

Use of Flavored E-Cigarettes Among Adolescents, Young Adults, and Older Adults: Findings From the Population Assessment for Tobacco and Health Study

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Abstract

Objectives: The use of flavored electronic cigarettes (e-cigarettes) is common among e-cigarette users, but little is known about the potential harms of flavorings, the extent to which the concurrent use of multiple flavor types occurs, and the correlates of flavor type use. The objective of this study was to assess the types of e-cigarette flavors used by adolescent (aged 12-17), young adult (aged 18-24), and older adult (aged ≥ 25) e-cigarette users.

Methods: We assessed the prevalence of flavored e-cigarette use within the past month by flavor types and concurrent use of multiple flavor types among past-month e-cigarette users sampled during Wave 2 (2014-2015) of the Population Assessment for Tobacco and Health Study among 414 adolescents, 961 young adults, and 1711 older adults. We used weighted logistic regression models for the use of fruit-, candy-, mint/menthol-, tobacco-, or other-flavored e-cigarettes and concurrent use of multiple flavor types. Covariates included demographic characteristics, e-cigarette use frequency, cigarette smoking status, current use of other tobacco products, and reasons for e-cigarette use.

Results: The leading e-cigarette flavor types among adolescents were fruit, candy, and other flavors; among young adults were fruit, candy, and mint/menthol; and among older adults were tobacco or other flavors, fruit, and mint/menthol. Compared with older adults, adolescents and young adults were more likely to use fruit-flavored e-cigarettes (adjusted odds ratio [aOR] = 3.35; 95% confidence interval [CI], 2.56-4.38; and aOR = 2.31; 95% CI, 1.77-3.01, respectively) and candy-flavored e-cigarettes (aOR = 3.81; 95% CI, 2.74-5.28; and aOR = 2.95; 95% CI, 2.29-3.80, respectively) and concurrently use multiple flavor types (aOR = 4.58; 95% CI, 3.39-6.17; and aOR = 2.28; 95% CI, 1.78-2.91, respectively).

Conclusions: Regulation of sweet e-cigarette flavors (eg, fruit and candy) may help reduce the use of e-cigarettes among young persons without substantially burdening adult e-cigarette users.

Keywords

electronic cigarettes, flavors, tobacco, regulation

The use of electronic cigarettes (e-cigarettes), especially flavored e-cigarettes, among adolescents has increased rapidly over time.¹⁻³ For example, the percentage of high school students who used e-cigarettes in the past month increased from 1.5% in 2011 to 20.8% in 2018.^{4,5} Approximately 8 in 10 adolescent (aged 12-17) e-cigarette users and 6 in 10 young adult (aged 18-24) e-cigarette users reported that their first e-cigarette was flavored to taste like menthol, mint, clove, spice, candy, fruit, chocolate, alcohol (eg, wine or cognac), or other sweets.³ Adolescent and young adult e-cigarette users report appealing flavors as a leading reason for use.^{3,6} They also are more interested in experimenting with fruit-, candy-, or menthol-flavored e-cigarettes than

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with tobacco-flavored e-cigarettes.⁷ These populations perceive fruit- and sweet-flavored e-cigarettes as less harmful than tobacco-flavored e-cigarettes.^{8,9} However, fruit and sweet flavors may be particularly toxic because of the chemicals (eg, diacetyl) included in these flavors.¹⁰⁻¹² For example, common components of fruit- and sweet-flavored e-cigarettes may impair lung function,¹³ stimulate an inflammatory response in respiratory cells,¹⁴ be associated with respiratory disease,¹⁵ and cause irritation in the respiratory tract when inhaled.¹² In addition to the potential harms from e-cigarette flavorings, nicotine intake levels from e-cigarettes may be similar to levels from combustible cigarette smoking among experienced e-cigarette users.¹⁶

The large number of e-cigarette flavors available on the market¹⁷ and the breadth of these flavors present a regulatory challenge to the US Food and Drug Administration (FDA), which has requested information on “the role that flavors (including menthol) in tobacco products play in attracting youth and may play in helping some smokers switch to potentially less harmful forms of nicotine delivery.”¹⁸ Fruit- and candy-flavored e-cigarettes are popular among e-cigarette users across age groups and across cigarette smoking status.^{19,20} Yet the extent to which the concurrent use of multiple flavor types occurs and the correlates of flavor type use are not known.

The primary objective of our study was to address these research gaps by assessing the types of e-cigarette flavors used by adolescent, young adult, and older adult e-cigarette users. A secondary objective was to compare the salience of the availability of appealing flavors as a reason for e-cigarette use across these groups of e-cigarette users. A tertiary objective was to assess potential demographic, e-cigarette-related, and tobacco use-related correlates of the use of flavor types, including fruit-, candy-, mint/menthol-, and tobacco-flavored e-cigarettes and the concurrent use of multiple flavor types. By providing information on flavor types, this study could help the FDA and other regulatory agencies in refining effective e-cigarette regulation.

Methods

Sample

We used data from Wave 2 (2014-2015) of the Population Assessment for Tobacco and Health (PATH) Study, Youth and Adult Samples.^{21,22} The PATH Study is a nationally representative longitudinal cohort study conducted by the National Institute on Drug Abuse and the FDA’s Center for Tobacco Products. The PATH Study recruited adolescent and adult (aged ≥ 18) respondents by using an address-based, area-probability sampling design with an in-person household screener. The PATH Study adjusted the weighting procedures for oversampling and nonresponse and further adjusted data so that the sum of weights matched independent population totals (based on US Census data) for standard demographic groups.²³ The overall weighted response

rate was 83.2% for the Adult Interview and 87.3% for the Youth Interview. Details on the PATH Study are available elsewhere.²¹

The study focused on 414 adolescent (aged 12-17) past-month e-cigarette users, 961 young adult (aged 18-24) past-month e-cigarette users, and 1711 older adult (aged ≥ 25) past-month e-cigarette users (hereinafter “users”). We excluded 1 adolescent, 7 young adults, and 14 older adults from the analysis because they were missing information on past-month flavored e-cigarette use.

E-Cigarette Flavors

The PATH Study assessed the following e-cigarette flavor categories: alcohol, candy or sweets (hereinafter “candy”), chocolate, clove or spice, fruit, menthol or mint, and tobacco or other flavors. The PATH Study asked respondents: (1) “In the past 30 days, were any of the e-cigarettes you used flavored to taste like menthol, mint, clove, spice, fruit, chocolate, alcoholic drinks, candy, or other sweets?” and (2) “Which flavors have you used in the past 30 days? If multiple flavors were mixed together, choose all that apply: menthol or mint, clove or spice, fruit, chocolate, an alcoholic drink (such as wine, cognac, margarita, or other cocktails), candy or other sweets, some other flavor.” Users who answered no to the first question were categorized as using tobacco- or other-flavored e-cigarettes.

Reasons for E-Cigarette Use

The study also ascertained 13 reasons for e-cigarette use: “They come in flavors I like,” “they might be less harmful to me than cigarettes,” “they might be less harmful to persons around me than cigarettes,” “using them helps persons to quit smoking,” “they can be used in places where smoking cigarettes is not allowed,” “they are more acceptable to non-tobacco users,” “they do not smell,” “they are affordable,” “I like socializing while using them,” “persons in the media or other public figures use them,” “persons who are important to me use them,” “using them feels like smoking a regular cigarette,” and “the advertising appeals to me.”²¹ Respondents could select multiple reasons for use.

Covariates

The study assessed frequency of e-cigarette use within the past month through the following question: “On how many of the past 30 days did you use an e-cigarette?” Categories included 1-5 days, 6-29 days, and 30 days per month.²⁴ The 26 (6%) adolescent users who responded 0 days to the survey question were categorized as 1-5 days per month in the analysis. Respondents were categorized as never cigarette smokers, former cigarette smokers, current cigarette smokers who had not tried to quit smoking within the past year, and current cigarette smokers who had tried to quit smoking within the past year. Respondents were considered former

cigarette smokers if they had ever smoked a cigarette but had not smoked a cigarette in the past month (adolescents) or did not currently smoke every day or some days (young adults and older adults). Respondents were considered current cigarette smokers if they had ever smoked a cigarette and had smoked a cigarette in the past month (adolescents) or currently smoked every day or some days (young adults and older adults).

Cigarette-smoking respondents were considered to have tried to quit smoking within the past year if they responded yes to the following questions: “In the past 12 months, have you tried to completely stop smoking cigarettes?” (adolescents) or “yes, I have tried to quit completely,” or “yes, I have tried to quit by reducing or cutting back,” or “no, I have reduced or cut back instead of trying to quit” to the question, “In the past 12 months, have you tried to quit tobacco products?”

Respondents were categorized as current cigar smokers if they had smoked a cigarillo, little filtered cigar, or traditional cigar within the past 30 days (adolescents) or currently smoked cigarillos, little filtered cigars, or traditional cigars every day or some days (young adults and older adults). Respondents were categorized as current hookah smokers if they smoked hookah within the past 30 days (adolescents) or currently smoked hookah every day or some days (young adults and older adults). Finally, respondents were categorized as current smokeless tobacco users if they used snus (moist, finely ground tobacco sealed in a small pouch)²⁵ or smokeless tobacco within the past 30 days (adolescents) or currently used snus or smokeless tobacco every day or some days (young adults and older adults).

Statistical Analysis

We first estimated the weighted prevalence of demographic characteristics; frequency of e-cigarette use; cigarette smoking status; and current cigar, hookah, and smokeless tobacco use. Second, we estimated the weighted prevalence of each reason for e-cigarette use by age group. Third, we estimated the weighted prevalence of flavored e-cigarette use by age group. Fourth, we estimated the weighted prevalence of single versus concurrent use of multiple flavor types, flavor types used among single flavor type users, and flavor types used among multiple flavor type users by age group.

Finally, we fit separate weighted logistic regression models among past-month e-cigarette users for (1) fruit-flavored e-cigarette use, (2) candy-flavored e-cigarette use, (3) mint- or menthol-flavored e-cigarette use, (4) tobacco- or other-flavored e-cigarette use, and (5) concurrent use of multiple non-tobacco flavor types. Covariates included age group, sex, race/ethnicity, frequency of e-cigarette use, cigarette smoking status, current cigar smoking, current hookah smoking, current smokeless tobacco use, and the 13 reasons for e-cigarette use. We conducted all analyses using R version 3.5.1,²⁶ and we used balanced repeated replication weights to account for sampling and nonresponse in the PATH Study. The Dartmouth College

Committee for the Protection of Human Subjects waived institutional review board review for this study.

Results

Characteristics of Past-Month E-Cigarette Users

Most adolescent, young adult, and older adult users were male and non-Hispanic white (Table 1). Everyday e-cigarette use was more prevalent among adolescent users (8.5%; 95% confidence interval [CI], 6.5%-10.4%) than among young adult users (5.6%; 95% CI, 3.5%-7.6%) or older adult users (6.6%; 95% CI, 5.2%-8.0%). Cigarette smoking status varied by age group: 35.8% of adolescent users (95% CI, 32.6%-39.0%), 14.1% of young adult users (95% CI, 12.3%-15.9%), and 3.6% of older adult users (95% CI, 2.7%-4.5%) had never smoked cigarettes. Similarly, 15.6% of adolescent users (95% CI, 13.8%-17.4%), 17.3% of young adult users (95% CI, 15.7%-18.9%), and 19.5% of older adult users (95% CI, 17.3%-21.7%) were current cigarette smokers who had not tried to quit smoking in the past year. Finally, 14.7% of adolescent users (95% CI, 11.3%-18.1%), 37.4% of young adult users (95% CI, 35.1%-39.7%), and 48.5% of older adult users (95% CI, 46.8%-50.2%) were current cigarette smokers who had tried to quit smoking in the past year.

Reasons for E-Cigarette Use

The leading reason for e-cigarette use among adolescent and young adult users was the availability of appealing flavors: 77.9% of adolescent users (95% CI, 75.3%-80.4%) and 90.3% of young adult users (95% CI, 89.0%-91.7%) selected this reason (Table 2). Adolescent and young adult e-cigarette users also commonly endorsed beliefs that e-cigarettes might be less harmful than cigarettes to themselves (75.0% of adolescent users; 95% CI, 72.4%-77.6%; and 81.0% of young adult users; 95% CI, 77.9%-84.0%) or other persons (74.2% of adolescent users; 95% CI, 70.4%-77.9%; and 84.2% of young adult users; 95% CI, 81.7%-86.6%). A nontrivial proportion of adolescent (14.2%; 95% CI, 12.0%-16.4%), young adult (15.2%; 95% CI, 13.7%-16.6%), and older adult (15.2%; 95% CI, 13.8%-16.6%) users reported appealing e-cigarette advertising as a reason for use.

In contrast with the leading reasons among adolescent users and young adult users, the leading reasons among older adult users were (1) the beliefs that e-cigarettes might be less harmful than cigarettes to other persons (81.9%; 95% CI, 80.8%-83.0%) or themselves (79.0%; 95% CI, 77.7%-80.2%) and (2) the acceptability of e-cigarette use in places where cigarette smoking is not allowed (79.3%; 95% CI, 78.3%-80.3%) (Table 2). More than 7 in 10 (71.5%; 95% CI, 69.9%-73.2%) older adult users believed e-cigarettes aided in smoking cessation. The availability of appealing flavors was the seventh most commonly reported reason (66.4%) among older adult users.

Table 1. Characteristics of past-month adolescent, young adult, and adult e-cigarette users, Population Assessment for Tobacco and Health (PATH) Study, United States, 2014-2015^{a,b}

Characteristic	Adolescent (Aged 12-17) E-Cigarette Users (n = 414), % (95% CI)	Young Adult (Aged 18-24) E-Cigarette Users (n = 961), % (95% CI)	Older Adult (Aged ≥25) E-Cigarette Users (n = 1711), % (95% CI)
Sex			
Male	56.9 (52.8-61.1)	62.3 (60.0-64.6)	51.6 (49.8-53.4)
Female	43.1 (38.9-47.2)	37.7 (35.4-40.0)	48.4 (46.6-50.2)
Race/ethnicity			
Non-Hispanic white	69.3 (64.8-73.8)	67.3 (64.4-70.1)	76.4 (74.3-78.4)
Non-Hispanic black	5.5 (3.9-7.0)	5.6 (4.2-7.0)	8.1 (6.9-9.3)
Hispanic	17.1 (14.1-20.2)	19.1 (17.4-20.7)	8.5 (7.3-9.8)
Non-Hispanic other ^c	8.1 (6.3-9.9)	8.1 (7.1-9.1)	7.0 (5.5-8.5)
Frequency of e-cigarette use during past month, d			
1-5	61.2 (57.5-64.9)	71.2 (69.0-73.4)	61.3 (59.2-63.5)
6-29	30.3 (26.1-34.6)	23.3 (21.1-25.4)	32.0 (30.3-33.7)
30	8.5 (6.5-10.4)	5.6 (3.5-7.6)	6.6 (5.2-8.0)
Cigarette smoking status			
Never cigarette smoker	35.8 (32.6-39.0)	14.1 (12.3-15.9)	3.6 (2.7-4.5)
Former cigarette smoker	33.9 (31.1-36.6)	31.2 (28.7-33.7)	28.4 (26.5-30.4)
Current smoker and did not try to quit smoking in the past year	15.6 (13.8-17.4)	17.3 (15.7-18.9)	19.5 (17.3-21.7)
Current smoker and tried to quit smoking in the past year	14.7 (11.3-18.1)	37.4 (35.1-39.7)	48.5 (46.8-50.2)
Current cigar smoker ^d	13.1 (11.1-15.1)	25.0 (22.7-27.3)	16.3 (14.7-17.9)
Current hookah smoker ^e	10.5 (8.3-12.7)	33.8 (31.4-36.2)	7.1 (6.1-8.2)
Current smokeless tobacco user ^f	9.2 (7.6-10.8)	11.4 (9.8-13.0)	6.6 (5.6-7.6)

^aData source: Population Assessment for Tobacco and Health Study, Wave 2.²²

^bWeighting procedures adjusted for oversampling and nonresponse. Sum of weights matched independent population totals (based on US Census data) for standard demographic groups.

^cAsian and other races, including multiracial.

^dSmoked a cigarillo, little filtered cigar, or traditional cigar within the past 30 days (adolescents) or currently smoked cigarillos, little filtered cigars, or traditional cigars every day or some days (young adults and older adults).

^eSmoked a hookah within the past 30 days (adolescents) or currently smoked a hookah every day or some days (young adults and older adults).

^fUsed snus or smokeless tobacco within the past 30 days (adolescents) or currently used snus or smokeless tobacco every day or some days (young adults and older adults).

Prevalence of E-Cigarette Use by Flavor Type

The prevalence of alcohol, candy, chocolate, clove/spice, fruit, or mint/menthol e-cigarette use, either exclusively or in conjunction with tobacco- or other-flavored e-cigarette use, was 74.2% among adolescent users (95% CI, 66.9%-81.5%), 79.1% among young adult users (95% CI, 74.3%-84.0%), and 60.5% among older adult users (95% CI, 57.5%-63.3%) (Table 3). The prevalence of only tobacco- or other-flavored e-cigarette use within the past month was 16.1% among adolescent users (95% CI, 13.3%-18.9%), 15.5% among young adult users (95% CI, 14.1%-16.8%), and 37.9% among older adult users (95% CI, 36.3%-39.5%).

Single flavor type use was less common among adolescent users (57.1%; 95% CI, 53.7%-60.4%) or young adult users (57.0%; 95% CI, 54.5%-59.4%) than among older adult users (76.3%; 95% CI, 74.7%-77.7%) (Table 3). The most common flavor type among single flavor type users was fruit for adolescent users (43.3%; 95% CI, 35.6%-51.1%) and young adult users (39.0%; 95% CI, 36.2%-41.8%) and tobacco or other flavors (50.5%; 95% CI, 48.6%-52.5%) for

older adult users. Conversely, the concurrent use of multiple flavor types was more common among adolescent users (42.9%; 95% CI, 39.6%-46.3%) and young adult users (43.0%; 95% CI, 40.6%-45.5%) than among older adult users (23.7%; 95% CI, 22.3%-25.3%). Concurrent use of multiple flavor types most commonly included fruit- and candy-flavored e-cigarettes among adolescent, young adult, and older adult users. Concurrent use of multiple flavor types most commonly occurred with 2 flavor types.

Correlates of Flavored E-Cigarette Use

The odds of fruit-flavored e-cigarette use were higher among adolescent users (adjusted odds ratio [aOR] = 3.35; 95% CI, 2.56-4.38) and young adult users (aOR = 2.31; 95% CI, 1.77-3.01) than among older adult users (Table 4). The odds of fruit-flavored e-cigarette use were also higher among female users (aOR = 1.22; 95% CI, 1.01-1.47) than among male users. Similarly, the odds of candy-flavored e-cigarette use were higher among adolescent users (aOR = 3.81; 95% CI, 2.74-5.28) and young adult users (aOR = 2.95; 95% CI,

Table 2. Reasons for e-cigarette use among adolescent, young adult, and older adult current e-cigarette users, weighted, Population Assessment for Tobacco and Health (PATH) Study, United States, 2014-2015^{a,b}

Reason	Past-Month Adolescent (Aged 12-17) E-Cigarette Users (n = 414), % (95% CI)	Past-Month Young Adult (Aged 18-24) E-Cigarette Users (n = 961), % (95% CI)	Past-Month Older Adult (Aged ≥25) E-Cigarette Users (n = 1711), % (95% CI)
	They come in flavors I like.	77.9 (75.3-80.4)	90.3 (89.0-91.7)
They might be less harmful to me than cigarettes.	75.0 (72.4-77.6)	81.0 (77.9-84.0)	79.0 (77.7-80.2)
They might be less harmful to persons around me than cigarettes.	74.2 (70.4-77.9)	84.2 (81.7-86.6)	81.9 (80.8-83.0)
Using them helps persons to quit smoking.	63.5 (59.7-67.3)	75.0 (72.3-77.6)	71.5 (69.9-73.2)
They can be used in places where smoking cigarettes is not allowed.	58.8 (54.1-63.4)	75.6 (72.7-78.6)	79.3 (78.3-80.3)
They are more acceptable to non-tobacco users.	56.5 (53.4-59.6)	67.7 (65.2-70.3)	69.0 (67.6-70.5)
They do not smell.	53.7 (49.9-57.6)	69.2 (67.4-70.9)	73.2 (71.8-74.7)
They are affordable.	48.1 (45.1-51.1)	59.4 (57.1-61.8)	61.1 (60.1-62.2)
I like socializing while using them.	45.9 (42.9-48.8)	50.2 (47.0-53.3)	37.1 (36.2-38.0)
Persons in the media or other public figures use them.	36.2 (33.0-39.4)	17.4 (15.4-19.5)	15.7 (14.3-17.2)
Persons who are important to me use them.	34.9 (31.4-38.5)	24.7 (22.3-27.2)	20.1 (19.2-21.0)
Using them feels like smoking a regular cigarette.	25.0 (21.3-28.6)	29.7 (26.6-32.8)	49.4 (48.1-50.7)
The advertising appeals to me.	14.2 (12.0-16.4)	15.2 (13.7-16.6)	15.2 (13.8-16.6)

^aData source: Population Assessment for Tobacco and Health Study, Wave 2.²²

^bWeighting procedures adjusted for oversampling and nonresponse. Sum of weights matched independent population totals (based on US Census data) for standard demographic groups.

2.29-3.80) than among older adult users, and higher among female users (aOR = 1.50; 95% CI, 1.24-1.82) than among male users. Conversely, the odds of tobacco- or other-flavored e-cigarette use were lower among adolescent users (aOR = 0.70; 95% CI, 0.50-0.98) and young adult users (aOR = 0.64; 95% CI, 0.51-0.80) than among older adult users. The odds of tobacco- or other-flavored e-cigarette use were also lower among female users (aOR = 0.72; 95% CI, 0.60-0.87) than among male users. The odds of mint/menthol-flavored e-cigarette use were higher among non-Hispanic black users (aOR = 3.81; 95% CI, 2.78-5.22) and Hispanic users (aOR = 1.60; 95% CI, 1.18-2.18) than among non-Hispanic white users. The odds of concurrent use of multiple flavor types were higher among adolescent users (aOR = 4.58; 95% CI, 3.39-6.17) and young adult users (aOR = 2.28; 95% CI, 1.78-2.91) than among older adult users.

The odds of fruit-, candy-, and mint/menthol-flavored e-cigarette use, as well as the concurrent use of multiple flavor types, were all higher for e-cigarette users who indicated the availability of appealing flavors as a reason for e-cigarette use (eg, aOR = 3.99; 95% CI, 3.14-5.07 for fruit-flavored e-cigarette use). Conversely, the odds of tobacco- or other-flavored e-cigarette use were lower for users who indicated this reason (aOR = 0.27; 95% CI, 0.21-0.33) than for users who did not indicate this reason. The odds of using tobacco- or other-flavored e-cigarettes were higher for users who believed e-cigarettes felt like smoking a regular cigarette (aOR = 1.32; 95% CI, 1.10-1.59) and used e-cigarettes because persons in the media or other public figures used

them (aOR = 1.36; 95% CI, 1.07-1.72) than for users who did not indicate this reason. The odds of using mint/menthol-flavored e-cigarettes were higher for users who used e-cigarettes because they could be used in places where cigarette smoking was not allowed (aOR = 1.39; 95% CI, 1.08-1.79) and because they do not smell (aOR = 1.32; 95% CI, 1.04-1.68) than for users who did not indicate these reasons.

The odds of tobacco- or other-flavored e-cigarette use were higher for current cigarette smokers who tried to quit smoking within the past year (aOR = 2.12; 95% CI, 1.22-3.71) and for current cigarette smokers who did not try to quit smoking within the past year (aOR = 2.02; 95% CI, 1.14-3.59) than for never smokers. The odds of mint/menthol-flavored e-cigarette use were higher for users who also were current cigar smokers (aOR = 1.43; 95% CI, 1.14-1.80) and current smokeless tobacco users (aOR = 1.43; 95% CI, 1.06-1.94) than for persons who did not use those products. Finally, the odds of fruit-, candy-, and mint-flavored e-cigarette use and concurrent use of multiple flavor types were higher for users who were also current hookah smokers compared with those who were not current hookah smokers (eg, aOR = 1.81; 95% CI, 1.38-2.38 for fruit-flavored e-cigarette use).

Discussion

Four central findings emerged from this analysis of nationally representative data. First, the availability of appealing flavors was a more salient reason for e-cigarette use among adolescent users and young adult users than for older adult users. Second, adolescent users and young adult users were

Table 3. Flavored e-cigarette use in past month among adolescents, young adults, and adults, by flavor type, weighted Population Assessment for Tobacco and Health (PATH) Study, United States, 2014-2015^{a,b}

Flavored E-Cigarette Use	Past-Month Adolescent (Aged 12-17) E-Cigarette Users (n = 414), % (95 CI)	Past-Month Young Adult (Aged 17-24) E-Cigarette Users (n = 961), % (95 CI)	Past-Month Older Adult (Aged ≥25) E-Cigarette Users (n = 1711), % (95 CI)
Flavor used			
Alcohol, candy/sweets, chocolate, clove/spice, fruit, or mint/menthol only	61.1 (56.0-66.2)	66.7 (63.9-69.5)	52.3 (50.2-54.3)
Tobacco or other flavor only	16.1 (13.3-18.9)	15.5 (14.1-16.8)	37.9 (36.3-39.5)
Both (1) alcohol, candy/sweets, chocolate, clove/spice, fruit, or mint/menthol and (2) tobacco or other flavor	13.1 (10.9-15.3)	12.4 (10.4-14.5)	8.2 (7.3-9.0)
Do not know	9.7 (7.8-11.7)	5.4 (4.1-6.7)	1.7 (1.3-2.1)
Single vs multiple flavor types used concurrently			
Single	57.1 (53.7-60.4)	57.0 (54.5-59.4)	76.3 (74.7-77.7)
Multiple	42.9 (39.6-46.3)	43.0 (40.6-45.5)	23.7 (22.3-25.3)
Flavor types used among single flavor type users			
Fruit	43.3 (35.6-51.1)	39.0 (36.2-41.8)	15.9 (14.4-17.3)
Tobacco/other	31.2 (25.5-37.0)	28.7 (25.9-31.4)	50.5 (48.6-52.5)
Candy/sweets	16.5 (11.8-21.2)	15.9 (12.5-19.3)	7.8 (6.6-8.9)
Mint/menthol	4.8 (3.5-6.1)	13.7 (11.8-15.6)	23.3 (21.6-25.0)
Clove/spice	1.7 (0.4-3.0)	0.1 (0-0.3)	0.6 (0.4-0.9)
Chocolate	1.6 (0.4-2.8)	1.2 (0.4-2.1)	1.3 (0.5-2.1)
Alcohol	0.8 (0-1.7)	1.4 (0.8-2.0)	0.6 (0.2-1.0)
Flavor types used among concurrent multiple flavor type users			
Included fruit	87.8 (83.7-91.9)	88.9 (86.3-91.6)	80.9 (79.1-82.8)
Included tobacco or other flavor	33.9 (29.4-38.4)	30.6 (25.4-35.9)	33.5 (30.3-36.6)
Included candy/sweets	78.6 (72.1-85.2)	78.4 (75.0-81.8)	70.9 (68.1-73.8)
Included mint/menthol	35.5 (28.8-42.3)	45.0 (42.4-47.5)	39.4 (34.8-44.0)
Included clove/spice	8.2 (4.0-12.4)	5.1 (2.8-7.3)	6.4 (4.7-8.2)
Included chocolate	19.1 (14.4-23.8)	18.4 (15.3-21.5)	15.2 (12.9-17.5)
Included alcohol	16.0 (11.8-20.3)	14.5 (11.4-17.5)	9.8 (7.8-11.8)
Number of flavor types used among multiple flavor type users			
2	53.4 (47.5-59.2)	50.2 (45.6-54.9)	56.7 (51.7-61.6)
3	26.1 (19.8-33.6)	30.0 (26.3-34.1)	32.4 (29.7-35.2)
≥4	20.5 (15.7-26.3)	19.7 (16.2-23.8)	10.9 (8.0-14.8)

^aData source: Population Assessment for Tobacco and Health Study, Wave 2.²²

^bWeighting procedures adjusted for oversampling and nonresponse. Sum of weights matched independent population totals (based on US Census data) for standard demographic groups.

more likely to use fruit- and candy-flavored e-cigarettes than were older adult users. Older adult users and cigarette smokers were more likely to use tobacco- or other-flavored e-cigarettes than were adolescent and young adult users and nonsmokers, respectively. Third, adolescent users and young adult users were more likely to concurrently use multiple flavor types than were older adult users. Finally, current cigarette smokers who tried to quit smoking within the past year were more likely than never cigarette smokers to use tobacco- or other-flavored e-cigarettes.

Our study contributes to a growing body of evidence on the use of flavored e-cigarettes.^{19,27} First, our study extends earlier findings based on PATH data and found that the availability of appealing flavors was a leading reason for adolescent and young adult e-cigarette use in 2014-2015.^{3,6} Our study also supports earlier findings that the availability

of appealing flavors was a less salient reason for e-cigarette use among older adult users than harm reduction and serving as a smoking cessation aid.^{20,24} Second, our findings are consistent with the findings of a 2015 study on the use of tobacco- and mint/menthol-flavored e-cigarettes among adult cigarette smokers, which found that interest in tobacco- and mint/menthol-flavored e-cigarettes was highest among 15 flavors considered.²⁸

Flavorings may make the use of e-cigarettes more enjoyable, satisfying, and appealing.²⁹ Flavors may also increase the rewarding and relative reinforcing value of e-cigarettes.³⁰ Sweet-flavored e-cigarettes increased appeal, willingness to use again, and perceived monetary value compared with non-sweet or unflavored e-cigarettes.³¹ Thus, the higher prevalence of fruit- and candy-flavored e-cigarette use among adolescent users and young adult users compared with older adult users

Table 4. Characteristics of past-month e-cigarette users, by flavored e-cigarette use, weighted Population Assessment for Tobacco and Health (PATH) Study, United States, 2014-2015^a

Characteristic	Fruit	Candy/Sweets	Mint/Menthol	Tobacco/ Other	Concurrent Use of Multiple Flavors
Age group					
Adolescents (aged 12-17)	3.35 (2.56-4.38)	3.81 (2.74-5.28)	0.68 (0.50-0.94)	0.70 (0.50-0.98)	4.58 (3.39-6.17)
Young adults (aged 18-24)	2.31 (1.77-3.01)	2.95 (2.29-3.80)	0.90 (0.70-1.16)	0.64 (0.51-0.80)	2.28 (1.78-2.91)
Older adults (aged ≥25)	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Sex					
Male	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Female	1.22 (1.01-1.47)	1.50 (1.24-1.82)	1.28 (1.05-1.55)	0.72 (0.60-0.87)	1.14 (0.94-1.38)
Race/ethnicity					
Non-Hispanic white	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic black	1.25 (0.93-1.68)	0.53 (0.35-0.79)	3.81 (2.78-5.22)	0.26 (0.18-0.36)	1.02 (0.67-1.53)
Hispanic	0.83 (0.64-1.06)	0.92 (0.63-1.33)	1.60 (1.18-2.18)	0.70 (0.54-0.91)	1.54 (1.21-1.97)
Non-Hispanic other ^c	0.78 (0.59-1.04)	0.91 (0.61-1.37)	1.69 (1.19-2.39)	0.63 (0.42-0.94)	1.52 (1.04-2.21)
Frequency of past-month e-cigarette use					
1-5	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
6-29	1.26 (1.04-1.54)	1.41 (1.10-1.81)	0.85 (0.69-1.05)	1.31 (1.08-1.59)	1.34 (1.06-1.69)
30	0.86 (0.59-1.27)	1.64 (1.06-2.56)	0.79 (0.55-1.14)	1.32 (0.87-2.02)	1.24 (0.80-1.92)
Reasons for e-cigarette use					
They come in flavors I like.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	3.99 (3.14-5.07)	3.55 (2.61-4.84)	1.77 (1.35-2.33)	0.27 (0.21-0.33)	2.19 (1.65-2.91)
They might be less harmful to me than cigarettes.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.73 (0.56-0.94)	1.10 (0.84-1.45)	1.04 (0.82-1.31)	0.94 (0.75-1.18)	1.43 (1.11-1.86)
They might be less harmful to persons around me than cigarettes.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	1.64 (1.26-2.15)	0.80 (0.56-1.15)	1.10 (0.81-1.50)	1.14 (0.86-1.51)	1.05 (0.75-1.45)
Using them helps persons to quit smoking.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	1.18 (0.95-1.46)	1.33 (1.03-1.72)	1.19 (0.97-1.46)	0.84 (0.69-1.03)	1.19 (0.95-1.50)
They can be used in places where smoking cigarettes is not allowed.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.93 (0.73-1.18)	1.16 (0.87-1.55)	1.39 (1.08-1.79)	0.85 (0.67-1.08)	1.04 (0.80-1.36)
They are more acceptable to non-tobacco users.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.98 (0.80-1.21)	1.00 (0.80-1.26)	1.05 (0.82-1.34)	1.16 (0.97-1.38)	0.93 (0.76-1.14)
They do not smell.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.73 (0.57-0.93)	0.75 (0.60-0.94)	1.32 (1.04-1.68)	0.92 (0.73-1.17)	0.72 (0.58-0.89)
They are affordable.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.90 (0.74-1.11)	1.07 (0.88-1.30)	0.87 (0.70-1.10)	1.07 (0.88-1.31)	1.16 (0.94-1.44)
I like socializing while using them.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	1.39 (1.12-1.73)	1.23 (0.98-1.54)	0.83 (0.67-1.02)	0.87 (0.73-1.03)	0.93 (0.75-1.17)
Persons in the media or other public figures use them.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.67 (0.52-0.86)	0.88 (0.64-1.20)	0.75 (0.58-0.98)	1.36 (1.07-1.72)	0.74 (0.56-0.98)
Persons who are important to me use them.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	1.11 (0.89-1.38)	0.90 (0.71-1.13)	0.96 (0.75-1.22)	0.84 (0.67-1.05)	1.04 (0.81-1.34)

(continued)

Table 4. (continued)

Characteristic	Fruit	Candy/Sweets	Mint/Menthol	Tobacco/ Other	Concurrent Use of Multiple Flavors
Using them feels like smoking a regular cigarette.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.87 (0.70-1.08)	0.97 (0.78-1.21)	0.91 (0.75-1.11)	1.32 (1.10-1.59)	1.06 (0.87-1.29)
The advertising appeals to me.					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.82 (0.62-1.08)	0.59 (0.42-0.81)	0.97 (0.73-1.30)	1.71 (1.32-2.21)	0.74 (0.56-0.97)
Cigarette smoking status					
Never cigarette smoker	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Former cigarette smoker	1.39 (0.84-2.29)	1.03 (0.54-1.95)	0.46 (0.25-0.86)	1.59 (0.91-2.79)	0.81 (0.46-1.42)
Current cigarette smoker and did not try to quit within the past year	1.11 (0.68-1.82)	0.77 (0.42-1.40)	0.39 (0.23-0.66)	2.02 (1.14-3.59)	0.75 (0.44-1.26)
Current cigarette smoker and tried to quit within the past year	1.39 (0.87-2.21)	0.92 (0.52-1.63)	0.34 (0.20-0.57)	2.12 (1.22-3.71)	0.68 (0.40-1.13)
Currently smoke cigars ^d					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.76 (0.61-0.96)	1.26 (0.94-1.69)	1.43 (1.14-1.80)	0.87 (0.67-1.13)	0.86 (0.68-1.07)
Currently smoke hookah ^e					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	1.81 (1.38-2.38)	1.74 (1.28-2.37)	1.61 (1.24-2.11)	0.59 (0.44-0.79)	2.43 (1.90-3.11)
Currently use smokeless tobacco ^f					
No	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Yes	1.03 (0.76-1.41)	0.99 (0.68-1.43)	1.43 (1.06-1.94)	0.88 (0.65-1.19)	1.06 (0.79-1.41)

^aData source: Population Assessment for Tobacco and Health Study, Wave 2.²²

^bWeighting procedures adjusted for oversampling and nonresponse. Sum of weights matched independent population totals (based on US Census data) for standard demographic groups.

^cAsian and other races, including multiracial.

^dSmoked a cigarillo, little filtered cigar, or traditional cigar within the past 30 days (adolescents) or currently smoked cigarillos, little filtered cigars, or traditional cigars every day or some days (young adults and older adults).

^eSmoked a hookah within the past 30 days (adolescents) or currently smoked a hookah every day or some days (young adults and older adults).

^fUsed snus or smokeless tobacco within the past 30 days (adolescents) or currently used snus or smokeless tobacco every day or some days (young adults and older adults).

suggests that the range of available sweet e-cigarette flavors could pose a public health harm to these younger age groups. For example, the availability of sweet e-cigarette flavors could increase the number of cigarette smoking initiators (ie, young persons who transition from e-cigarette use to dual e-cigarette use and cigarette smoking or to exclusive cigarette smoking). In addition, the thermal decomposition of flavor-containing e-cigarette liquid produces several known and probable carcinogens at levels higher than deemed safe by occupational standards.³²⁻³⁴ The FDA could enact product standards to reduce harms in tobacco and e-cigarette products that occur because of the flavor compounds themselves.^{35,36}

In 2018, the FDA announced a comprehensive regulatory plan to reduce tobacco-related disease and death, which included the possibility of “regulating kid-appealing flavors in e-cigarettes.”³⁷ Our study found that many of the flavor types that were attractive to adolescent and young adult e-cigarette users (eg, fruit) were less attractive to older adult e-cigarette users, who more often favored tobacco and other flavors and mint/menthol. Thus, future FDA regulations that ban or heavily restrict sweet flavor types (eg, fruit and candy) could achieve the intended public health goal of reducing

e-cigarette use among young persons. Such regulation may not produce the unintended consequence of harming older adult e-cigarette users—most of whom are former and current cigarette smokers—because they differentially prefer tobacco- and mint/menthol-flavored e-cigarettes. It is not known, however, if young e-cigarette users would simply switch to tobacco-flavored e-cigarettes if sweet flavor types were banned or restricted or if they would stop e-cigarette use altogether, given their tendency to use multiple flavor types. A 2016 study found that adolescents were less interested in trying tobacco-flavored e-cigarettes than sweet-flavored e-cigarettes. In addition to regulation on sweet flavor types, restrictions on e-cigarette marketing could reduce use among young persons because a reasonably high proportion reported appealing e-cigarette advertising as a reason for use.

State and local efforts could also complement federal regulatory policies. Several state and local jurisdictions have enacted sales restrictions on flavored e-cigarettes, either within their jurisdiction or within a set radius of schools.³⁸ However, it is not yet known if these sales restrictions reduce e-cigarette use among young persons and how they affect tobacco use.

The debate on possible FDA regulation of e-cigarette flavors shares some—although not complete—commonality with the longstanding call to ban menthol in cigarettes. The 2009 Family Smoking Prevention and Tobacco Control Act banned characterizing flavors (other than tobacco or menthol), partly because of evidence that the tobacco industry promoted flavored cigarettes to attract young smokers.³⁹ A ban on menthol in cigarettes would likely produce limited, if any, unintended harm at the population level because menthol is associated with nicotine dependence and not associated with higher rates of successful smoking cessation among adults.^{40,41} On the other hand, several evidence reviews concluded that banning menthol in cigarettes would yield a public health benefit because menthol in cigarettes is associated with increased smoking initiation among young persons.⁴²⁻⁴⁴ If flavored e-cigarettes are similarly associated with initiation of cigarette smoking among young persons, a ban on flavors may benefit public health. Stringent regulation of e-cigarette flavors could also have a public health benefit if it limits exposure to toxins in flavors that produce cellular and respiratory damage because of the presence of known toxins.^{45,46}

It is not known if tobacco-flavored e-cigarette use increases the probability of long-term smoking cessation more than sweet-flavored e-cigarette use among adult cigarette smokers. Several longitudinal studies concluded that adult cigarette smokers who used e-cigarettes intensively (eg, daily for ≥ 1 month) or for ≥ 2 years had higher rates of smoking cessation than their counterparts who used standard or no cessation aides.⁴⁷⁻⁴⁹ Our study showed that cigarette smokers—both those who tried to quit smoking within the past year and those who did not try to quit smoking within the past year—were more likely to use tobacco-flavored e-cigarettes than their never cigarette-smoking counterparts. However, the longitudinal studies did not assess whether cessation rates differed by e-cigarette flavor. It is also not known if the use of tobacco-flavored e-cigarettes, compared with the use of other flavor types, increases the probability of sustained abstinence among former cigarette smokers.

Limitations

This study had several limitations. First, the PATH Study did not explicitly ascertain the use of tobacco-flavored e-cigarettes. Respondents who used tobacco-flavored e-cigarettes and respondents who used other flavored e-cigarettes would both have answered no to the survey question, “In the past 30 days, were any of the e-cigarettes you used flavored to taste like menthol, mint, clove, spice, fruit, chocolate, alcoholic drinks, candy, or other sweets?” And respondents who answered “some other flavor” to the question “Which flavors have you used in the past 30 days? If multiple flavors were mixed together, choose all that apply” could have meant tobacco or another flavor entirely (eg, the Apollo E-Cigs flavor nacho cheese). Similarly, some e-cigarette flavors could fit into several categories specified in the PATH Study. For example, respondents may have categorized the Blu flavor

Vivid Vanilla or Vuse flavor Chai as candy or other flavor. Third, this study was based on one wave of PATH data; as such, we could not determine if and how the use of flavor types has changed over time. Wave 1 of the PATH Study (2013-2014) assessed all flavor types together, not separately. Future studies could include additional waves of the PATH Study to assess whether the level of cigarette smoking cessation varied across categories of e-cigarette flavors among dual cigarette smokers and e-cigarette users. Finally, current flavor preference among adolescent, young adult, and older adult e-cigarette users may differ from the preferences assessed in Wave 2 of the PATH Study because new brands (eg, JUUL) have become prominent.

Conclusion

We found that the flavor types preferred by current adolescent and young adult e-cigarette users differed from the flavor types preferred by current older adult e-cigarette users. Stricter regulation or banning of sweet e-cigarette flavors, while continuing to allow sales of tobacco and mint/menthol flavors, could help to reduce e-cigarette use among young persons. At the same time, such regulations may not burden older adult e-cigarette users, many of whom use e-cigarettes to aid in cigarette smoking cessation.

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