

Flavored Electronic Cigarette Use and Smoking Among Youth

Hongying Dai, PhD,^{a,b,c} Jianqiang Hao, PhD^d

abstract

BACKGROUND AND OBJECTIVE: Flavored electronic cigarettes (e-cigarettes) are not prohibited in the United States, and e-cigarette flavors proliferate on the market. This study sought to examine flavored e-cigarette use and its association with smoking among youth.

METHODS: Estimates of flavored e-cigarette use from the 2014 National Youth Tobacco Survey were investigated. A logistic regression model was used to assess whether flavored e-cigarette use was associated with (1) intention to initiate cigarette use among never-smoking youth ($n = 16\,471$), (2) intention to quit tobacco use among current-smoking youth ($n = 1338$), and (3) perception of tobacco's danger among all respondents ($n = 21\,491$).

RESULTS: A total of 2017 respondents reported using e-cigarettes in the last 30 days, of whom 1228 (60.9%) reported using flavored e-cigarettes. Among never-smoking youth, 55.6% (288) of current e-cigarette users reported using flavored e-cigarettes. Among current smokers, 68.4% (495) of current e-cigarette users reported using flavored e-cigarettes. Compared with not using e-cigarettes in the past 30 days, using flavored e-cigarettes was associated with higher odds of intention to initiate cigarette use among never-smoking youth (adjusted odds ratio [aOR] = 5.7; $P < .0001$), lower odds of intention to quit tobacco use among current-smoking youth (aOR = 0.6; $P = .006$), and a lower prevalence of perception of tobacco's danger among all respondents (aOR = 0.5; $P < .0001$).

CONCLUSIONS: Flavored e-cigarette use is associated with increased risks of smoking among youth. Comprehensive tobacco control and prevention strategies that address flavored e-cigarette products are critically needed to reduce tobacco use among youth.

FREE

^aDivision of Health Services and Outcomes Research, Children's Mercy Hospital, Kansas City, Missouri; ^bDepartments of Biomedical and Health Informatics, and ^cPediatrics, University of Missouri-Kansas City, Kansas City, Missouri; and ^dCollege of Business, Bellevue University, Omaha, Nebraska

Dr Dai conceptualized the study, performed analyses, and drafted the initial manuscript; Dr Hao acquired data, assisted in data presentation and result interpretation, and drafted the initial manuscript; and both authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

DOI: 10.1542/peds.2016-2513

Accepted for publication Aug 26, 2016

Address correspondence to Hongying Dai, PhD, Division of Health Services and Outcomes Research, Children's Mercy Hospital, 2401 Gillham Rd, Kansas City, MO 64108. E-mail: hdai@cmh.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2016 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose

FUNDING: No external funding.

WHAT'S KNOWN ON THIS SUBJECT: Because of a proliferation of e-cigarette flavors on the market, flavored e-cigarette use among youth in the United States has increased significantly. The majority of youth who have ever used e-cigarettes started with a flavored product.

WHAT THIS STUDY ADDS: Flavored e-cigarette use among youth might serve as a gateway for future smoking and was associated with decreased odds of quitting smoking. Flavored e-cigarette use was also associated with decreased perception of tobacco's danger among youth.

To cite: Dai H and Hao J. Flavored Electronic Cigarette Use and Smoking Among Youth. *Pediatrics*. 2016;138(6):e20162513

The number of young people using electronic cigarettes (e-cigarettes) in the United States has risen from ~780 000 in 2013 to >3 million in 2015.¹ One explanation for the surge in e-cigarette use is the availability of a large number of different flavors that might appeal to youth. One recent study found that the leading reason for youth e-cigarette use in 2013 to 2014 was the availability of appealing flavors, with 81% of youth e-cigarette users citing this reason.²

Although the 2009 Family Smoking Prevention and Tobacco Control Act banned cigarettes with characterizing flavors (eg, candy, fruit, and clove) except menthol, this rule is not applied to e-cigarettes.³ As a result, >460 brands and 7700 flavors of e-cigarettes are on the market, including flavors such as candy crush, gummy bear, and bubble gum.⁴ A total of 63.3% of current tobacco users in US middle and high schools, or nearly 1.58 million youth, had used flavored e-cigarettes in 2014.⁵ In May 2016, the US Food and Drug Administration finalized a rule extending its authority to regulate e-cigarettes, cigars, hookah tobacco, and pipe tobacco, along with other emerging tobacco products,⁶ but this rule does not prohibit flavored e-cigarettes.

Concern is growing that widespread availability of flavored e-cigarettes will increase the use of e-cigarette products by youth and will thus reinforce the acceptability of vaping behavior.^{5,7-9} The normalization of e-cigarette use among youth could also lead to e-cigarettes becoming a gateway for future smoking,¹⁰⁻¹³ marking a setback in the decades-long antismoking battle. Furthermore, concerns have been raised about the potential inhalation toxicity of these flavorings. Benzaldehyde, a key ingredient in natural fruit flavors, has been shown to cause irritation of respiratory airways. A recent study detected benzaldehyde in 108 of 145 flavored

e-cigarette products, with the highest levels found in cherry-flavored products.¹⁴

Little is known about the association between using flavored e-cigarettes and initiating cigarettes, quitting smoking, and perceiving the danger of tobacco among youth. This information is critically needed to understand the role of e-cigarette flavoring in youth tobacco use. To address the gaps in knowledge, we used data from the 2014 National Youth Tobacco Survey (NYTS) and specifically sought to (1) examine the association between flavored e-cigarette use and intention to initiate cigarette smoking among never-smoking youth, (2) analyze the association between flavored e-cigarette use and intention to quit tobacco use in the next 12 months among current youth smokers, and (3) assess the association between flavored e-cigarette use and youth perception of the danger of tobacco.

METHODS

Data

The 2014 NYTS is a cross-sectional and school-based survey that supports estimation of the tobacco-related knowledge, attitudes, and behaviors of students in middle school (grades 6–8) and high school (grades 9–12) from all 50 states and the District of Columbia. The 2014 NYTS used a stratified, 3-stage cluster sampling procedure to generate a nationally representative sample of US middle and high school students. A detailed description of 2014 NYTS survey design, questionnaires, and data collection can be found on the NYTS Web site.¹⁵

In the 2014 NYTS survey, 258 schools were selected and 207 (80.2%) participated. Among 24 084 eligible students, 22 007 (91.4%) completed the questionnaires. The overall response rate was 73.3%.¹⁶ Because the data were de-identified and

publically available, this study was exempt from institutional review board approval.

Measures

Flavored E-cigarette Use

Two items from the 2014 NYTS were used to define flavored e-cigarette use: (1) “During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes such as Blu, 21st Century Smoke or NJOY?”; and (2) “Which of the following tobacco products that you used in the past 30 days were flavored to taste like menthol (mint), alcohol (wine, cognac), candy, fruit, chocolate or other sweets?” Students were asked to select from a list of options to designate the flavored product or products they had used or indicate that they had not used flavored tobacco in the past 30 days. Those who selected “Electronic cigarettes or e-cigarettes” to the second question were considered users of flavored e-cigarettes. We classified the survey respondents as: not current users of e-cigarettes (students who had not used e-cigarettes in the past 30 days); current users of nonflavored e-cigarettes (students who had used e-cigarettes at least 1 day during the past 30 days but did not use flavored e-cigarettes); and current users of flavored e-cigarettes (students who had used e-cigarettes at least 1 day during the last 30 days and used flavored e-cigarettes). We excluded 516 students whose answers were missing or inconsistent, resulting in 21 491 respondents in the study.

Intention To Initiate Cigarette Use/Quit Smoking/Perception of Tobacco's Danger

The current tobacco smoking status was coded as never (students who had never smoked cigarettes), former (students who had smoked at least 100 cigarettes in their lifetime but had not smoked in the past 30 days), and current smokers (students who

had smoked at least 100 cigarettes in their lifetime and at least 1 cigarette in the past 30 days) based on 2 items: (1) "Have you ever tried cigarette smoking, even one or two puffs?"; and (2) "During the past 30 days, on how many days did you smoke cigarettes?"

Among never-smoking youth, the intention to smoke cigarettes was measured on the basis of 2 NYTS questionnaire items: (1) "Do you think you will smoke a cigarette in the next year?" and (2) "Do you think you will try a cigarette soon?" Responses for these questions included "Definitely yes," "Probably yes," "Probably not," and "Definitely not." The respondents who answered "Definitely not" to both questions were classified into the group "no intention to initiate cigarette smoking." The respondents who answered "Definitely yes," "Probably yes," or "Probably not" to either of these 2 questions were classified into the group "intention to initiate cigarette smoking."¹⁷⁻¹⁹

Among current-smoking youth, the intention to quit tobacco use was measured by the question, "Are you seriously thinking about quitting the use of all tobacco products?" The respondents who answered, "Yes, within the next 30 days," "Yes, within the next 6 months," or "Yes, within the next 12 months" were classified into the group "intention to quit smoking in next 12 months." Those who responded, "Yes, but not within the next 12 months" or "No, I am not thinking about quitting cigarettes" were classified into the group "no intention to quit smoking in next 12 months."

Among all respondents, the perception of tobacco's danger was measured by the item, "How strongly do you agree with the statement 'All tobacco products are dangerous?'" The respondents who answered "Strongly agree" or "Agree" were classified into the group "perceived tobacco danger," and those who

answered "Disagree" or "Strongly disagree" were classified into the group "no perceived tobacco danger."

Figure 1 summarizes the study design and sample size for this analysis.

Covariates

Several covariates were included in the analysis to control for other tobacco-related influences, such as age, sex (boy or girl), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or non-Hispanic other), and grade (middle/high school). Current smoking status was also included as a covariate in assessing the association between flavored e-cigarette use and perception of tobacco's danger.

Statistical Methods

Weighted estimates along with 95% confidence intervals (CI) of the prevalence of intention to initiate cigarette use among never smokers, intention to quit tobacco use in the next 12 months among current smokers, and perception of tobacco's danger among all respondents were calculated. Sampling weights and survey stratum were included in the analyses to account for the complex survey design. A logistic regression model was used to examine the associations between flavored e-cigarette use and tobacco use and perception of tobacco's danger among youth. The students who reported not using e-cigarettes in the past 30 days served as the control group. Adjusted odds ratios (aORs) were calculated in the multivariate analysis. Statistical analyses were performed using SAS 9.4 (SAS Institute, Inc, Cary, NC) and a *P* value <0.05 was considered statistically significant.

RESULTS

Of all respondents (*n* = 21 491), 16 471 (76.6%) were never smokers and 1338 (6.2%) were current smokers. Of never smokers, 518

(3.1%) used e-cigarettes at least 1 day during the past 30 days and of these, 55.6% (288) used flavored e-cigarettes. Of current smokers, 724 (54.1%) used e-cigarettes at least 1 day during the past 30 days and of these and of these, 68.4% (495) used flavored e-cigarettes. Overall, 2017 respondents used e-cigarettes in the last 30 days and 1228 (60.9%) of them used flavored e-cigarettes.

Table 1 presents the prevalence of intention to initiate cigarette use among never smokers, intention to quit tobacco use in next 12 months among current smokers, and the perception of tobacco's danger among all respondents. Among never smokers, the use of flavored e-cigarettes was associated with a higher prevalence of intention to initiate cigarette use compared with those who had not used e-cigarettes in the past 30 days (58.3% vs 20.1%) or with those who had used nonflavored e-cigarettes (58.3% vs 47.4%). Among youth who reported using flavored e-cigarettes, younger students (<15 vs ≥15 years old) were more likely to intend to initiate cigarette use (69.6% vs 53.3%), and girls were more likely than boys to intend to initiate cigarette use (63.8% vs 53.3%). Among current smokers, students who reported using flavored e-cigarettes were least likely to quit tobacco use compared with those who reported using nonflavored e-cigarettes (24.1% vs 33.5%) or with those who reported not using e-cigarettes (24.1% vs 32.7%). Among the students who reported using flavored e-cigarettes, older or high school students were less likely to intend to quit tobacco use than were younger or middle school students. Girls were less likely to intend to quit tobacco use than were boys, and non-Hispanic blacks were less likely to intend to quit tobacco use than were other races. Among all respondents, students who reported using flavored e-cigarettes were least likely to perceive tobacco's danger compared with those who reported

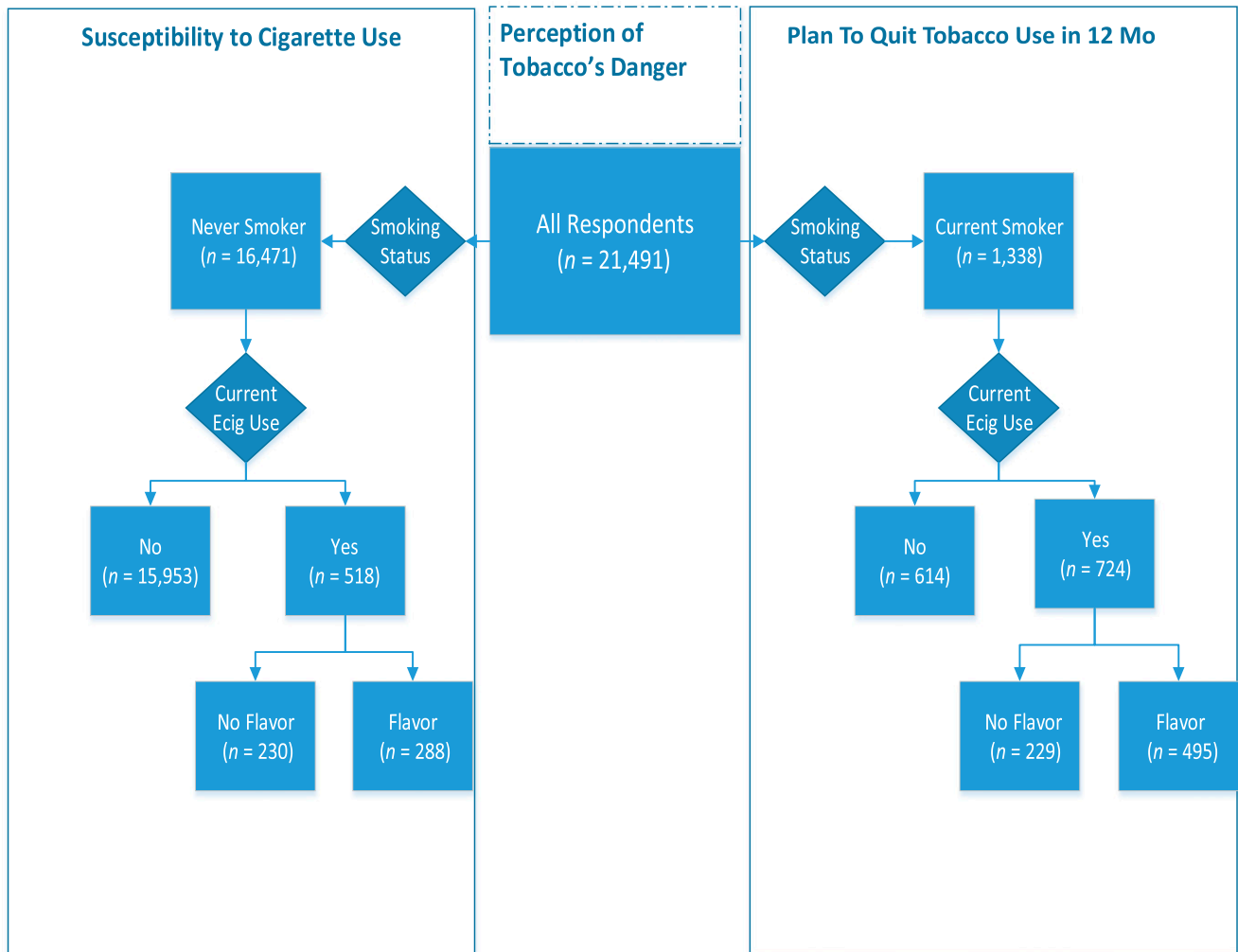


FIGURE 1
Study design and sample size. Ecig, e-cigarette.

using nonflavored e-cigarettes (74.8% vs 77.1%) or those who reported not using e-cigarettes (74.8% vs 91.3%). The low prevalence of perception of tobacco’s danger was observed among users of flavored e-cigarettes across sociodemographic groups and current smoking status, especially among young students, boys, middle schoolers, non-Hispanic blacks, and current smokers.

Prediction for the Intention To Initiate Cigarette Use Among Never Smokers

Factors associated with the intention to initiate cigarette use among never smokers are presented in Table 2. The use of flavored e-cigarettes

was associated with higher odds of intention to initiate cigarette use (aOR = 5.7; $P < .0001$) compared with not using e-cigarettes. Compared with users of nonflavored e-cigarettes, users of flavored e-cigarettes also had higher odds of intention to initiate cigarette use (aOR = 1.7; $P = .02$, not shown in Table 2). Hispanic students were more likely to intend to initiate cigarette use than were non-Hispanic whites (aOR = 1.7; $P < .0001$).

Prediction for the Intention To Quit Tobacco Use Among Current Smokers

Among current smokers, using flavored e-cigarettes was associated

with decreased odds of intention to quit tobacco use in the next 12 months compared with not using e-cigarettes (aOR = 0.6; $P = .006$) (Table 2). In contrast, using nonflavored e-cigarettes was not significantly associated with decreased odds of intention to quit tobacco use compared with not using e-cigarettes (aOR = 0.9; $P =$ not significant). Other social demographic factors were not significantly associated with the intention to quit tobacco use in the multivariate analysis.

Prediction of Perception of Tobacco’s Danger

Among all respondents, the students who reported using flavored

TABLE 1 Flavored E-cigarette Use and Intention To Initiate Cigarettes, Intention To Quit Smoking, and Perception of Tobacco's Danger by Social Demographic Status Among US Middle and High School Students, NYTS, 2014

	Never Smoker (n = 16471)		Susceptibility to Cigarette Use		Current Smoker (n = 1358)		Plan To Quit Tobacco Use in 12 Mo		All Respondents (n = 21491)		Perception of Tobacco's Danger	
	No Eciq Use	Eciq Use (No Flavor)	Eciq Use (No Flavor)	Eciq Use (Flavor)	No Eciq Use	Eciq Use (Flavor)	No Eciq Use	Eciq Use (Flavor)	No Eciq Use	Eciq Use (No Flavor)	Eciq Use (No Flavor)	Eciq Use (Flavor)
N	15953	230	288	614	229	495	19474	789	1228			
Prevalence	20.1 (19.3–20.9)	47.4 (39.2–55.5)	58.3 (51.4–65.1)	32.7 (27.5–37.9)	33.5 (26.1–40.8)	24.1 (19.1–29.0)	91.3 (90.8–91.9)	77.1 (73.6–80.6)	74.8 (71.9–77.7)			
Age												
<15 y	20.2 (19.2–21.3)	60.0 (48.4–71.6)	69.6 (59.5–79.7)	33.9 (20.4–47.3)	34.1 (19.5–48.7)	27.6 (16.5–38.6)	92.6 (91.8–93.3)	71.8 (65.3–78.2)	65.5 (59.1–71.8)			
≥15 y	19.9 (18.7–21.1)	40.2 (29.8–50.6)	53.3 (44.7–62.0)	32.3 (26.9–37.7)	33.2 (24.7–41.8)	23.5 (18.0–29.0)	90.1 (89.3–90.9)	78.9 (74.7–83.0)	77.2 (73.9–80.5)			
Gender												
Boy	21.0 (19.8–22.1)	51.3 (41.1–61.6)	53.3 (43.6–62.9)	33.3 (26.5–40.2)	32.5 (23.2–41.8)	27.2 (20.2–34.2)	91.1 (90.4–91.8)	73.1 (68.3–77.9)	70.4 (66.4–74.5)			
Girl	19.2 (18.1–20.3)	40.9 (28.0–53.8)	63.8 (54.2–73.5)	32.1 (24.2–40.0)	35.1 (22.7–47.4)	20.9 (13.9–28.0)	91.6 (90.8–92.5)	82.4 (77.5–87.4)	80.2 (76.0–84.4)			
Grade												
Middle school	20.1 (19.0–21.1)	63.4 (51.3–75.6)	68.9 (56.9–80.8)	36.7 (20.9–52.4)	32.4 (17.9–47.0)	29.6 (17.0–42.1)	92.4 (91.6–93.2)	75.4 (68.9–82.0)	62.3 (55.2–69.4)			
High school	20.1 (19.0–21.2)	40.4 (30.5–50.3)	55.0 (47.0–63.1)	32.1 (26.8–37.4)	33.6 (25.1–42.1)	23.3 (17.9–28.7)	90.4 (89.7–91.1)	77.5 (73.4–81.6)	77.2 (74.1–80.4)			
Race												
NH-white	17.8 (16.7–18.9)	48.7 (35.4–62.0)	59.7 (50.9–68.5)	29.8 (23.7–36.0)	30.0 (19.7–40.2)	21.1 (15.3–27.0)	92.9 (92.1–93.6)	76.8 (71.5–82.0)	75.0 (71.2–78.8)			
NH-black	19.3 (17.5–21.2)	39.2 (22.0–56.5)	54.0 (32.9–75.0)	47.5 (31.8–63.1)	36.9 (12.4–61.4)	19.8 (3.3–36.3)	88.2 (86.7–89.7)	82.7 (74.5–91.0)	66.2 (52.6–79.7)			
Hispanic	27.7 (26.0–29.4)	47.9 (36.2–59.6)	57.8 (43.3–72.3)	37.3 (24.2–50.4)	38.9 (25.6–52.2)	26.0 (16.9–35.1)	90.0 (88.9–91.1)	75.1 (69.5–80.8)	74.6 (69.5–79.7)			
NH-other	20.2 (17.3–23.1)	38.3 (2.5–74.0)	44.9 (17.5–72.3)	43.9 (12.6–75.3)	22.8 (0.0–47.1)	31.6 (7.1–56.1)	94.1 (92.7–95.4)	75.7 (59.9–91.5)	86.5 (77.5–95.6)			
Smoking status												
Never	—	—	—	—	—	—	93.1 (92.7–93.6)	85.4 (80.4–90.3)	82.8 (78.0–87.5)			
Former	—	—	—	—	—	—	83.6 (81.3–85.9)	82.6 (77.0–88.2)	80.2 (75.4–85.1)			
Current	—	—	—	—	—	—	80.0 (76.2–83.9)	63.8 (56.5–71.0)	67.9 (62.8–73.0)			

Weighted estimates and 95% CIs are presented in parentheses. Sample weights and strata have been included in the analysis to account for the complex survey design. Eciq, e-cigarette; NH, non-Hispanic; —, not applicable.

e-cigarettes had lower odds of perceiving tobacco's danger (aOR = 0.5; $P < .0001$) than those who reported not using e-cigarettes (Table 2). A similar result was found for those who reported using nonflavored e-cigarettes (aOR = 0.6; $P < .0001$). Overall, boys had a lower prevalence of perceiving tobacco's danger than did girls (aOR = 0.9; $P = .01$) and non-Hispanic blacks and Hispanics were less likely to perceive tobacco's danger than were non-Hispanic whites. Former smokers (aOR = 0.4; $P < .0001$) and current smokers (aOR = 0.3; $P < .0001$) were also less likely to perceive tobacco's danger than were never smokers.

DISCUSSION

Cigarette smoking is the leading cause of preventable death in the United States. It is estimated that 5.6 million youth will die early from a cigarette smoking-related illness unless youth smoking rates drop rapidly.²⁰ Although the current use of cigarettes among youth has been declining, e-cigarette use is gaining popularity, with 16.0% of high school students and 5.3% of middle school students reporting use of e-cigarettes in the past 30 days in 2015.¹ The majority of youth who have ever used e-cigarettes started with a flavored product,² and >60% of current youth e-cigarette users report use of a flavored product.⁵ However, new rules issued by the Food and Drug Administration in May 2016 to regulate e-cigarettes and other tobacco-related products do not restrict the sale of candy-flavored and fruit-flavored noncigarette products, including flavored e-cigarettes. As the number of e-cigarette flavors on the market continues to grow, it is important to understand how flavored e-cigarette use is associated with youth tobacco use and perceived harmfulness of tobacco products.

TABLE 2 Factors Associated With Intention To Initiate Smoking/Quit Smoking and Perception of Tobacco's Danger Among US Middle and High School Students, NYTS, 2014

	Never Smoker (<i>n</i> = 16 471) Susceptibility to Cigarette Use		Current Smoker (<i>n</i> = 1338) Plan To Quit Tobacco Use in 12 Mo		All Respondents (<i>n</i> = 21 491) Perception of Tobacco's Danger	
	aOR	<i>P</i>	aOR	<i>P</i>	aOR	<i>P</i>
E-cigarette use						
No use	REF	REF	REF	REF	REF	REF
Use with no flavor	3.3 (2.4–4.7)	<.0001	0.9 (0.6–1.4)	NS	0.6 (0.4–0.7)	<.0001
Use with flavor	5.7 (4.2–7.7)	<.0001	0.6 (0.4–0.9)	.006	0.5 (0.4–0.6)	<.0001
Age						
<15 y	REF	REF	REF	REF	REF	REF
≥15 y	0.9 (0.7–1.1)	NS	1.1 (0.6–2.2)	NS	1 (0.8–1.3)	NS
Gender						
Boy	1.1 (1–1.2)	.046	1.1 (0.8–1.6)	NS	0.9 (0.7–0.97)	.01
Girl	REF	REF	REF	REF	REF	REF
Grade						
Middle school	REF	REF	REF	REF	REF	REF
High school	1.1 (0.9–1.3)	NS	0.8 (0.4–1.6)	NS	1 (0.7–1.3)	NS
Race						
NH-white	REF	REF	REF	REF	REF	REF
NH-black	1.1 (1–1.3)	NS	1.6 (1–2.6)	NS	0.6 (0.5–0.7)	<.0001
Hispanic	1.7 (1.5–1.9)	<.0001	1.4 (1–2.1)	NS	0.8 (0.7–0.9)	.0008
NH-other	1.1 (0.9–1.4)	NS	1.4 (0.6–3)	NS	1.3 (1–1.7)	NS
Smoking status						
Never	—	—	—	—	REF	REF
Former	—	—	—	—	0.4 (0.4–0.5)	<.0001
Current	—	—	—	—	0.3 (0.2–0.3)	<.0001

NH, non-Hispanic; NS, not significant; REF, reference; — not applicable.

The results from the 2015 Monitoring the Future survey show that >60% of youth reported use of nicotine-free flavored e-liquids with flavors like cotton candy and gummy bears.²¹ The effects of nicotine addiction and long-term harms of nicotine use have been well documented in the literature,²⁰ but the potential harm of flavored e-juice remains unknown, which might lead to a false perception that flavored e-cigarettes are less harmful than nonflavored ones. Concerns have also been raised that e-cigarette makers are using the flavorings as a marketing strategy to attract young people, because these flavored tobacco products are often packaged to look like candy and are sold next to candy,²² and thus normalize vaping behaviors.^{5,7–9} In this study, we found that flavored e-cigarette use among never-smoking youth was associated with higher odds of intention to initiate cigarette use (aOR = 5.7; *P* < .0001) compared with never-smoking youth who reported not using e-cigarettes. Compared with users of nonflavored

e-cigarettes, users of flavored e-cigarettes also had higher odds of intention to initiate cigarette use (aOR = 1.7; *P* = .02). The intention to initiate cigarette use among never-smoking youth was especially higher among younger students who reported use of flavored e-cigarettes than among those who reported not using e-cigarettes. Consistent with previous findings about e-cigarette use,^{10–13} our findings suggest that youth use of flavored e-cigarettes might serve as a gateway for future cigarette use. These findings could provide evidence for regulators in restricting the sale of flavored e-cigarettes.

Some studies show that e-cigarettes may help reduce tobacco consumption and facilitate tobacco abstinence.^{23,24} However, many youths use e-cigarettes for novelty and flavors rather than to quit smoking.²⁵ Our study confirmed that current youth smokers who reported use of flavored e-cigarettes had a significantly lower intention

to quit tobacco use in the next 12 months (aOR = 0.6; *P* = .006) compared with those who reported not using e-cigarettes. In contrast, using nonflavored e-cigarettes was not significantly associated with decreased odds of intention to quit tobacco use. Flavor in e-cigarettes is one of the most critical factors in the youth vaping experience and can make e-cigarette or other tobacco product use more addictive for youth. A wide range of flavors (ie, fruit, dessert, menthol, coffee) have been produced to resemble the familiar tobacco blends and evoke favorite treats and indulgences. A recent study showed that flavored tobacco products contain similar or even higher levels of flavor chemicals as compared with candy and Kool-Aid drink mix, which allows flavored tobacco products to deliver the familiar, chemical-specific sensory cues that are associated with fruit flavors in candy and drink products.²⁶ Furthermore, an experimental study showed that flavored e-cigarette advertisements were

more appealing than nonflavored e-cigarette advertisements and elicited greater interest in youth to buy and try e-cigarettes.^{27,28} Because flavor is not banned in a wide range of noncigarette tobacco products, flavored e-cigarette users may additionally become dual users of other flavored tobacco products. All these factors could contribute to decreased odds of intention to quit tobacco products among flavored e-cigarette users.

The overall perception of tobacco's danger was high among adolescents. Over 90% of middle and high school students agreed or strongly agreed that all tobacco products are dangerous. After controlling for other covariates, we found that flavored e-cigarette use was associated with lower odds of perceived harmfulness of tobacco use (aOR = 0.5; $P < .0001$) compared with not using e-cigarettes. Past studies have found that perceived harmfulness of tobacco products is associated with increased tobacco use and decreased tobacco cessation outcomes.^{20, 29–31} Health practitioners and school administrators should be aware of the lower perception of tobacco's danger among users of flavored

e-cigarettes than among other students. Educating youth about the danger of tobacco is also warranted to increase awareness of the risks of using tobacco products and prevent youth from smoking.

This study has limitations. First, the 2014 NYTS data were collected from students who attended either public or private schools. By excluding high school dropouts and home-schooled students, the school-based survey might have sampling bias and might not be generalizable to all-aged youth. Second, flavored e-cigarette use was self-reported. Thus, recall biases might have existed in this study, especially for younger respondents.³² Third, flavored e-cigarette use was obtained from a check-all-that-apply response, which might yield lower estimates than forced-choice options. Finally, the data are cross-sectional; thus, we were unable to establish causal inferences.

CONCLUSIONS

Despite the limitations described above, this study is the first of its kind to examine the associations between flavored e-cigarette use and

smoking among youth by analyzing a nationally representative sample. We found that compared with not using e-cigarettes in the past 30 days, flavored e-cigarette use was associated with higher odds of intention to initiate cigarette use among never-smoking youth, lower odds of intention to quit tobacco use among current-smoking youth, and a lower prevalence of perception of tobacco's danger among users of flavored e-cigarettes. Comprehensive tobacco control and prevention strategies that address flavored e-cigarette products are critically needed to reduce tobacco use among youth.

ACKNOWLEDGMENTS

We thank the Medical Writing Center at Children's Mercy Hospital for editing this manuscript.

ABBREVIATIONS

aOR: adjusted odds ratio
CI: confidence interval
e-cigarettes: electronic cigarettes
NYTS: National Youth Tobacco Survey

POTENTIAL CONFLICTS OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

REFERENCES

1. Singh T, Arrazola RA, Corey CG, et al. Tobacco use among middle and high school students—United States, 2011–2015. *MMWR Morb Mortal Wkly Rep.* 2016;65(14):361–367
2. Ambrose BK, Day HR, Rostron B, et al. Flavored tobacco product use among US youth aged 12–17 years, 2013–2014. *JAMA.* 2015;314(17):1871–1873
3. Family Smoking Prevention And Tobacco Control Act, Pub. L. No. 111–131, H.R. 1256 (June 22, 2009). Available at: <http://www.fda.gov/TobaccoProducts/Labeling/RulesRegulationsGuidance/ucm246129.htm>
4. Zhu SH, Sun JY, Bonnevie E, et al. Four hundred and sixty brands of e-cigarettes and counting: implications for product regulation. *Tob Control.* 2014;23(suppl 3):iii3–iii9
5. Corey CG, Ambrose BK, Apelberg BJ, King BA. Flavored tobacco product use among middle and high school students—United States, 2014. *MMWR Morb Mortal Wkly Rep.* 2015;64(38):1066–1070
6. U.S. Food and Drug Administration. FDA's New Regulations for E-Cigarettes, Cigars, and All Other Tobacco Products. Available at: <http://www.fda.gov/tobaccoproducts/labeling/rulesregulationsguidance/ucm394909.htm>. Accessed September 30, 2016
7. Arazolla RA, Sing T, Corey CG, et al. Tobacco use among middle and high school students—United States, 2011–2014. *MMWR Morb Mortal Wkly Rep.* 2015;64(14):381–385
8. Berg CJ. Preferred flavors and reasons for e-cigarette use and discontinued use among never, current, and former smokers. *Int J Public Health.* 2016;61(2):225–236
9. Farsalinos KE, Romagna G, Tsiapras D, Kyrzopoulos S, Spyrou A, Voudris V. Impact of flavour variability on

- electronic cigarette use experience: an internet survey. *Int J Environ Res Public Health*. 2013;10(12):7272–7282
10. Leventhal AM, Strong DR, Kirkpatrick MG, et al. Association of electronic cigarette use with initiation of combustible tobacco product smoking in early adolescence. *JAMA*. 2015;314(7):700–707
 11. Wills TA, Knight R, Sargent JD, Gibbons FX, Pagano I, Williams RJ. Longitudinal study of e-cigarette use and onset of cigarette smoking among high school students in Hawaii [published online ahead of print January 25, 2016]. *Tob Control*. doi:10.1136/tobaccocontrol-2015-052705
 12. Primack BA, Soneji S, Stoolmiller M, Fine MJ, Sargent JD. Progression to traditional cigarette smoking after electronic cigarette use among US adolescents and young adults. *JAMA Pediatr*. 2015;169(11):1018–1023
 13. Barrington-Trimis JL, Urman R, Berhane K, et al. E-cigarettes and future cigarette use. *Pediatrics*. 2016;138(1). Available at: <http://pediatrics.aappublications.org/content/138/1/e20160379>
 14. Kosmider L, Sobczak A, Prokopowicz A, et al. Cherry-flavoured electronic cigarettes expose users to the inhalation irritant, benzaldehyde. *Thorax*. 2016;71(4):376–377
 15. Centers for Disease Control and Prevention. 2014 National Youth Tobacco Survey. Available at: www.cdc.gov/tobacco/data_statistics/surveys/nyts/. Accessed July 5, 2016.
 16. Office on Smoking and Health. 2014 National Youth Tobacco Survey, methodology report. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking Health; 2015
 17. Mantey DS, Cooper MR, Clendennen SL, Pasch KE, Perry CL. E-cigarette marketing exposure is associated with e-cigarette use among US youth. *J Adolesc Health*. 2016;58(6):686–690
 18. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Berry CC. Tobacco industry promotion of cigarettes and adolescent smoking. *JAMA*. 1998;279(7):511–515
 19. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Merritt RK. Validation of susceptibility as a predictor of which adolescents take up smoking in the United States. *Health Psychol*. 1996;15(5):355–361
 20. U.S. Department of Health and Human Services. *The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General*. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014
 21. National Institute of Drug Abuse. Monitoring the future 2015 survey results. Available at: www.drugabuse.gov/related-topics/trends-statistics/infographics/monitoring-future-2015-survey-results. Accessed June 30, 2016
 22. Villanti AC, Richardson A, Vallone DM, Rath JM. Flavored tobacco product use among U.S. young adults. *Am J Prev Med*. 2013;44(4):388–391
 23. Caponnetto P, Campagna D, Cibella F, et al. Efficiency and Safety of an eElectronic cigAreTte (ECLAT) as tobacco cigarettes substitute: a prospective 12-month randomized control design study. *PLoS One*. 2013;8(6):e66317
 24. Caponnetto P, Russo C, Bruno CM, Alamo A, Amaradio MD, Polosa R. Electronic cigarette: a possible substitute for cigarette dependence. *Monaldi Arch Chest Dis*. 2013;79(1):12–19
 25. Monitoring the Future. Most youth using e-cigarettes for novelty and flavors—not to quit smoking. Available at: <http://www.monitoringthefuture.org/pressreleases/15ecigr.pdf>
 26. Brown JE, Luo W, Isabelle LM, Pankow JF. Candy flavorings in tobacco. *N Engl J Med*. 2014;370(23):2250–2252
 27. Vasiljevic M, Petrescu DC, Marteau TM. Impact of advertisements promoting candy-like flavoured e-cigarettes on appeal of tobacco smoking among children: an experimental study [published online ahead of print January 17, 2016]. *Tob Control*. doi:10.1136/tobaccocontrol-2015-052593
 28. Dai H, Hao J. Exposure to advertisements and susceptibility to electronic cigarette use among youth [published online ahead of print August 12, 2016]. *J Adolesc Health*. doi:10.1016/j.jadohealth.2016.06.013
 29. Cooper M, Case KR, Loukas A, Creamer MR, Perry CL. E-cigarette dual users, exclusive users and perceptions of tobacco products. *Am J Health Behav*. 2016;40(1):108–116
 30. Smith SY, Curbow B, Stillman FA. Harm perception of nicotine products in college freshmen. *Nicotine Tob Res*. 2007;9(9):977–982
 31. McBride CM, Emmons KM, Lipkus IM. Understanding the potential of teachable moments: the case of smoking cessation. *Health Educ Res*. 2003;18(2):156–170
 32. Brener ND, Billy JO, Grady WR. Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *J Adolesc Health*. 2003;33(6):436–457

Flavored Electronic Cigarette Use and Smoking Among Youth

Hongying Dai and Jianqiang Hao

Pediatrics 2016;138;

DOI: 10.1542/peds.2016-2513 originally published online November 7, 2016;

Updated Information & Services

including high resolution figures, can be found at:
<http://pediatrics.aappublications.org/content/138/6/e20162513>

References

This article cites 25 articles, 4 of which you can access for free at:
<http://pediatrics.aappublications.org/content/138/6/e20162513#BIBL>

Subspecialty Collections

This article, along with others on similar topics, appears in the following collection(s):

Substance Use

http://www.aappublications.org/cgi/collection/substance_abuse_sub

Smoking

http://www.aappublications.org/cgi/collection/smoking_sub

Permissions & Licensing

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:

<http://www.aappublications.org/site/misc/Permissions.xhtml>

Reprints

Information about ordering reprints can be found online:

<http://www.aappublications.org/site/misc/reprints.xhtml>

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Flavored Electronic Cigarette Use and Smoking Among Youth

Hongying Dai and Jianqiang Hao

Pediatrics 2016;138;

DOI: 10.1542/peds.2016-2513 originally published online November 7, 2016;

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/138/6/e20162513>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2016 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

