



Flavored e-cigarette use: Characterizing youth, young adult, and adult users

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ABSTRACT

The purpose of this study is to investigate how the use of flavored e-cigarettes varies between youth (12–17 years old), young adults (18–29 years old), and older adults (30+ years old). Cross-sectional surveys of school-going youth ($n = 3907$) and young adult college students ($n = 5482$) in Texas, and young adults and older adults ($n = 6051$) nationwide were administered in 2014–2015. Proportions and 95% confidence intervals were used to describe the percentage of e-cigarette use at initiation and in the past 30 days that was flavored, among current e-cigarette users. Chi-square tests were applied to examine differences by combustible tobacco product use and demographic factors. Most e-cigarette users said their first and “usual” e-cigarettes were flavored. At initiation, the majority of Texas school-going youth (98%), Texas young adult college students (95%), and young adults (71.2%) nationwide said their first e-cigarettes were flavored to taste like something other than tobacco, compared to 44.1% of older adults nationwide. Fruit and candy flavors predominated for all groups; and, for youth, flavors were an especially salient reason to use e-cigarettes. Among adults, the use of tobacco flavor at initiation was common among dual users (e-cigarettes + combustible tobacco), while other flavors were more common among former cigarette smokers ($P = 0.03$). Restricting the range of e-cigarette flavors (e.g., eliminating sweet flavors, like fruit and candy) may benefit youth and young adult prevention efforts. However, it is unclear what impact this change would have on adult smoking cessation.

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1. Introduction

An astonishing number of “characterizing flavors” are now widely available for those who use e-cigarettes – by one estimate, over 7500 (Zhu et al., 2014). In addition to tobacco and menthol, e-cigarettes come in sweet flavors, like fruit, candy, and dessert. Enticing flavors like these were banned from conventional cigarettes in 2009 to reduce youth smoking, as they were often used as a starter product (FDA, Family Smoking Prevention and Tobacco Control Act, 2015; US Department of Health Human Services, 2012). Flavors alone are harmful to health (Barrington-Trimis et al., 2014; Hutzler et al., 2014; Grana et al., 2014; Kosmider et al., 2016; Tierney et al., 2015; Behar et al., 2014). Toxic compounds like diacetyl, which has been linked to severe respiratory disease, have been found in 75% of flavored e-cigarettes (Allen et al., 2015; Farsalinos et al., 2014).

Data on the occurrence of flavored e-cigarette use across different age groups are sparse. The prevalence of flavored e-cigarette use among youth current (i.e., past 30 day) e-cigarette users is estimated between 63.3% (Corey et al., 2015) and 85.3%, (Ambrose et al., 2015) according to the 2014 National Youth Tobacco Survey (NYTS) and the 2013–2014 Population Assessment of Tobacco and Health Study (PATH), respectively. Preliminary, unpublished results from 2013 to 2014 PATH suggest the proportion of flavored e-cigarette use among 18–24 year old young adult current users is similar to youth, at 83.0%, while that among adults 25+ years old is lower, at 63.0% (Hyland et al., 2016). Only one published study of young adults' flavored tobacco products use is available, which showed only 17% of 18–34 year old young adult current e-cigarette users used a flavored e-cigarette in 2012, before the sharp increase in e-cigarette use nationwide (Villanti et al., 2013). There are no published studies on adults' flavored e-cigarette use. Until more data on this topic are available, it remains unclear whether preferences for flavored e-cigarettes vary by age group. This evidence will be important to determine whether regulation, like the ban on cigarette flavors, is also needed for e-cigarettes.

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Though some adults begin using e-cigarettes as a device to stop smoking conventional cigarettes (Grana & Ling, 2014; McRobbie et al., 2014), other reasons, like curiosity (Schmidt et al., 2014; Biener et al., 2015; Kong et al., 2014; McDonald & Ling, 2015; Surís et al., 2015; Sutfin et al., 2015; Biener & Hargraves, 2014), are more relevant to youth and young adult e-cigarette users. Among these reasons, flavors play a particularly prominent role. In the 2013–2014 PATH survey, 81.5% of youth e-cigarette users said that they used e-cigarettes “because they come in flavors I like” (Ambrose et al., 2015). Data from smaller, qualitative studies of young adults suggest flavors are an attractive aspect of using e-cigarettes, contributing to the novelty of these devices, which are “fun toys” (McDonald & Ling, 2015; Choi et al., 2012). Among adults use e-cigarettes to quit conventional cigarette smoking, tobacco flavor is often preferred at the start, though sweet flavors become more relevant as e-cigarette use continues (Farsalinos et al., 2014; Dawkins et al., 2013).

The impact of flavors on the uptake of e-cigarettes among youth compared to adults is not without controversy. The most influential study to date that drives this debate is that by Shiffman and colleagues (Shiffman et al., 2015). Nonsmoking youth ($n = 216$, 13–17 years old) and adult cigarette smokers with varied histories of e-cigarette use ($n = 432$, 19–80 years old) were asked to rate their preferences for flavors being offered in 2014 by NJOY e-cigarettes. Across all flavors, adult smokers' interest surpassed that of nonsmoking youth. The authors concluded their data do *not* support the hypothesis that flavors in e-cigarettes will entice nonsmoking youth to use them. Concerns about the reliability and validity of this study, funded by NJOY, have been raised (Glantz, 2015). Additional research is needed to elucidate if flavors are disproportionately preferred by young people or adults.

The purpose of this paper is to investigate whether the use of flavored e-cigarettes varies between youth (12–17 years old), young adults (18–29 years old), and adults (30+ years old). We examine the use of flavored e-cigarettes at initiation and whether “usual” e-cigarettes, for current users, are flavored. Differences in flavored e-cigarette use by combustible tobacco product use are considered, as are differences by sex and race/ethnicity. We investigate a variety of flavors: tobacco; menthol or mint; fruit (e.g., cherry, strawberry); candy (e.g., gummy bear) or dessert (e.g., chocolate, vanilla); coffee or alcohol; and spice (e.g., cinnamon); as well as unflavored e-cigarettes, among adults. Finally, we consider the relevance of flavors as a reason to use e-cigarettes.

2. Methods

2.1. Data sources

Data are derived from three separate studies to represent e-cigarette use profiles across three age groups and include studies of youth (12–17 years old), young adults (18–29 years old), and adults (30+ years old). The studies are the (a) Texas Adolescent Tobacco and Marketing Surveillance System (TATAMS); (b) Marketing and Promotions Across Colleges in Texas Project (M-PACT); and (c) the Tobacco Products and Risk Perceptions Survey (TPRPS). The first two studies are characteristic of the 4 largest metropolitan areas in Texas (i.e., Houston, Dallas/Fort Worth, San Antonio, and Austin), while the last study is representative of non-institutionalized adults in the United States. This study was a collaboration across two different Tobacco Centers of Regulatory Science (TCORS) recently established by the Food and Drug Administration and, as such, represents value in cross-institutional collaboration.

2.1.1. TATAMS

The Texas Adolescent Tobacco and Marketing Surveillance System (TATAMS) is a multiple component, rapid response surveillance system administered by the Texas Tobacco Center of Regulatory Science on Youth & Young Adults (Texas TCORS). Data from the Texas Education

Agency, Texas Private School Accreditation Commission, and the National Center for Education Statistics were used to generate a sampling frame of all public, private and charter schools with 6th, 8th and 10th graders in 2014–15 in the 5 counties surrounding the 4 largest cities in Texas (Houston, Dallas/Ft. Worth, Austin, San Antonio). A complex multistage probability sample of public schools was drawn using probability proportional to the grades' enrollment, and all private and charter schools were invited to participate. Details about this procedure are provided in Pérez et al. (Pérez et al., 2015). Data for this manuscript are taken from the baseline survey, which was administered October 2014–June 2015, on an electronic form on computerized tablets (Delk et al., n.d.). Seventy nine schools and 3907 middle and high school students participated, representing a population of 461,069 6th, 8th, and 10th graders in these major metropolitan areas (Pérez et al., 2015). The Institutional Review Board at University of Texas' Health Science Center, Houston approved all protocols (HSC-SPH-13-0377).

2.1.2. M-PACT

The Marketing and Promotions Across Colleges in Texas Project (M-PACT) is also affiliated with the Texas TCORS and is a rapid-response surveillance system that runs parallel to TATAMS in 2- and 4-year colleges across the same cities. Three colleges of each type were selected from each city, for a total of 24. Participants were full- or part-time degree- or certificate-seeking 18–29 year old undergraduate students attending the 4-year college or a vocational/technical program at the 2-year college. Recruitment at 2-year colleges was limited to students enrolled in vocational/technical programs as they have an elevated prevalence of cigarette use (Loukas et al., 2008). Over 13,000 college students ($n = 13,714$) were eligible to participate and recruited via an e-mail invitation. Of these, 5482 (40%) completed the baseline survey in November 2014–February 2015, from which the data here are drawn. More details regarding the sampling for this study can be found elsewhere (Loukas, 2015). The University of Texas at Austin's Institutional Review Board approved all protocols (2013-06-0034).

2.1.3. TPRPS

The Tobacco Products and Risk Perceptions Survey (TPRPS) is administered by the Georgia State University Tobacco Center of Regulatory Science (GSU TCORS). The survey presented here was conducted August to September 2015 and was administered to a cross-sectional, probability sample drawn from GfK's KnowledgePanel, a probability-based web panel representative of non-institutionalized US adults. Of these KnowledgePanel members, 8135 were invited to participate in the online survey and 6091 qualified as completers. Forty cases were excluded due to refusing to answer more than one-half of the survey questions, for a final sample of 6051 adults, representing 238,226,996 nationwide. The average panel recruitment rate (RECR) for this study, reported by GfK, was 13.8% (rate at which those from the target population accept the invitation to join KnowledgePanel), the average profile rate (PROR) was 64.6% (rate at which those of the target population who accept the invitation to join KnowledgePanel complete the required GfK profile surveys to become members of KnowledgePanel), and the study completion rate (COMR) was 76.0% (the percentage invited to participate in the survey that completed the survey) for a cumulative response rate of 6.8% (RECR*PROR*COMR). More details about this design and the computation of these response rates are found here (Callegaro & DiSogra, 2008; Weaver et al., n.d.). The Institutional Review Board at Georgia State approved all study protocols (H14028).

2.2. Experimental

2.2.1. Measures

Survey questions for all three studies were developed from a catalogue of valid and reliable measures used in state and national tobacco

Table 1
Constructs, questions, and operationalization of e-cigarette measures (2014–2015).

Constructs	Questions and responses			Operationalization
	TATAMS ^a	M-PACT ^b	TPRPS ^c	
Behaviors				
Ever use	Have you EVER used an electronic cigarette, vape pen, or e-hookah, even one or two puffs? No/Yes	Have you ever used an ENDS ^d product, (i.e. e-cigarette, vape pen, or e-hookah) as intended (i.e. with nicotine cartridges and/or e-liquid/e-juice), even one or two puffs? No/Yes	Have you ever used electronic vapor products, even one or two times? No/yes	0 = No; 1 = Yes
Current use	During the past 30 days, on how many days did you use an electronic cigarette, vape pen, or e-hookah? Please enter the number of days (from 0 to 30 days) 0–30	During the past 30 days, have you used any ENDS product, (i.e. an e-cigarette, vape pen, or e-hookah), even one or two puffs, as intended (i.e. with nicotine cartridges and/or e-liquid/ejuice)? No/yes	In the past 30 days, have you used electronic vapor products, even one or two times? No/yes	TATAMS: 0 = no; 1 = yes, ≥ 1 day Others: 0 = no; 1 = yes
Flavors				
Flavor use at initiation	Think back to the FIRST electronic cigarette, vape pen, or e-hookah you tried. What flavor was it? Tobacco; menthol or mint; Candy, such as gummy bear Fruit, such as grape; Coffee or an alcoholic drink, such as wine; Spice, such as cinnamon; other flavor; I don't remember	When you first started using any ENDS products (i.e. e-cigarettes, vape pens, or e-hookah), were they flavored to taste like... Check all that apply Tobacco; Not flavored; Menthol or Mint; Candy (e.g. chocolate, vanilla); Fruit (e.g. strawberry, banana); Coffee or an alcoholic drink (e.g. pina colada); Other I don't remember, but I know it was flavored	When you first started using electronic vapor products, were they flavored? No-unflavored; yes-tobacco flavored; yes-flavored but not tobacco flavor; don't remember	Unflavored; Tobacco flavored; Flavored, not tobacco
Current flavor use	When you use an electronic cigarette, vape pen, or e-hookah, do you usually use any of the following flavors? (yes or no response for each flavor) Tobacco; menthol or mint. Candy, such as gummy bear; Fruit, such as grape; Coffee or an alcoholic drink, such as wine; Spice, such as cinnamon; other flavor	Is your usual brand of disposable e-cigarette or e-cigarette with disposable nicotine cartridges flavored to taste like... AND When you use a vape pen/personal vaporizer, do you usually use e-liquid/e-juice flavored to taste like... (yes or no response for each flavor) Tobacco; Not flavored; Menthol or Mint; Candy (e.g. chocolate, vanilla) Fruit (e.g. strawberry, banana); Coffee or an alcoholic drink (e.g. pina colada); Other	In the past 30 days, have you used electronic vapor products that are flavored (including tobacco flavor)? Yes/no If NO, they are coded as unflavored product users. If YES, they are asked the question stated here. Which flavors have you used in electronic vapor products in the past 30 days? (yes or no response for each flavor) Mint, wintergreen, menthol; fruit (e.g. cherry, blueberry, strawberry, watermelon, coconut, etc.); coffee (coffee or any related flavor–e.g. espresso, latte, cappuccino, etc.); candy or dessert flavors (e.g. caramel, vanilla, chocolate, ice cream, mud pie); Spice (e.g. clove, cinnamon, nutmeg); Alcohol or cocktail (e.g. wine, bourbon, rum, brandy, tequila, whiskey beer, mai-tai, daiquiri); Tobacco flavor; Some other flavor Please indicate how important it is to you in your use of electronic vapor products. They come in flavors I like was measured using 6 point Likert scale where, 0 (not at all important) and 6 (very important)	Unflavored; Tobacco flavored; Flavored, not tobacco Tobacco flavored; mint/menthol; fruit Coffee/alcohol; candy/dessert; spice; other
Reasons to use: flavors	How much do you agree or disagree with the following statements? I tried using electronic cigarette, vape pen, or e-hookah because electronic cigarettes come in flavors I like. Strongly disagree; disagree; agree; strongly agree	I tried ENDS products (i.e. e-cigarettes, vape pens, or e-hookah) as intended because... they came in flavors I liked.		TATAMS: 0 = strongly disagree/disagree; 1 = agree/strongly agree M-PACT: 0 = no; 1 = yes TPRPS: 0–3 = no; 4–6 = yes

^a TATAMS-The Texas Adolescent Tobacco and Marketing Surveillance System.^b M-PACT- Marketing and Promotions Across Colleges in Texas Project.^c TPRPS- The Tobacco Products and Risk Perceptions Survey.^d ENDS- Electronic Nicotine Delivery Systems.

surveillance, including the PATH study (United States Department of Health and Human Services. National Institutes of Health. National Institute on Drug Abuse, a.U.S.D.o.H.a.H.S.F.a.D.A. Population Assessment of Tobacco and Health (PATH) Study, 2013–2016). Measures specific to e-cigarettes in the three studies are summarized in

Table 1. The constructs are included ever and current use; use of flavors at initiation and “regularly”; and flavors as a reason to use e-cigarettes. The differences across studies in these measures include the following. For *flavor use at initiation*, TATAMS did not ask about unflavored e-cigarette use, and M-PACT participants were asked to check all flavor

categories that applied. If any flavor was chosen, respondents were categorized as “flavored, not tobacco” in Table 2. This same rule was applied to all studies for *current use of flavors* in Table 2. In Fig. 1, the raw “check all that apply” form of current use item was retained instead to illustrate the maximum variability in flavors across the studies. M-PACT applied the *flavor use at initiation* question to only current users, while the other studies also applied it to ever users. For *flavors as a reason to use*, responses were dichotomized across all studies. The TPRPS survey only asked this question of adult current e-cigarette users (Table 3).

The measure of combustible tobacco product use included cigarettes, hookah, and all types of cigar products (large cigars, cigarillos, and little filtered cigars). *Former combustible* use was defined as participants who reported ever use of any combustible product, but not current use. TPRPS defined ever use of cigarettes as reporting smoking 100 or more cigarettes in their lifetime; ever use of all other products was defined as having used the product even one or two times in their lifetime. TATAMS and M-PACT defined ever use of each product the same: reporting using the product (even one or two times) in their lifetime. *Current combustible* product use was defined as participants who reported use of any combustible product at least 1 day in the past 30 (for TATAMS or M-PACT participants) or “every day” or “some days” (for TPRPS participants). In addition, we also focused in analyses on the subset of current combustible users that were currently smoking cigarettes, regardless of their other combustible product use; these are noted as *current cigarette* (Tables 2 and 3). *Never combustible* use was defined as those who reported “no” to ever use of all of these products. Questions that define ever use and current use of these products are identical to the questions in Table 1 for e-cigarette use, except e-cigarettes are replaced by these other tobacco products, each with a separate question.

2.2.2. Data analysis

Proportions and 95% confidence intervals were used to describe the percentage of e-cigarette use at initiation and in the past 30 days that can be attributed to the use of flavored e-cigarettes (Table 2). Statistics were calculated overall and then stratified by combustible tobacco product use. Sample sizes for never combustible users were only large enough to be examined in TATAMS and M-PACT, as most adult e-cigarette users had already used combustible tobacco products. Chi-square tests were used to study differences between current and former combustible users (Table 2) and to investigate differences by sex and race/ethnicity across e-cigarette flavor categories among current e-cigarette users (results presented in text). Proportions of e-cigarette use in the past 30 days that could be attributed to all types of flavors, including tobacco, mint/menthol, fruit, coffee/alcohol, candy/dessert, spice, or other flavor were calculated (Fig. 1). To determine the salience of flavors as a reason to use e-cigarettes, proportions and 95% confidence intervals were calculated (Table 3). Analyses of TPRPS data were stratified by age group (18–29 years old vs. 30+ years old) to provide estimates for young adults nationwide that could be compared with those from Texas (M-PACT). Sampling weights were applied to the TATAMS and TPRPS data, but not to M-PACT, as M-PACT employed a convenience sample, while TATAMS and TPRPS used random sampling protocols that allow the results to generalize back to the population from which the sample was drawn, when weights are applied. Detailed information about the calculation and application of sampling weights is provided elsewhere (Pérez et al., 2015; Callegaro & DiSogra, 2008; Weaver et al., n.d.). Estimates that relied on denominators ≤ 50 were suppressed as the results would be statistically unreliable.

3. Results

E-cigarette use was most common among young adult college students in Texas. The prevalence of ever e-cigarette use among

Texas youth and young adult college students (18–29 years old) was 19.5% (95% CI: 15.9%, 24.0%) and 44.6% (95% CI: 43.3%, 46.0%), respectively, while it was 29.5% (95% CI: 26.0%, 33.3%) and 13.8% (95% CI: 12.6%, 15.0%) among young adults (18–29 years old) and adults (30+ years old) nationwide. Current e-cigarette use was 7.4% (95% CI: 5.9%, 9.0%), 15.3% (95% CI: 14.3%, 16.3%), 9.3% (95% CI: 7.2%, 12.0%) and 4.5% (95% CI: 3.8%, 5.2%) across these different samples, respectively.

3.1. Use of flavored e-cigarettes at initiation

Most youth, young adult, and adult e-cigarette users said their first e-cigarette was flavored, with the majority reporting their first e-cigarette was flavored to taste like something

other than tobacco (Table 2). The proportion of current users who started with an e-cigarette flavored with something other than tobacco was considerably higher in Texas youth (98.6%) and young adults in Texas (95.2%) and nationwide (71.2%) compared to older adults nationwide (44.1%). Tobacco flavor was significantly more common among older adults nationwide (47.5%), compared to young adults nationwide (21.0%) and young adult college students (4.8%), and youth (1.4%) in Texas.

No significant differences were noted by combustible tobacco product use for youth in Texas, but significant differences emerged for young adult college students in Texas and adults nationwide. At initiation, the use of tobacco-flavored e-cigarettes was more common among current dual users (e-cigarette and combustible tobacco product users) than exclusive e-cigarette users (i.e., former combustible tobacco product users), for both age groups ($p < 0.05$, both). Among adults nationwide, 43.5% of current combustible users said their first e-cigarette was flavored to taste like tobacco, compared to 27.8% of former combustible product users.

3.2. Current use of flavored e-cigarettes

Similar trends in flavored e-cigarette use in the past 30 days were noted (Table 2). Overall, most youth, young adult, and adult e-cigarette users reported the “usual” e-cigarette they used in the past 30 days was flavored, with the majority reporting that it was flavored to taste like something other than tobacco. The proportion of current users whose “usual” e-cigarette was flavored but not with tobacco was appreciably higher for Texas youth (97.9%) and young adults (96.7%) in Texas and nationwide (82.2%) compared to older adults nationwide (69.3%). In older adults, current use of an e-cigarette flavored with something other than tobacco (69.3%) was also significantly higher than the same at initiation (44.1%). No differences by combustible product use were observed for any age group.

3.3. Preference for and salience of flavors

Among current e-cigarette users, there were no significant differences in use of flavored e-cigarettes at initiation or “usually” by sex or racial/ethnic group for any age group (all $p > 0.05$, data not shown in Table). Fig. 1 illustrates preferences for specific flavors among current e-cigarette users, for the “usual” e-cigarette. Across all studies, fruit flavors predominated, endorsed by 76% of Texas youth, 83% of Texas young adult college students, 74% of young adults nationwide, and 47% of older adults nationwide. The next most popular flavor was candy or dessert, reported by 57% of Texas youth, 52% of Texas young adult college students, 50% of young adults nationwide, and 27% of older adults nationwide. Tobacco flavor was the least commonly reported as a usual flavor among all groups, at 13% of Texas youth, 23% of Texas young adult college students, 1% of young adults nationwide, and 13% of older adults nationwide.

Table 2
Use of flavored e-cigarettes among youth, young adult, and adult current e-cigarette users (2014–2015).

	n	N	Unflavored		Tobacco flavored		Flavored, not tobacco		P-value	
			%	95% CI	%	95% CI	%	95% CI		
Use of flavored e-cigarettes at initiation										
TATAMS^a	Youth (overall)	218	28,301		1.4%	0.5%, 3.9%	98.6%	96.1%, 99.5%		
	Never combustible ^d	78	9853		0.2%	0.0%, 1.4%	99.8%	98.6%, 100.0%		
	Current combustible ^e	88	12,317		1.8%	0.4%, 7.2%	98.2%	92.8%, 99.6%		
	Current cigarette ^f	42	5477		2.5%	0.4%, 15.0%	97.5%	85.0%, 99.6%		
	Former combustible ^g	52	6132		2.5%	0.4%, 13.4%	97.5%	86.6%, 99.6%	0.33	
M-PACT^b	Young adults (overall)	944	NA		4.8%	3.6%, 6.3%	95.2%	93.7%, 96.4%		
	Never combustible ^d	21	NA		***	***	***	***		
	Current combustible ^e	740	NA		5.5%	4.1%, 7.4%	94.5%	92.6%, 95.9%		
	Current cigarette ^f	498	NA		7.4%	5.4%, 10.1%	92.6%	89.9%, 94.6%		
	Former combustible ^g	183	NA		1.6%	0.6%, 4.7%	98.4%	95.3%, 99.4%	0.05	
TPRPS^c	Adults (overall)	355	11,020,944	8.2%	5.1%, 12.9%	37.7%	31.3%, 44.6%	54.1%	47.0%, 61.1%	
	Never combustible ^d	6	375,247	***	***	***	***	***		
	Current combustible ^e	279	7,650,505	9.2%	5.3%, 15.5%	43.5%	35.4%, 51.9%	47.3%	38.8%, 56.0%	
	Current cigarette ^f	256	6,483,643	9.0%	4.8%, 16.2%	47.4%	38.6%, 56.3%	43.6%	34.9%, 52.8%	
	Former combustible ^g	70	29,95,192	6.5%	2.7%, 14.9%	27.8%	17.9%, 40.3%	65.7%	52.7%, 76.7%	0.03
	Young adults (18–29 y)	86	4,074,947	7.8%	2.9%, 19.6%	21.0%	12.9%, 32.4%	71.2%	58.2%, 81.4%	
	Never combustible ^d	4	288,503	***	***	***	***	***		
	Current combustible ^e	58	2,416,473	11.6%	3.9%, 30.0%	25.2%	14.1%, 41.0%	63.2%	45.5%, 77.9%	
	Current cigarette ^f	49	1,747,919	***	***	***	***	***		
	Former combustible ^g	24	1,369,971	***	***	***	***	***		
	Older adults (30+ y)	269	6,945,996	8.3%	5.1%, 13.4%	47.5%	39.8%, 55.4%	44.1%	36.5%, 52.1%	
	Never combustible ^d	2	86,744	***	***	***	***	***		
	Current combustible ^e	221	5,234,031	8.1%	4.5%, 14.0%	51.9%	42.7%, 61.0%	40.0%	31.3%, 49.4%	
	Current cigarette ^f	207	4,735,724	7.3%	3.9%, 13.4%	53.5%	43.8%, 63.0%	39.2%	30.1%, 49.1%	
	Former combustible ^g	46	1,625,221	***	***	***	***	***		
Current or “usual” use of flavored e-cigarettes										
TATAMS^a	Youth (overall)	235	30,756		2.1%	0.5%, 8.7%	97.9%	91.3%, 99.5%		
	Never combustible ^d	87	11,340		0.2%	0.0%, 1.2%	99.8%	98.8%, 100.0%		
	Current combustible ^e	93	13,604		3.5%	0.5%, 20.8%	96.5%	79.2%, 99.5%		
	Current cigarette ^f	46	6543		7.2%	1.0%, 36.3%	92.8%	63.7%, 99.0%		
	Former combustible ^g	55	5813		2.6%	0.4%, 13.8%	97.4%	86.2%, 99.6%	0.26	
M-PACT^b	Young adults (overall)	798	NA		3.3%	2.2%, 4.7%	96.7%	95.3%, 97.8%		
	Never combustible ^d	21	NA		***	***	***	***		
	Current combustible ^e	626	NA		3.8%	2.6%, 5.6%	96.2%	94.4%, 97.4%		
	Current cigarette ^f	444	NA		4.7%	3.1%, 7.1%	95.3%	92.9%, 96.9%		
	Former combustible ^g	152	NA		0.7%	0.1%, 3.6%	99.3%	96.4%, 99.9%	0.07	
TPRPS^c	Adults (overall)	378	11,802,533	17.3%	12.6%, 23.1%	8.7%	6.0%, 12.2%	74.1%	67.9%, 79.5%	
	Never combustible ^d	7	410,639	***	***	***	***	***		
	Current combustible ^e	298	8,126,307	16.9%	11.8%, 23.6%	9.1%	6.1%, 13.3%	74.0%	66.9%, 80.1%	
	Current cigarette ^f	271	6,832,639	16.8%	11.4%, 24.1%	10.3%	6.9%, 15.2%	72.9%	65.1%, 79.5%	
	Former combustible ^g	73	3,265,586	18.9%	9.8%, 33.1%	8.7%	4.0%, 17.8%	72.5%	58.5%, 83.1%	0.89
	Young adults (18–29 y)	92	4,352,335	16.7%	9.2%, 28.4%	1.1%	0.3%, 4.8%	82.2%	70.5%, 89.9%	
	Never combustible ^d	4	288,503	***	***	***	***	***		
	Current combustible ^e	62	2,452,927	10.2%	5.0%, 19.7%	0.6%	0.1%, 4.3%	89.2%	79.6%, 94.6%	
	Current cigarette ^f	52	1,734,218	9.0%	4.2%, 18.2%	0.9%	0.1%, 6.0%	90.1%	80.7%, 95.2%	
	Former combustible ^g	26	1,610,905	***	***	***	***	***		
	Older adults (30+ y)	286	7,450,198	17.6%	12.3%, 24.6%	13.1%	9.1%, 18.4%	69.3%	61.9%, 75.9%	
	Never combustible ^d	3	122,136	***	***	***	***	***		
	Current combustible ^e	236	5,673,380	19.8%	13.3%, 28.4%	12.8%	8.6%, 18.6%	67.4%	58.7%, 75.1%	
	Current cigarette ^f	219	5,098,420	19.5%	12.7%, 28.7%	13.5%	9.0%, 19.8%	67.0%	57.7%, 75.2%	
	Former combustible ^g	47	1,654,682	***	***	***	***	***		

*** Estimates suppressed as denominators <50 and are therefore statistically unreliable. Note. P-values obtained from a chi-square test of differences in flavored e-cigarette use by combustible product use status.

^a TATAMS-The Texas Adolescent Tobacco and Marketing Surveillance System.

^b M-PACT- The Marketing and Promotions Across Colleges in Texas Project.

^c TPRPS- The Tobacco Products and Risk Perceptions Survey

^d Never combustible: reported never using cigarettes, hookah, and cigar products.

^e Current combustible: reported past 30-use (TATAMS and M-PACT) or “every day”/“someday” use (TPRPS) of cigarettes, cigar products, or hookah.

^f Current cigarette: subset of current combustible; reported current use of cigarettes.

^g Former combustible: reported ever use of cigarettes, cigar products or hookah, but not current use of these products; n = survey sample size; N = weighted sample size or the population size to which estimates generalize back to cells are grayed out because unflavored e-cigarette use was not assessed in TATAMS and only three participants reported exclusive unflavored e-cigarette use in the M-PACT study, so tobacco and unflavored were combined.

Table 3 presents the proportion of participants who said they used e-cigarettes because they “come in flavors I like”. Among current e-cigarette users, more Texas youth (72.9%) than young adult college students in Texas (57.4%) and young adults (64.8%) and adults (54.0%) nationwide endorsed this item. The same trend was noted for ever users, overall, comparing youth (64.9%) to young

adult college students (49.5%) in Texas. Among youth and young adult ever e-cigarette users in Texas, this was lowest among those who had never used a combustible tobacco product (53.5% and 34.0% respectively) and higher among those who had some experience with combustible tobacco product use (79.8% and 50.9% respectively).

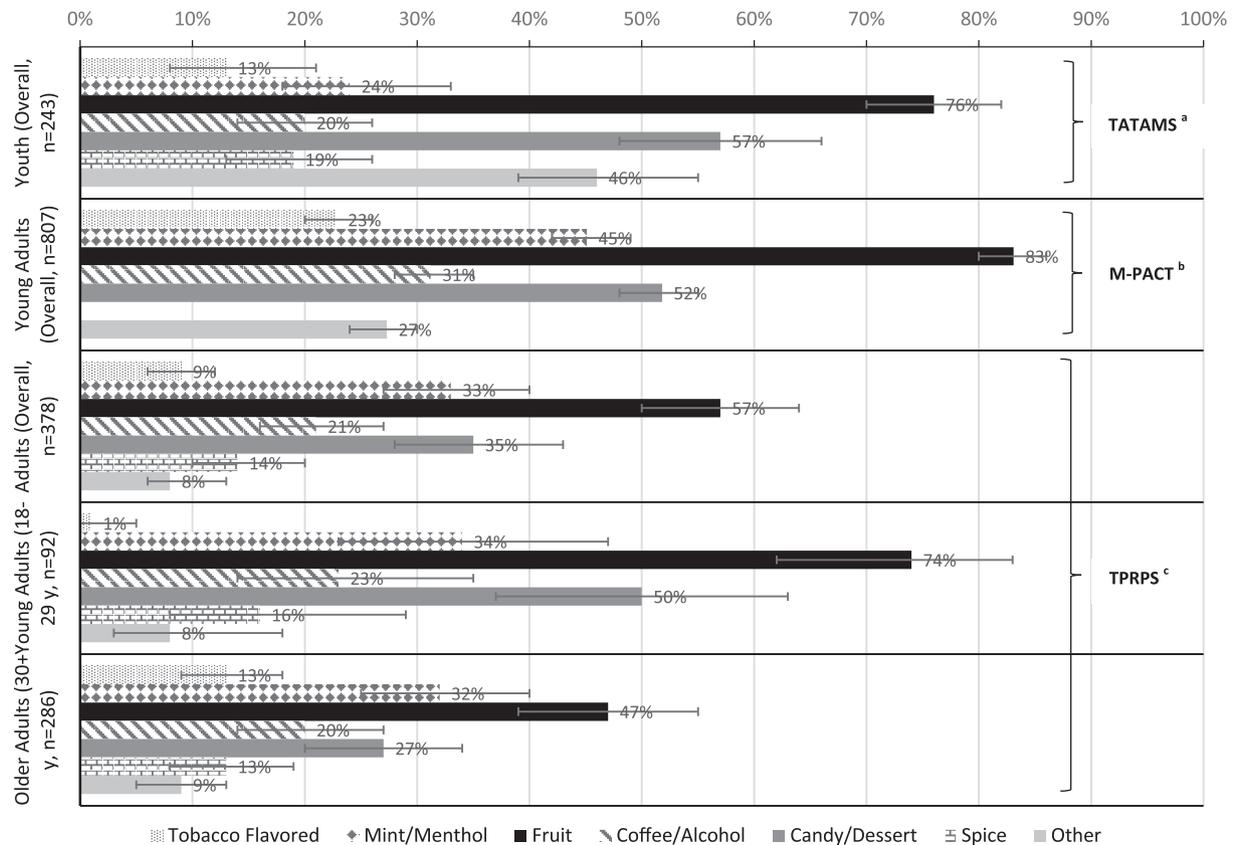


Fig. 1. Variability in flavored e-cigarette use among youth, young adult and adult current e-cigarette users.

4. Discussion

Although the use of flavored e-cigarettes was not uncommon among older adults, our study underscores the relevance and importance of this issue for both youth and young adults. For school-going youth and young adult college students in Texas, almost all first (>95%) and “usual” (>96%) e-cigarette use was with a product flavored to taste like something other than tobacco. The large majority of young adults nationwide also preferred flavored e-cigarettes (71.2% and 82.2%, at first and “usual” use respectively). By comparison, fewer adults nationwide reported the same at initiation (44.1%), and at “usual” use (69.3%). The latter finding suggests flavors other than tobacco become increasingly relevant to older adults as they continue using e-cigarettes.

This study is the first one to date that explicitly compares patterns of flavored e-cigarette use across age groups. Our findings are troubling and suggest that, like conventional cigarettes (US Department of Health Human Services, 2012), characterizing flavors could be especially enticing to young people, at onset and with continued use. Eliminating or restricting e-cigarette flavors in future could be an essential element of comprehensive tobacco control policies designed to reduce the appeal of tobacco products for young people. Already, Chicago and New York City have begun to restrict the sale of flavored tobacco products and e-cigarettes (Emanuel, 2013). As e-cigarettes are now under the authority of FDA to regulate (FDA/USDA, 2014), other regulations like the ban placed on flavored cigarettes (FDA. Family Smoking Prevention and Tobacco Control Act, 2015) could be considered, also. No rules specific to flavorings in e-cigarettes were set forth in the recent deeming action taken by the FDA.

Given our findings and that of others', regulatory actions would not only impact youth and young adults, but also older adults. Preferences for certain flavors differ slightly by age group in studies to date, including this one, and also by cigarette smoking status (Krishnan-Sarin et al.,

2015; Berg, 2015). Sweet flavors, like fruit and candy, are most commonly preferred by youth, young adults, and adults alike and exceed >75% of flavored e-cigarette use in most studies (Farsalinos et al., 2014; Dawkins et al., 2013; Krishnan-Sarin et al., 2015; Berg, 2015). In one study from the UK, sweet flavors reduced perceptions of harm from e-cigarettes among youth (Ford et al., 2015). In our study, preference for sweet flavors was appreciably lower among older adults, at <50%. Across studies of youth, young adults, and adults, mint or menthol and tobacco flavors are preferred more often among e-cigarette users who also smoke cigarettes (dual users), compared to exclusive e-cigarette users, and those who have never smoked a cigarette, especially at initiation (Farsalinos et al., 2014; Dawkins et al., 2013; Krishnan-Sarin et al., 2015; Berg, 2015). Still, use of these flavors is at considerably lower rates than sweeter flavors, varying between 25% and 50% of youth and adult cigarette smokers, respectively (Farsalinos et al., 2014; Dawkins et al., 2013; Krishnan-Sarin et al., 2015; Berg, 2015). These data suggest that tobacco and mint/menthol flavored e-cigarettes could be most relevant to and helpful for adult cigarette smokers who may use e-cigarettes to try to quit smoking. Thus, restricting the range of flavors by eliminating sweet ones may offer the most benefit to youth and young adult prevention efforts, without doing harm to adults. Though e-cigarettes are not a proven tool for adult cigarette smoking cessation, it is unclear what impact this action may have on these efforts, instead (Grana et al., 2014; Grana & Ling, 2014; McRobbie et al., 2014). Remarkably, trends in flavored e-cigarette use reported here did not vary by sex or race/ethnicity for any of the age groups, suggesting the impact of any actions specific to this issue might only differ across different life stages and/or by combustible product use.

Limitations include the study's reliance on self-report and cross-sectional analyses that do not allow for the direct estimation of the role that flavors have in initiation or cessation among youth, young adults, or

Table 3
Saliency of flavors as a reason to use e-cigarettes among youth, young adults, and adults (2014–2015).

	Ever e-cigarette users					Current e-cigarette users				
	n	N	%	95% CI	P-value	n	N	%	95% CI	P-value
TATAMS^a										
Youth (overall)	681	88,953	64.9%	61.0%, 68.8%		259	34,005	72.9%	65.4%, 80.3%	
Never combustible ^d	315	38,511	53.5%	45.6%, 60.9%		99	12,793	58.2%	42.5%, 73.9%	
Current combustible ^e	136	22,551	79.8%	70.1%, 89.5%		103	14,727	83.7%	76.0%, 91.3%	
Current cigarette ^f	68	12,496	76.9%	60.5%, 93.3%		50	7086	88.4%	79.8%, 97.1%	
Former combustible ^g	230	27,892	68.8%	61.4%, 76.2%	< 0.01	57	6492	77.2%	57.1%, 97.3%	0.03
M-PACT^b										
Young adults (overall)	2636	NA	49.5%	47.6%, 51.4%		944	NA	52.2%	49.0%, 55.4%	
Never combustible ^d	144	NA	34.0%	26.8%, 42.1%		21	NA	***	***	
Current combustible ^e	1493	NA	50.9%	48.4%, 53.4%		740	NA	53.0%	49.4%, 56.5%	
Current cigarette ^f	1003	NA	48.0%	44.9%, 51.0%		498	NA	51.2%	46.8%, 55.6%	
Former combustible ^g	997	NA	49.6%	46.6%, 52.8%	< 0.01	183	NA	50.3%	43.1%, 57.4%	0.55
TPRPS^c										
Adults (overall)	355	1,1370,853	57.9%	50.2%, 65.1%		7	410,639	***	***	
Never combustible ^d	7	410,639	***	***		279	7,627,740	52.6%	44.0%, 61.0%	
Current combustible ^e	279	7,627,740	52.6%	44.0%, 61.0%		259	6,536,123	48.9%	40.0%, 57.8%	
Current cigarette ^f	259	6,536,123	48.9%	40.0%, 57.8%		69	3,332,474	69.8%	52.0%, 83.1%	0.22
Former combustible ^g	69	3,332,474	69.8%	52.0%, 83.1%		86	4,092,588	64.8%	49.6%, 77.4%	
Young adults (18–29 y)	4	288,503	***	***		63	2,570,723	60.9%	43.6%, 75.9%	
Never combustible ^d	4	288,503	***	***		54	1,894,898	51.8%	33.4%, 69.8%	
Current combustible ^e	63	2,570,723	60.9%	43.6%, 75.9%		19	1,233,361	***	***	
Current cigarette ^f	54	1,894,898	51.8%	33.4%, 69.8%		269	7,278,265	54.0%	45.4%, 62.3%	
Former combustible ^g	19	1,233,361	***	***		3	122,136	***	***	
Older adults (30+ y)	269	7,278,265	54.0%	45.4%, 62.3%		216	5,057,017	48.4%	39.1%, 57.8%	
Never combustible ^d	3	122,136	***	***		205	4,641,225	47.7%	37.9%, 57.5%	
Current combustible ^e	216	5,057,017	48.4%	39.1%, 57.8%		50	2,099,112	***	***	
Current cigarette ^f	205	4,641,225	47.7%	37.9%, 57.5%						
Former combustible ^g	50	2,099,112	***	***						

Notes. P-values obtained from a chi-square test of differences in saliency of flavored e-cigarette use by combustible product use status.

***Estimates suppressed as denominators <50 and are therefore statistically unreliable.

^a TATAMS-The Texas Adolescent Tobacco and Marketing Surveillance System.

^b M-PACT- The Marketing and Promotions Across Colleges in Texas Project.

^c TPRPS- The Tobacco Products and Risk Perceptions Survey.

^d Never combustible: reported never using cigarettes, hookah, and cigar products.

^e Current combustible: reported past 30-use (TATAMS and M-PACT) or “every day”/“someday” use (TPRPS) of cigarettes, cigar products, or hookah.

^f Current cigarette: subset of current combustible; reported current use of cigarettes.

^g Former combustible: reported ever use of cigarettes, cigar products or hookah, but not current use of these products; n = survey sample size; N = weighted sample size or the population size to which estimates generalize back to; saliency of flavors as a reason to use e-cigarettes was not assessed among ever e-cigarette users in TPRPS, so these cells are grayed out in the table.

older adults. TATAMS and M-PACT are specific to school-going participants, who may not generalize to out-of-school youth. Also, these studies from Texas may not be representative of similarly-aged students living elsewhere, though e-cigarette use rates are comparable to those from national studies (Ford et al., 2015; Singh, 2016). Studies have not yet evaluated whether e-cigarette use rates are similar between young people who do and do not attend school, though data indicate that youth and young adults who do not attend school are more likely to smoke combustible cigarettes (United States Department of Health and Human Services, 2012). Finally, minor differences in the wording of items and procedures used across all three studies to assess flavored e-cigarette use may be a potential limitation of the study, too. Though these three studies were not designed to be directly comparable, every effort was made post-hoc to align measures and analyses.

5. Conclusion

Characterizing flavors, especially sweet ones (e.g., fruit, candy, dessert), appear to be particularly relevant to e-cigarette use among young people, the rates of which have risen substantially in recent years (Singh, 2016; United States Department of Health and Human Services, 2012; Neff et al., 2015; Arrazola et al., 2015). Nationwide, past 30 day e-cigarette use was highest in 2014 among youth (13.4%) (Neff et al., 2015) and young adults (14.2%, 18–24 year olds) (Arrazola et al., 2015) compared to adults (2.4%, 25–44 year olds). (Agaku et al., 2014) Given new longitudinal research that shows that e-cigarette use also predicts the onset of combustible tobacco product use among

both youth and young adults (Leventhal et al., 2015; Primack et al., 2015; Wills et al., 2016), acting like a “gateway” drug, it is imperative to identify feasible and effective intervention strategies that could potentially decrease the onset of and continued e-cigarette use. Eliminating or restricting characterizing flavors for e-cigarettes, especially sweet ones (e.g., fruit, candy, dessert) may offer the most benefit to youth and young adult prevention efforts. However, it is unclear what impact this strategy might have on adult cigarette smoking cessation.

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