chi^2 = 0.64$, $p = .76$) on perceived harm of flavored e-cigarettes.

Perceived Addictiveness of E-cigarettes

The F-test statistics, associated degrees of freedom, and associated p-values for the interaction terms for race/ethnicity and current e-cigarette use, sex and current e-cigarette use, race/ethnicity and ever e-cigarette use, and sex and ever e-cigarette use were: $F(2,76) =$

2.13 ($p = .13$), $F(1,77) = 0.00$ ($p = .98$), $F(2,76) = 0.18$ ($p = .84$), and $F(1,77) = 0.78$ ($p = .38$), respectively. Again, none of these interactions was statistically significant. As Table 2 shows, youth who currently used e-cigarettes had higher odds ($OR = 1.72$; 95% CI: 1.12 – 2.65) of reporting that e-cigarettes were “not at all” addictive compared to non-current users after adjusting for sex, grade, race/ethnicity, socioeconomic status, and cigarette or other tobacco product use. Similarly, youth who had ever used e-cigarettes also had higher odds ($OR = 1.49$; 95% CI: 1.18 – 1.87) of reporting that e-cigarettes were “not at all” addictive compared to never users after adjusting for covariates (Table 3). The Hosmer-Lemeshow goodness-of-fit tests indicated good model fit for the adjusted logistic regression models examining current use ($\chi^2 = 0.24$, $p = .99$) and ever use ($\chi^2 = 0.29$, $p = .97$) on perceived addictiveness of e-cigarettes.

DISCUSSION

This study contributes to the limited evidence that low perceptions of harm and addictiveness for e-cigarettes among youth are associated with e-cigarette ever use (including experimentation) and current use. By examining both measures, we have a deeper understanding of the stages of tobacco use in this young age group that may be in an experimentation or more regular stage of use. To our knowledge, this is the first study to explore the association between perceived harm of flavored e-cigarettes and current and ever e-cigarette use. Contrary to expectations, neither race/ethnicity nor sex was detected as moderators, meaning that current and ever e-cigarette use was consistent across sex and race/ethnicity strata.

Current findings are generally consistent with emerging research exploring risk perceptions and e-cigarette consumption among youth.^{4,6,9} For example, our findings are consistent with those of Ambrose et al⁴ who found that ever use of e-cigarettes was significantly associated with perceiving e-cigarettes as less harmful than cigarettes among middle and high school students nationwide. Amrock et al⁶ also investigated the comparative harm of e-cigarettes to cigarettes, and found that both ever users and current users of e-cigarettes reported that e-cigarettes were less harmful than cigarettes. Chaffee et al⁹ examined perceived risks and benefits of e-cigarettes in a sample of high school boys and found that increasing perceived risk was associated with lower prevalence of ever use of e-cigarettes. Our study extends these findings further, as it is specific to the *absolute* harm and addictiveness associated with e-cigarettes – not compared to other product use, like cigarettes. It is important to understand youth perceptions of absolute harm from e-cigarettes rather than the relative harm compared to cigarettes to gain an understanding of how middle school and high school students perceive the potential dangers of e-cigarettes separately from cigarettes, for which the hazards are well-documented and better understood by youth.³⁴ This information may become increasingly relevant, as the prevalence of cigarette smoking continues to decline and e-cigarette use rises in youth.²

We found that the vast majority of current e-cigarette users used flavored products, which is consistent with previous research documenting that appealing flavors were a top-cited reason for youth experimentation with e-cigarettes.⁸ Furthermore, this is the first study to assess the relationship between the role of flavorings in youth’s perceptions about the harmfulness of

e-cigarettes and e-cigarette use, finding that youth who were current and ever e-cigarette users had higher odds of reporting flavored e-cigarettes as less harmful than non e-cigarette users. This finding extends previous research which found that fruit flavorings in hookah contributed to youth's perceptions of fewer health risks.³⁵ It is possible that the less e-cigarettes resemble conventional cigarettes in taste, the less harmful they are thought to be, though the reasons behind these perceptions for e-cigarettes should be explored in future studies among youth.

To our knowledge, no other studies have investigated the association between perceived addictiveness of e-cigarettes and current and ever use of e-cigarettes in a youth population. Not only was the association between perceived addictiveness and e-cigarette use statistically significant, it is particularly noteworthy to mention that over half of youth (55.5%) reported that e-cigarettes were "not at all" addictive in this study. This finding is generally consistent with Anand et al's survey of public high school students in North Carolina, 60% of whom reported that e-cigarettes were safe or had minimal hazards.⁷ It is important to note, however, that neither the current manuscript nor the Anand et al study queried youth on specific nicotine concentration levels used in e-cigarettes; thus, it remains unknown how differing nicotine levels may influence youth risk perceptions.

Researchers have not yet reached a consensus regarding the short-term or long-term health consequences of e-cigarettes for youth. Although many have concluded that e-cigarettes are likely less harmful than conventional cigarettes,³⁶ there is, however, evidence suggesting they are not harmless.³⁷ For example, although the level of nicotine delivered to users via an e-cigarette is variable and the threshold for addiction to nicotine associated with e-cigarette use in youth is unknown, nicotine itself is still considered a highly addictive substance. In a neuroimaging study, exposure to intravenous nicotine increased neuronal activity in brain regions also shown to produce reinforcing and dependence properties associated with cocaine, amphetamine and opiates.³⁸ In addition, other studies of e-cigarette aerosols have revealed that some contain potentially harmful toxicants.^{39,40} Finally, there is emerging literature that has suggested that some flavorings in e-cigarettes present more potential for harm. Farselinos et al⁴¹ tested sweet-flavored e-cigarette liquids for the presence of diacetyl and acetyl propionyl, both constituents associated with respiratory disease when inhaled. They found that between 40% and 50% of the samples tested exposed users to levels higher than the recommended safety limits for either substance.

Although we cannot determine causation because this is a cross-sectional study, the lower perceptions of risk among youth may contribute to a decision to use an e-cigarette. Alternatively, previous use of an e-cigarette may contribute to the formulation of favorable perceptions of these products. Future research should explore the association of perceptions of harm and addictiveness as contributors to a decision to use an e-cigarette in longitudinal studies. The study population was limited to students in 6th, 8th and 10th grades within 4 cities in Texas. Therefore, findings may not be generalizable outside of this population including other regions of the US and other countries where e-cigarette regulations and advertising are variable. Additional research also should examine whether and how exposure to e-cigarette advertising influences perceptions of harm and addictiveness specific to e-cigarette use, including use of flavored e-cigarettes, among youth. In a content analysis of

365 YouTube videos featuring e-cigarettes, 85% of which were sponsored by e-cigarette companies, 301 videos (or 82%) presented some sort of positive health claim.⁴² YouTube has an expansive reach, especially to adolescent audiences. In fact, 54% of all US teens use the website.⁴³ Whereas our current study does not measure media and advertising exposure and e-cigarette use, one previous study has found that most US adolescents learn about e-cigarettes through television advertisements;⁷ in contrast, a study conducted among Korean youth found the most common contact route on e-cigarettes was the internet.⁴⁴ This calls into question the content of e-cigarette advertising via various media as it may influence perceptions of harm and addictiveness in this vulnerable population, including perceptions about flavored e-cigarette products.

IMPLICATIONS FOR TOBACCO REGULATION

Our finding that youth e-cigarette users viewed flavored e-cigarettes as less harmful than non-flavored e-cigarettes is especially concerning and provides scientific rationale for the FDA to regulate characterizing flavors in these products as they are associated with lower harm perceptions. Future health communication campaigns, such as the FDA's "The Real Cost," which does not explicitly address e-cigarettes at present,⁴⁵ should focus on dispelling commonly held misperceptions by youth that e-cigarettes are not harmful and not addictive. This is particularly important given our current finding that 55.5% believed they were not at all addictive and other findings that some e-cigarette aerosol contains toxins such as carbonyl compounds, volatile organic compounds, and nitrosamines, albeit at lower levels than traditional cigarettes.⁴⁶ Nicotine concentrations typically range from 6 to 24 mg/ml in e-cigarettes,⁴⁷ making them potentially addictive products. Future campaigns also should address misperceptions that flavored e-cigarettes are less harmful than non-flavored e-cigarettes.

The current study confirms limited research to date that perceived harm and addictiveness of e-cigarettes are related to e-cigarette use in youth. Our study uses a measure of absolute harm which adds a new dimension to previous research, highlighting the perceptions of harm of e-cigarettes alone (rather than compared to cigarettes, which are known to be extremely harmful). In addition, it is the first US study to note that youth e-cigarette users had higher odds of reporting flavored e-cigarettes as less harmful than non-flavored e-cigarettes. Finally, more than half of the youth reported that e-cigarettes are "not at all" addictive, a finding that warrants attention given that nicotine is present in many, though not all, e-cigarettes. Findings should inform future regulatory action on e-cigarettes and communication campaigns for young people, now that the FDA has the authority to act on these products.

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Table 1

Weighted Wave 1 Estimates of Youth Population (n = 3704; N = 434,601)

Socio-Demographic Characteristics	n; N (Weighted %)
<i>Sex</i>	
Male	1617; 220,682 (50.8%)
Female	2087; 213,919 (49.2%)
<i>Race/ethnicity</i>	
Hispanic	1430; 237,314 (54.6%)
Non-Hispanic White/Other	1687; 121,721 (28.0%)
Non-Hispanic Black	487; 75,566 (17.4%)
<i>Grade</i>	
6th	1061; 139,477 (32.1%)
8th	1255; 149,791 (34.5%)
10th	1388; 145,333 (33.4%)
<i>Socioeconomic status</i>	
Very well off	830; 84,079 (19.4%)
Living comfortably	2308; 270,268 (62.2%)
Just getting by/nearly poor/poor	566; 80,254 (18.5%)
Tobacco Use Behaviors	n; N (Weighted %)
<i>Past 30 day e-cigarette user status</i>	
Non-current E-cigarette User	3466; 403,909 (92.9%)
Current E-cigarette User	238; 30,692 (7.1%)
<i>Ever e-cigarette user status</i>	
Never E-cigarette User	3062; 351,030 (80.8%)
Ever E-cigarette User	642; 83,571 (19.2%)
<i>Past 30 day flavored e-cigarette use (n = 238, N = 30,692)</i>	
Non-flavored (ie, tobacco flavoring)	25; 3,559 (11.6%)
Flavored (ie, mint, candy, fruit, coffee/alcohol, spice, or other flavoring)	213; 27,133 (88.4%)
<i>Other past 30 day tobacco product use</i>	
No	3537; 408,450 (94.0%)
Yes	167; 26,151 (6.0%)
Perceptions of E-cigarettes	n; N (Weighted %)
<i>Perceived harm</i>	
4 (Extremely harmful)	1502; 180,522 (41.5%)
3	662; 70,310 (16.2%)
2	949; 108,241 (24.9%)
1 (Not at all harmful)	591; 75,528 (17.4%)
<i>Perceived harm of flavored e-cigarettes</i>	
More harmful	702; 87,287 (20.1%)
About as harmful	2066; 230,209 (53.0%)

Socio-Demographic Characteristics	n; N (Weighted %)
Less harmful	936; 117,106 (27.0%)
<i>Perceived addictiveness</i>	
Very addictive	652; 76,272 (17.6%)
Somewhat addictive	1081; 117,153 (27.0%)
Not at all addictive	1971; 241,176 (55.5%)

Note.

N = Population of students potentially available; n = actual sample size

Table 2

Adjusted Odds of Current Users Reporting E-cigarettes are “Not at All” Harmful, Flavored E-cigarettes are “Less Harmful” than Non-flavored E-cigarettes, and E-cigarettes are “Not at All” Addictive (n = 3704, N = 434,601)

	“Not at all” Harmful	Flavored as “Less Harmful”	“Not at all” Addictive
	adjOR (95% CI)	adjOR (95% CI)	adjOR (95% CI)
<i>Non-current e-cigarette use (ref)</i>	1	1	1
<i>Current e-cigarette use</i>	4.77 *** (3.19 – 7.15)	2.84 *** (1.91 – 4.21)	1.72 * (1.12 – 2.65)
Sex			
Male (ref)	1	1	1
Female	0.90 (0.70 – 1.15)	0.88 (0.67 – 1.15)	0.73 ** (0.57 – 0.92)
Race			
Non-Hispanic White/Other (ref)	1	1	1
Non-Hispanic Black	1.41 (0.93 – 2.13)	1.32 (0.97 – 1.79)	1.86 ** (1.22 – 2.94)
Hispanic	1.54 ** (1.13 – 2.09)	1.09 (0.84 – 1.42)	1.63 ** (1.22 – 2.84)
Grade			
6th (ref)	1	1	1
8th	1.30 (0.96 – 1.76)	1.76 * (1.11 – 2.78)	0.74 (0.46 – 1.18)
10th	1.94 *** (1.37 – 2.76)	2.38 *** (1.57 – 3.62)	0.74 (0.49 – 1.12)
Socioeconomic Status			
Very well off (ref)	1	1	1
Living comfortably	0.97 (0.63 – 1.48)	1.21 (0.84 – 1.75)	0.79 (0.54 – 1.13)
Just getting by/nearly poor/poor	0.75 (0.48 – 1.16)	1.28 (0.81 – 2.02)	0.73 (0.49 – 1.08)
Other tobacco use	2.22 ** (1.30 – 3.78)	2.48 ** (1.45 – 4.23)	1.71 * (1.12 – 2.60)

p < .001

**
p < .01

*
p < .05

Note.

N = Population of students potentially available; n = actual sample size

Table 3

Adjusted Odds of Ever Users Reporting E-cigarettes are “Not at All” Harmful, Flavored E-cigarettes are “Less Harmful” than Non-flavored E-cigarettes and E-cigarettes are “Not at All” Addictive (n = 3704, N = 434,601)

	“Not at all” Harmful	Flavored as “Less Harmful”	“Not at all” Addictive
	adjOR (95% CI)	adjOR (95% CI)	adjOR (95% CI)
<i>Never e-cigarette use (ref)</i>	1	1	1
<i>Ever e-cigarette use</i>	3.61 *** (2.48 – 5.28)	2.88 *** (2.42 – 3.42)	1.49 ** (1.18 – 1.87)
Sex			
Male (ref)	1	1	1
Female	0.87 (0.69 – 1.10)	0.86 (0.65 – 1.13)	0.72 ** (0.57 – 0.91)
Race			
Non-Hispanic White/Other (ref)	1	1	1
Non-Hispanic Black	1.32 (0.87 – 2.00)	1.27 (0.93 – 1.73)	1.84 ** (1.21 – 2.80)
Hispanic	1.46 * (1.06 – 2.02)	1.05 (0.82 – 1.34)	1.61 ** (1.21 – 2.13)
Grade			
6th (ref)	1	1	1
8th	1.11 (0.83 – 1.50)	1.57 * (1.01 – 2.45)	0.71 (0.44 – 1.15)
10th	1.53 * (1.06 – 2.21)	1.96 ** (1.30 – 2.96)	0.70 (0.46 – 1.06)
Socioeconomic Status			
Very well off (ref)	1	1	1
Living comfortably	0.99 (0.66 – 1.48)	1.24 (0.85 – 1.81)	0.79 (0.55 – 1.14)
Just getting by/nearly poor/poor	0.76 (0.49 – 1.17)	1.30 (0.82 – 2.04)	0.73 (0.50 – 1.08)
Other tobacco use	2.09 ** (1.27 – 3.44)	2.08 ** (1.25 – 3.44)	1.69 ** (1.15 – 2.47)

p < .001

**
p < .01

*
p < .05

Note.

N = Population of students potentially available; n = actual sample size