



Impact of existing and potential e-cigarette flavor restrictions on e-cigarette use among young adult e-cigarette users in 6 US metropolitan areas

Katelyn F. Romm^{a,b,*}, Lisa Henriksen^c, Jidong Huang^d, Daisy Le^{b,e}, Michelle Clausen^e, Zongshuan Duan^a, Caroline Fuss^f, Breesa Bennett^g, Carla J. Berg^{a,b}

^a Department of Prevention and Community Health, Milken Institute School of Public Health, Washington, DC, USA

^b George Washington Cancer Center, George Washington University, Washington, DC, USA

^c Stanford Prevention Research Center, Department of Medicine, Stanford University School of Medicine, Palo Alto, CA, USA

^d Department of Health Policy & Behavioral Sciences, School of Public Health, Georgia State University, Atlanta, GA, USA

^e Department of Policy, Populations, and Systems, School of Nursing, George Washington University, Washington, DC, USA

^f Department of Global Health, Milken Institute School of Public Health, George Washington University, Washington, DC, USA

^g Department of Epidemiology, Milken Institute School of Public Health, George Washington University, Washington, DC, USA

ARTICLE INFO

Keywords:

E-cigarettes
Flavor restrictions
Young adults
Mixed-methods

ABSTRACT

Given the 2020 federal restrictions on flavored cartridge-based e-cigarettes and increasing state/local flavored e-cigarette sales restrictions, this mixed-methods study examined US young adult e-cigarette users' responses to flavored e-cigarette sales restrictions (e.g., changes in use, products used, access). We descriptively analyzed Fall 2020 survey data from 726 past 6-month e-cigarette users ($M_{\text{age}} = 24.15$, 51.1% female, 4.4% Black, 10.2% Asian, 12.1% Hispanic, 35.5% sexual minority), and qualitatively analyzed Spring 2021 semi-structured interview data among 40 participants ($M_{\text{age}} = 26.30$, 35.0% female, 5.0% Black, 22.5% Asian, 12.5% Hispanic, 45.0% sexual minority). Across all participants (i.e., survey and interview participants), $\geq 80\%$ most commonly used non-tobacco flavors; $\geq 40\%$ used tank-based devices. Survey participants most commonly reported that the federal restrictions did not impact their use: 35.8% used available flavors (i.e., tobacco, menthol), 30.4% continued to use tank-based e-cigarettes, and 10.1% switched to tank-based e-cigarettes. Only 8.4% reduced their e-cigarette use. Among interview participants, some indicated no impact on their e-cigarette use because they stocked up or obtained flavors from alternative sources (e.g., online). Some filled their own pods with e-liquids, switched to menthol/tobacco flavors, switched e-cigarette devices or brands, and/or reduced use. Regarding the anticipated impact of comprehensive flavor restrictions, some participants reported that they would: 1) quit vaping; 2) switch to cigarettes; or 3) not change their use (e.g., stock up on flavors). The potential unintended reactions to flavored e-cigarette sales restrictions (e.g., continued use of flavored cartridge-based e-cigarettes) underscore the need for ongoing surveillance of retail and consumer behavior to inform policy and compliance/enforcement efforts.

1. Introduction

Electronic cigarette (e-cigarette) use has increased over the past decade (Cornelius et al., 2020; Vogel et al., 2019; Wang et al., 2020) alongside rapid e-cigarette market expansion and product diversification (Campaign for Tobacco Free Kids, 2022; Zhu et al., 2014). E-cigarettes may provide a less harmful alternative for adult cigarette smokers, but contain nicotine and chemicals associated with addiction and disease (National Center for Chronic Disease Prevention and Promotion,

2016; Romberg et al., 2019). Use prevalence is higher for young adults than other age groups (Cornelius et al., 2020), with prevalence among US young adults (ages 18–24) nearly doubling from 5.2% (2014) to 9.3% (2019) (Cornelius et al., 2020; Dai and Leventhal, 2019). The availability of non-tobacco e-cigarette flavors are a key motivation for e-cigarette use among former and current adult cigarette users (Landry et al., 2019; Russell et al., 2018; Zare et al., 2018) as well as youth and young adults who perceive non-tobacco flavors as more appealing and less harmful than tobacco flavors (Soneji et al., 2019; Truth Initiative,

* Corresponding author at: Department of Prevention and Community Health, Milken Institute School of Public Health, George Washington University, 800 22nd Street NW, #7000, Washington, DC 20052, USA.

E-mail address: kromm@gwu.edu (K.F. Romm).

<https://doi.org/10.1016/j.pmedr.2022.101901>

Received 1 February 2022; Received in revised form 5 July 2022; Accepted 6 July 2022

Available online 9 July 2022

2211-3355/© 2022 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

2021). Specifically, 95% of adolescents and 71% of young adults (ages 18–29) initiated with non-tobacco flavored e-cigarettes versus 44% of older adults (Harrell et al., 2017).

Accordingly, 8 states and >335 localities implemented flavored e-cigarette sales restrictions (although some have been lifted or expired) (American Lung Association, 2022; Public Health Law Center, 2022). In November 2019, Massachusetts became the first state to restrict all flavored tobacco product sales (Public Health Law Center, 2022). In January 2020, the US Food and Drug Administration (FDA) issued an enforcement policy against companies that do not cease manufacture, distribution, and sales of unauthorized flavored cartridge-based e-cigarettes other than tobacco or menthol flavors (US Food and Drug Administration, 2022). While the FDA began reviewing Premarket Tobacco Applications, they will no longer authorize cartridge-based e-cigarettes containing flavors other than menthol or tobacco (US Food and Drug Administration, 2022). Multiple cities and states have replicated these tactics by either temporarily or permanently restricting flavored e-cigarette sales (some including menthol). Flavor restrictions will likely expand, despite mixed support for such policies. A 2018 survey indicated that 63.3% of US adults supported flavored e-cigarette sales restrictions. However, 2020 data indicated that 85% of US e-cigarette users opposed such restrictions, with former cigarette smokers being particularly opposed (Gravely et al., 2021).

While flavored e-cigarette sales restrictions may reduce adolescent and young adult e-cigarette use, there may be unintended consequences, like undermining harm reduction among adults who use e-cigarettes to quit cigarettes, prompting e-cigarette users to switch to cigarettes, or leading to youth initiation of conventional tobacco products (Buckell et al., 2018; Gravely et al., 2021; Yang et al., 2020). Investigating both intended and unintended consequences of regulatory approaches is needed to inform legislation.

There is limited data reflecting young adults' responses to anticipated federal flavored e-cigarette sales restrictions. However, studies suggest that when asked how they would respond to restrictions on all e-cigarette flavors with the exception of tobacco or menthol, US adult e-cigarette users indicated that they would most likely continue to obtain restricted flavors, switch to cigarettes, vape available flavors, or quit the use of both cigarettes and e-cigarettes (Gravely et al., 2021; Posner et al., 2021). Notably, daily and/or exclusive e-cigarette users were particularly likely to use available flavors or find ways to obtain flavors, whereas dual cigarette and e-cigarette users reported particular likelihood to smoke cigarettes exclusively (Gravely et al., 2021). Regarding actual behavioral responses to existing e-cigarette flavor restrictions, following the implementation of flavored e-cigarette restrictions in San Francisco, while 21% of young adult exclusive flavored e-cigarette users quit all tobacco use, 19% switched to other tobacco products, and 60% continued flavored e-cigarette use by obtaining products online, stocking up prior to restrictions, and traveling to surrounding cities (Yang et al., 2020). Given momentum toward implementing state and local e-cigarette sales restrictions and the need to inform federal regulation, the current study expands on previous research, largely focused on anticipated responses to federal flavored e-cigarette restrictions or actual behavioral responses to state or local restrictions (Gravely et al., 2021; Posner et al., 2021; Yang et al., 2020). This mixed-methods study used 2020–2021 data to examine young adult e-cigarette users' reactions to flavored e-cigarette sales restrictions after the federal flavor restrictions, including: 1) quantitatively assessing responses to flavored e-cigarette sales restrictions (i.e., tobacco use behaviors, types of products used, product access); and 2) qualitatively exploring a wider range of reactions to both existing restrictions and hypothetical restrictions on all flavored e-cigarette products.

1.1. Materials & methods

1.1.1. Study overview

This study analyzed data among young adults (aged 18–34)

participating in a 2-year, 5-wave longitudinal cohort study, the Vape shop Advertising, Place characteristics and Effects Surveillance (VAPES) study (Berg et al., 2021). VAPES examines the US vape retail environment and its impact on e-cigarette, other tobacco, and cannabis use, drawing participants from 6 MSAs (Atlanta, Boston, Minneapolis, Oklahoma City, San Diego, Seattle) with varied tobacco and cannabis legislation (Public Health Law Center, 2022), with only Massachusetts having flavored tobacco sales restrictions (effective 11/27/2019 for vape products; 6/1/2020 for all other tobacco products) – although Washington had temporarily restricted flavored e-cigarette sales (effective 10/9/2019–2/2020) (Campaign for Tobacco Free Kids, 2021). Several localities in California, Massachusetts, and Minnesota implemented local laws restricting sales of flavored vape and/or tobacco products, but none in Georgia, Oklahoma, or Washington had such restrictions (Campaign for Tobacco Free Kids, 2021; Public Health Law Center, 2022). This study was approved by the Emory University and George Washington University Institutional Review Boards.

Participants were recruited via ads on social media (Facebook, Reddit) in Fall 2018 targeting eligible individuals (ages 18–34, residing in zip codes of the 6 MSAs, English-speaking) and by identifying work groups or activities of interest that appeal to young adults (e.g., sports/athletics, entertainment), as well as tobacco-related interests (e.g., Marlboro, Juul) and using imagery of diverse young adults socializing, in work settings, etc. Purposive, quota-based sampling ensured sufficient representation of roughly 1/3 e-cigarette and cigarette users, respectively, equal numbers of men and women, and 40% racial/ethnic minority. Subgroup enrollment was capped by MSA (~500/MSA).

Individuals were directed to an online consent form, and then an eligibility screener assessing age, zip code, e-cigarette and cigarette use, gender, and race/ethnicity (to facilitate reaching subgroup enrollment). Eligible individuals were routed to complete the online Wave 1 survey via Alchemer. Upon survey completion, participants were asked to confirm their participation by clicking a “confirm” button included in an email, after which they were officially enrolled into the study and emailed their first incentive (\$10 Amazon e-gift card).

Recruitment took 87–104 days across MSAs. Of the 10,433 young adults who clicked on ads, 9,847 consented, of which 2,751 (27.9%) did not advance because they were either: a) ineligible ($n = 1,472$) and/or b) excluded to reach subgroup target enrollment ($n = 1,279$). The proportion of completers versus partial completers was 48.8% (3,460/7,096) versus 51.2% (3,636/7,096). The majority of partial completers ($n = 2,469$, 67.9%) completed only the initial sociodemographic section and were deemed ineligible for the study. Of the 3,460 completers, 3,006 (86.9%) confirmed participation (additional information available elsewhere) (Berg et al., 2021).

1.1.2. Quantitative data collection

This study uses Wave 1 sociodemographic data (September–December 2018, $n = 3,006$) and Wave 5 data (September–December 2020, $n = 2,476$; 82.4% retention) assessing e-cigarette and other tobacco use, e-cigarette use characteristics, and reactions to the federal flavored e-cigarette sales restrictions among past 6-month e-cigarette users, as well as current city and select demographics (e.g., marital status).

2. Measures

Sociodemographic Characteristics. At Wave 1, participants reported their age, gender, race/ethnicity, sexual orientation, education level, and relationship status.

E-Cigarette, Tobacco, and Cannabis Use. At Wave 5, participants reported days of e-cigarette use in the past 6 months; past 6-month users reported days of use in the past 30. Similar items assessed use of cigarettes, hookah/waterpipe, little cigars/cigarillos, large cigars, smokeless tobacco, and cannabis.

Past 6-month e-cigarette users reported on the 3 flavors they most

often use (e.g., tobacco, menthol or mint, fruit; Table 1); how often they use nicotine salt (i.e., nicotine base combined with acid(s) allowing nicotine to be inhaled more easily; 0 = never, 5 = all of the time (Barrington-Trimis and Leventhal, 2018; Felicione et al., 2021; Hammond et al., 2021; ITC Project, 2020); and type of e-cigarette device used most often (disposable, closed cartridge-based [i.e., rechargeable closed system], pod/box mods [i.e., rechargeable open system], other).

Reactions to Federal Flavored E-cigarette Restrictions. Past 6-month e-cigarette users were asked, “In 2020, the federal government banned sales of flavored cartridge-based e-cigarettes, with the exceptions of tobacco and menthol flavors. How has that ban impacted your

Table 1
Participant sociodemographic, e-cigarette, and other substance use characteristics.

	W5 past 6-month e-cigarette users n = 726	Interview participants n = 40
Sociodemographics	n (%) or M (SD)	n (%) or M (SD)
MSA, n (%)		
Atlanta	102 (14.0)	8 (20.0)
Boston	110 (15.2)	5 (12.5)
Minneapolis	134 (18.5)	10 (25.0)
Oklahoma City	77 (10.6)	3 (7.5)
San Diego	106 (14.6)	5 (12.5)
Seattle	131 (18.0)	6 (15.0)
Other	58 (8.0)	2 (5.0)
Age, M (SD)	24.15 (4.84)	26.30 (4.39)
Gender, n (%)		
Female	371 (51.1)	14 (35.0)
Male	333 (45.9)	25 (62.5)
Other	22 (3.0)	1 (2.5)
Sexual minority, n (%)	258 (35.5)	18 (45.0)
Race, n (%)		
White	534 (73.6)	23 (57.5)
Black	32 (4.4)	2 (5.0)
Asian	74 (10.2)	9 (22.5)
Other [^]	86 (11.8)	6 (15.0)
Hispanic, n (%)	88 (12.1)	5 (12.5)
Education ≥ Bachelor’s degree, n (%)	453 (62.4)	30 (75.0)
Married/living with partner, n (%)	272 (37.5)	12 (30.0)
E-cigarette use characteristics		
Any use in past 30 days, n (%)	616 (84.8)	40 (100.0)
Days of use in past 30 days (among past 6-month users), M (SD)	14.97 (12.84)	27.63 (4.97)
Flavors most commonly used (list up to 3), n (%)		
Tobacco	98 (13.5)	8 (20.0)
Menthol or mint	356 (49.0)	23 (57.5)
Fruit flavors	502 (69.1)	33 (82.5)
Candy flavors	196 (27.0)	14 (35.0)
Caramel, vanilla, chocolate, cream	85 (11.7)	5 (12.5)
Coffee or tea	35 (4.8)	1 (2.5)
Alcohol drink flavors	26 (3.6)	0 (0)
Other	101 (13.9)	4 (10.0)
Typically use nicotine salt, n (%)		
Never	290 (39.9)	14 (35.0)
Rarely	118 (16.3)	3 (7.5)
Some of the time	102 (14.0)	5 (12.5)
Most of the time	77 (10.6)	5 (12.5)
All of the time	139 (19.1)	13 (32.5)
Device type, n (%)		
Disposable	156 (21.5)	4 (10.0)
Closed cartridge-based (i.e., rechargeable closed system)	188 (25.9)	12 (30.0)
Pod/box mods (i.e., rechargeable open system)	347 (47.8)	23 (57.5)
Other	35 (4.8)	1 (2.5)
Other tobacco/substance use, past 30-days, n (%)		
Cigarettes	322 (44.4)	22 (55.0)
Other tobacco products	392 (54.0)	12 (30.0)
Cannabis	436 (60.1)	18 (45.0)

[^]American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, more than one race, and other aggregated due to low frequency.

use of e-cigarettes? (Check all that apply).” Respondents chose from 14 options (see Table 2 for response options).

3. Qualitative data collection

We recruited via email past 30-day e-cigarette users identified at Wave 5 to participate in semi-structured interviews, conducted in February-April 2021. An eligibility screener confirmed whether participants had used e-cigarettes in the past 30 days. We recruited participants to obtain representation across sexes, sexual orientation, and racial/ethnic backgrounds to the extent possible. Of the 139 recruited, 105 (75.5%) began the eligibility screener, and 94 (89.5%) completed

Table 2
Participant reports of the impact of the federal flavored e-cigarette restrictions on e-cigarette use.

	W5 past 6-month e-cigarette users n = 726	Interview participants n = 40
Variables	n (%)	n (%)
Impact of federal ban on e-cigarette use (check all that apply), n (%)		
No change; use available flavors and same cartridge-based e-cigarette previously used	260 (35.8)	–
No change; use tank-based device and can access various e-liquid flavors, like I always have	221 (30.4)	–
Switched from cartridge-based to open-tank device to access a variety of flavors	73 (10.1)	–
Started using flavor enhancers	23 (3.2)	–
Started mixing my own e-liquids using nicotine concentrates and flavors	14 (1.9)	–
Found ways to obtain flavored e-liquids despite the ban; specify*	37 (5.1)	–
Started using other available flavored tobacco products (e.g., Black & Milds Swisher Sweets)	11 (1.5)	–
Started using traditional cigarettes instead	32 (4.4)	–
Started using IQOS or Eclipse	7 (1.0)	–
Started using marijuana	44 (6.1)	–
Quit using e-cigarettes all together	21 (2.9)	–
Cut down my use of e-cigarettes	61 (8.4)	–
Other; specify**	31 (4.3)	–
None of the above	60 (8.3)	–
*Response: “I found a way to obtain flavored e-liquids despite the ban”; specify: (with N)		
<i>Adapted/changed product used</i> (8): Flavored disposables (e.g., Puff Bar) (6); Started refilling disposable cartridges with e-liquids (1); Off brand Juul pods (1)		
<i>Accessing online</i> (8): Ordered from Canada; Found foreign Juul pod importer selling on snapchat; Order online from overseas, but quit vaping over a month ago so no longer sure if they are still available (4); Ordered online; Websites that got around the ban; Internet (3); Some stores online still ship flavored e-liquids to MA (1)		
<i>Retailers illegally selling</i> (7): My store never stopped selling flavored pods, just not Juul; Stores selling illegally; Some stores sell to people they know (3); Vape shops (2); Smoke shops (1); Gas stations still have them (1)		
<i>Across state lines</i> : Buy them in New Hampshire; Stockpiled from another state; Drive over state lines (3)		
<i>Tribal retailers</i> (2): On the Native American reservation, they still sold it (1); Tribal vape shop (1)		
<i>Social sources</i> (4): Bought from a friend (3); Bought from people who bought before the ban (1)		
<i>Stockpiled</i> : Stocked up on mint before the ban and have not gone through my supplies yet (1)		
**Response: “Other”; specify		
<i>Switched to disposables</i> (e.g., Puff Bars) (11)		
<i>Social sources</i> : Only/usually use friends’ e-cigarettes, so use what they use (5)		
<i>Stockpile</i> : Bought a stockpile before the ban; I haven’t used up the flavors that I purchased prior to the ban (2)		
<i>Manipulate cartridges</i> : Fill juul pods with nic salt vape juice (1)		
<i>Switched vape system</i> (1)		
<i>No change</i> (6): Only ever used e-cigs for cannabis, never for nicotine/tobacco (4); Already mixed my own flavors, so no change (1); Not changed anything for me (1)		

the screener, of whom 34 (36.2%) were not eligible (i.e., no past-month e-cigarette use) and 60 (63.8%) were eligible and consented. Of the 60, 40 (66.7%) participated in a scheduled interview, at which point, saturation had been reached. The COREQ (Consolidated Criteria for Reporting Qualitative Research) guidelines guided the implementation and analysis of the semi-structured interviews (Tong et al., 2007).

The study team developed the semi-structured interview guide, which explored experiences with tobacco and cannabis use, and then piloted it through mock interviews among 4 graduate research assistants to examine question phrasing, clarity, and necessary probes. Current analyses focus on questions about e-cigarette flavor restrictions. We began by explaining, “There is a new policy restricting e-cigarette flavors. The FDA will now no longer authorize cartridge-based e-cigarettes containing flavors other than menthol or tobacco. Cartridge-based e-cigarettes (which are enclosed units that hold vaping liquid like Juul) have come under scrutiny because of their popularity among teens. The policy does not apply to tank-style vapes, which are larger, run on refillable e-liquids, and are commonly found at vape shops. Some states or local jurisdictions have also implemented restrictions on vape product sales.” We then asked, “How have you been impacted by the flavor restrictions (probes: amount, types of products used)? How have they impacted the ways you get your vaping products? Your use of other tobacco? What would you do if all flavored vaping products were banned (probes: quit vaping, switch to other tobacco/nicotine product)?” Participants in Massachusetts were guided to respond to their experiences with the existing state restrictions as well.

Four female graduate research assistants trained in qualitative data collection facilitated the interviews (~45 min). After obtaining online consent, interviews were conducted via Webex and audio-recorded for subsequent coding. Upon completion, participants were debriefed and compensated (\$35 Amazon e-gift card). All audio-recorded interviews were uploaded to a secure, password-protected computer, and transcribed verbatim by a professional transcription service.

4. Data analysis

Survey data were analyzed using descriptive statistics, in SPSS 24.0. Qualitative data were analyzed using QRS Software NVivo v12 and thematic analyses. Four members of the research team reviewed transcripts and determined codebook themes, which were then reviewed as a team, re-defined, and used by the 4 members for systematic coding. Coding discrepancies were resolved through team discussion. Inter-rater reliability was calculated for each code through use of an intra-class correlation coefficient (≥ 0.80 deemed acceptable), with high overall agreement (Kappa = 93.3%). Content codes thematically grouped similar interview text; themes were organized into overarching domains alongside representative quotes, which were edited for readability. Balancing the controversy in qualitative research regarding whether to quantify qualitative results, we indicated the frequency with which participants reported themes by “quantitizing” them as “most”, “many”, “almost half”, “some”, and “a few” (Eval Academy, 2022; Sandelowski et al., 2009).

4.1. Results

4.1.1. Quantitative results

Table 1 presents Wave 1 participant sociodemographic characteristics, Wave 5 e-cigarette use characteristics, and other tobacco use. Table 2 presents the impact of flavored e-cigarette sales restrictions. Past 6-month e-cigarette users at Wave 5 ($n = 726$) were an average age of 24.15 (SD = 4.84), 51.1% female, 35.5% sexual minority, 73.6% White, 4.4% Black, 10.2% Asian, and 12.1% Hispanic. MSA of residence ranged from 10.6% (Oklahoma City) to 18.5% (Minneapolis), with 8.0% residing outside of the 6 MSAs (moved since Wave 1).

Among past 6-month e-cigarette users, 616 (84.8%) reported past 30-day e-cigarette use. Past 6-month e-cigarette users used on average

14.97 (SD = 12.84) days in the past 30; past 30-day users used 17.51 days (SD = 12.17). Participants indicated most commonly using fruit (59.1%), menthol/mint (49.0%), and candy flavors (27.0%). Additionally, 21.5% most often used disposable devices, 25.9% closed cartridge-based devices, and 47.8% pod/box mods; 43.7% used nicotine salt at least some of the time. Roughly half reported past 30-day use of cigarettes (44.4%), other tobacco (54.0%), and cannabis (60.1%).

Participants were most likely to indicate that the federal e-cigarette flavor restrictions had no impact on their use because they: continued to use available flavors (35.8%), used tank-based e-cigarettes prior to the flavor restriction and continued use after the restriction allowing them to access various flavors (30.4%), or switched to tank-based e-cigarettes to access more flavors (10.1%; Table 2). Only 8.4% reduced use, and 4.4% switched to cigarettes. The most commonly reported responses among those who found ways to obtain flavored e-cigarettes despite sales restrictions (5.1%) included: accessing flavored e-cigarettes online (21.6%), adapting their device (e.g., refilling disposable cartridges; 21.6%), and access from non-compliant stores selling flavored e-cigarettes (18.9%).

4.1.2. Qualitative results

Per Wave 5 data, semi-structured interview participants ($n = 40$) were an average age of 26.30 (SD = 4.39), 35.0% female, 45.0% sexual minority, 57.5% White, 5.0% Black, 22.5% Asian, and 12.5% Hispanic (Table 1). MSA of residence ranged from 7.5% (Oklahoma City) to 25.0% (Minneapolis); 5.0% resided outside of the 6 MSAs (moved since Wave 1).

Table 3 presents themes, subthemes, and selected quotes regarding: 1) attitudes toward e-cigarette flavor restrictions; 2) personal impact of existing federal or state flavored e-cigarette sales restrictions; and 3) anticipated impact of comprehensive flavored e-cigarette sales restrictions (i.e., applied to all types of e-cigarettes and all flavors including menthol). First, various *attitudes toward sales restrictions on flavored e-cigarettes* were reported, with some indicating opposition toward such restrictions (e.g., because of concerns related to impact on small businesses, ineffective in reducing use) and some indicating support (e.g., due to potential youth prevention).

Regarding *personal impact of existing federal or state flavored e-cigarette sales restrictions*, participants reported various responses. Many indicated no impact on their e-cigarette use: some indicated no impact due to stocking up on flavored e-liquids or obtaining flavors from alternative sources (e.g., some traveling across state lines; a few via online, international sources, stores on tribal land, and stores illegally selling flavored e-liquids), and some filled their own pods with e-liquids, switched to menthol/tobacco flavors, or switched e-cigarette devices or brands. A current cigarette smoker from Atlanta said: “The day they stopped selling [flavored cartridge-based e-cigarettes], I stocked up on as many as I could. I spent money I did not have because it happened so quick.... And then that same day, I went to a vape shop and I bought a vape racket, put the flavored e-liquid in there. It makes no sense that you can put flavored juice in a vape, but you can’t buy the pods.”

However, some reduced their vaping. A current cigarette smoker in Boston said: “It has forced me to reduce because, if I run out, I won’t be able to get the same [flavor] because of the restrictions.”

Anticipated impacts of comprehensive flavored e-cigarette sales restrictions also varied. Participants commonly reported that complete sales restrictions on flavored e-cigarettes would not impact their use because they would find other ways to obtain their desired product. Specifically, some indicated they would make their own e-liquids or obtain flavored e-liquids via alternative sources (e.g., online). A few also reported they would stock up on flavored e-liquids if complete flavored e-cigarette sales restrictions occurred.

Some participants indicated that they would quit vaping. For example, a former cigarette smoker in Minneapolis said: “I think I’d quit if it was just tobacco. I cannot see any way I would find that tolerable for a long period of time... The absence of [flavors] in my opinion is

Table 3
Themes and quotes regarding experiences with and attitudes toward e-cigarette flavor restrictions.

Attitudes toward e-cigarette flavor restrictions	
Support for restrictions	- I think that's a positive thing. Too many kids use those. I think it is for their benefit to not allow that. – <i>Minneapolis, current cigarette user</i> - If something takes away their ability to get nicotine in a way that could harm them more than it's doing them any good? Sure. – <i>Minneapolis, current cigarette user</i>
Opposition	- A lot of the online stores had to close because not only was the FDA implementing the flavor thing and you have to register each product, but also the federal government stepped in, and the Postal Service won't ship vaping products anymore. So that sucks. And it really shuts down most online vaping stores. – <i>Boston, current cigarette user</i> - When the government started doing that, it's like the exact same thing as the prohibition. But just because you make it illegal doesn't mean it goes away. All it does is just move the revenue, which is a waste. – <i>Boston, former cigarette user</i>
Actual personal impact of existing federal or state flavor bans	
Cut down vaping	- It has forced me to reduce because, if I run out, I won't be able to get the same [flavor] because of the restrictions. – <i>Boston, current cigarette user</i>
No impact	- I only get the vape tobacco menthol flavors anyway. So it really didn't have an impact on me at all. I never really liked flavored tobacco flavored nicotine products. – <i>Boston, current cigarette user</i> - Nope [no impact]. So mine have the refill cartridges. That's what I do. – <i>Minneapolis, current cigarette user</i> - And as a customer, and as a super casual user, it didn't really affect me. – <i>Boston, current cigarette user</i>
Stocked up	- The day they stopped selling [flavored cartridge-based e-cigarettes], I stocked up on as many as I could. I spent money I did not have because it happened so quick. ... And then that same day, I went to a vape shop and I bought a vape racket, put the flavored e-liquid in there. It makes no sense that you can put flavored juice in a vape, but you can't buy the pods. – <i>Atlanta, current cigarette user</i> - I stored up before the flavor bands went into effect. So I'm set for a while. But when they start to run out, then I think I'll have to figure out a way to find some more. – <i>Boston, current cigarette user</i>
Filling own pods	- So initially, I used to vape only the mango Juul pods. After I ran out, I started refilling my pods with that flavor instead of mango from Juul. So it didn't really affect me. – <i>Minneapolis, former cigarette user</i>
Switched to menthol or tobacco flavors	- I thought okay, well what am I going to do like my habits gone, but then I switched to the menthol ones and it hasn't been an issue since. – <i>Minneapolis, former cigarette user</i> - I haven't been affected too greatly. I was sad when the mint pods went away because that used to be my go to but the menthols not that much different. And I don't really want all of like the fruity flavors personally. – <i>Oklahoma City, current cigarette user</i>
Switched devices	- That's why I stopped using Juul and switched to this thing. ... I hated that ban because I liked my little Juul and my little cartridges. It was easy. It was convenient. I liked how the Juul looked. I liked how it felt. I had my website that I got my Juul pod from. That website is now out of business. So I can't even get juices from it. I knew what brands of flavors I liked. And now I can't even get some of those brands of the bottles of juice. ... It made me switch from Juul to a refillable cartridge based system, I guess is the short version. – <i>Minneapolis, current cigarette user</i> - It hasn't impacted me or anyone that I know at all. I just switched. If you want to still use your Juul, you can buy nicotine salt e-liquids from a smoke shop for cheaper and refill your pods. And many other brands have their own Juul pods and many flavors that are sold at the smoke shops where Juul pods and different

Table 3 (continued)

Attitudes toward e-cigarette flavor restrictions	
	flavors used to be sold. So it just it didn't do anything. – <i>Minneapolis, former cigarette user</i>
Switched brands	- The ban made it so I wasn't able to get the same product that I was using, so I had to switch. – <i>Boston, former cigarette user</i>
Alternative sources	- Not really [impacted my vaping] at all. I mean, it did for a little while until I found out where to get them. – <i>Seattle, current cigarette user</i> - It sort of did, where I would have to get the e-liquid from somewhere instead of from where I used to. – <i>Minneapolis, former cigarette user</i>
Online	- I would buy the same product from the same company that was online. Then when the ban went through, they couldn't send it anymore. So then I tried to figure out, can I send it to a friend's house? So I did that for a while, but then he's like, "Oh, I don't want to have to keep dealing with your mail." And so then it was figuring out a different website. There's always another way. ... – <i>Boston, former cigarette user</i>
Across state lines	- Originally, when that first started happening, it was actually a big problem for me because I mostly like to vape flavors, like stuff like fruit and berries. I definitely would not want to smoke tobacco or menthol flavored juice out of my vape. And so when that first company in the state of Washington, I was panicked. I was like, "I need to go and stock up." I actually found out that the neighboring state of Oregon was more relaxed, so I went there, and stocked up on my favorite one. After that, it didn't really affect me. – <i>Seattle, current cigarette user</i> - Now I drive to Connecticut, Vermont and New Hampshire. And because Massachusetts put the vaping ban in place...which is absolutely stupid. Right before the vaping ban, I would usually just get it online from like, known sources. – <i>Boston, former cigarette user</i>
International sources	- I really liked the mango Juul pods. I actually used a service to buy mango Juul pods from Canada and had them shipped internationally. I spent a large amount of money to buy them in Canada and ship them to the United States. – <i>Atlanta, current cigarette user</i> - There are places that you can order from. I used it like once to get one of the Juul flavors that is now banned in the US. There's sites based in other countries that will send it to you. – <i>Seattle, former cigarette user</i>
Stores illegally selling	- I initially was like, okay, I guess it won't be like vaping anymore. But then I'm like, there's like a couple stores that do still sell it. So like whenever I'm down there, I would just get one. But that would be once a month or something like that. – <i>San Diego, current cigarette user</i>
Tribal stores	- I went to the local tribe until a club opened up a vape store that the feds couldn't restrict. So I couldn't buy them from the local vape stores I usually went to because they were banned for a while, but they got unbanned at least in Washington. – <i>Seattle, current cigarette user</i>
Anticipated impact of complete vaping product flavor ban	
Quit vaping	- I would probably have no choice but to quit because I wouldn't trust somebody selling it out of their garage. – <i>Boston, former cigarette user</i> - That would be the perfect incentive to stop and to get help and to quit. – <i>Seattle, current cigarette user</i> - It would probably upset me, first of all, as an addict. And as an adult, I do feel like, even though smoking vaping is terrible, if somebody wants to do that, they should be able to, but I don't know if I would switch to unflavored or just a menthol flavor. It might cause me to genuinely consider quitting. If it tasted nasty. But I don't know, if that ever happens, I guess I'll just have to see. – <i>Oklahoma City, former cigarette user</i>
No impact	- I'd just continue to vape. – <i>San Diego, former cigarette user</i> - I don't know if it would, probably wouldn't [impact my vaping]. – <i>San Diego, current cigarette user</i>
Make own e-liquids	- I would just make my own [flavored e-liquid]. It would be fine. – <i>San Diego, former cigarette user</i>

(continued on next page)

Table 3 (continued)

Attitudes toward e-cigarette flavor restrictions	
Stock up	<p>- It probably wouldn't stop a lot of people that make their own. But it would just mean that it would have to crack down and actually figure out how they would deal with that legally for people making their own. – <i>Oklahoma City, former cigarette user</i></p> <p>- I would definitely buy up all that I could of the flavor before the ban went into place. I don't know if I could say if I would say that I would necessarily be trying to find a dealer. Like Um, "Hey, man, you got that crunch berry?" – <i>Atlanta, current cigarette user</i></p> <p>- But I mean, I have so much juice in my apartment and stuff that I've not even seen for 10 years. I have tons of juice somewhere. So I don't think it's gonna affect me for quite a while these kind of bans. – <i>Seattle, current cigarette user.</i></p>
Alternative sources	<p>- I'd have to find like a black market vape place honestly. So, I honestly would be looking. – <i>Seattle, former cigarette user</i></p> <p>- If I could get e-cig juice online or something, I'd probably find ways to get fruit flavored menthol juice. – <i>San Diego, former cigarette user</i></p>
Switch to cigarettes	<p>- I would probably end up going back to cigarettes. Unfortunately. – <i>Minneapolis, current cigarette user</i></p> <p>- I would be upset. I understand why they want to do that. If all flavors were banned except for tobacco flavor, I'd probably just start smoking cigarettes. Because if I have to use a gross flavor? Why not just do the actual thing? – <i>Oklahoma City, current cigarette user</i></p>

disgusting, so banning flavors would be quite effective.”

Some also said they would switch to cigarettes. A former cigarette smoker in Seattle said: “I'm not gonna vape tobacco flavor. If I'm stuck with tobacco or menthol flavor, then I might as well be smoking cigarettes.”

4.2. Discussion

Among this sample of young adults (over one-third sexual, racial, and ethnic minorities) who currently used e-cigarettes, the largest proportion indicated that flavored e-cigarette sales restrictions did not impact their use because they continued using available flavors (i.e., menthol/tobacco), continued using or switched to tank-based e-cigarettes, adapted their devices (e.g., refilling disposable cartridges), or stocked up on flavored e-liquids prior to restrictions. Despite current flavor restrictions, participants commonly indicated continued access to flavors via online ordering (including international sources), stores illegally selling flavored e-cigarettes, traveling across state lines, or stores on tribal land. Fewer indicated cutting down on vaping.

Notably, many participants who stocked up, obtained flavors from alternative sources, or cut down on vaping resided in Boston, where state restrictions were more restrictive than the federal restrictions (Campaign for Tobacco Free Kids, 2021; Public Health Law Center, 2022). These findings expand upon results from the San Francisco study that examined reactions to restrictions on non-tobacco flavored e-cigarettes, menthol cigarettes, and other non-tobacco flavored tobacco products, where most participants (60%) continued using flavored e-cigarettes via alternative sources, with fewer quitting all tobacco products (21%) or switching to cigarettes (19%) (Yang et al., 2020). Current qualitative findings also align with experimental research indicating that individuals are more likely to purchase from illegal tobacco markets when product availability in legal markets is more restricted (Freitas-Lemos et al., 2021).

Current findings have multiple implications for research and policy. First, while quitting both vaping and cigarette use would be the most ideal scenario under a comprehensive flavor restriction, our findings and those from prior research underscore the potentially complex outcomes of restricting e-cigarette flavors (Buckell et al., 2018; Gravely et al.,

2021; Posner et al., 2021; Yang et al., 2020). Current findings suggest potential reductions in e-cigarette use in some young adults, but potential unintended consequences (e.g., switching to cigarettes) in others. Moreover, the ways participants accessed flavored e-cigarettes despite restrictions (e.g., non-compliant retailers, online) underscores regulatory loopholes and enforcement concerns (Boys et al., 2003; Ontario Chamber of Commerce, 2019). Thus, as federal, state, and local governments implement and enforce flavored e-cigarette sales restrictions and consider new regulations, it is critical to monitor young adults' responses to current flavored e-cigarette sales restrictions, as well as their anticipated responses to future restrictions using various approaches (e.g., surveys, qualitative research, experiments).

Furthermore, jurisdictions implementing flavor restrictions should consider complementary strategies such as public education campaigns to discourage initiating or continuing cigarette smoking, or tax increases on more harmful combustible tobacco products. Because prior research suggests that certain young adults (e.g., White vs. Black, sexual minority, former cigarette users) are more likely to continue using e-cigarettes or switch to cigarettes when asked about future e-cigarette flavor restrictions (Posner et al., 2021), future research should explore these factors in relation to young adults' actual responses to existing e-cigarette flavor restrictions to inform regulations and targeted public education campaigns.

4.2.1. Limitations

Among this study's limitations is limited generalizability to other young adults in the included MSAs or across the US due to our sampling strategy (e.g., recruiting roughly a third past 30-day e-cigarette and cigarette users). Additionally, assessments regarding the impact of current and hypothetical e-cigarette flavor restrictions were completed by current e-cigarette users only – thus not capturing reactions (e.g., policy support, behavioral impacts) among nonusers, including those who may have quit using e-cigarettes by Wave 5 (Fall 2020), which differ relative to users (Posner et al., 2021). Additional research should leverage natural experiments with longitudinal data before and after policy implementation to examine a range of predictors (e.g., sociodemographics, other tobacco use) on behavioral responses to flavored e-cigarette sales restrictions.

4.2.2. Conclusion

Results from this study highlight heterogeneity in young adult e-cigarette users' reactions to existing flavored e-cigarette sales restrictions and hypothetical restrictions. Some reduced e-cigarette use, but many reported intentions to continue e-cigarette use, by using tank-based e-cigarettes, available flavors, or flavors accessed through alternative sources. More concerning, some switched to cigarettes. Similarly, in response to future restrictions of all flavored e-liquids, young adult e-cigarette users largely indicated that they would either quit vaping – the ideal scenario – or switch to cigarettes – the least desirable scenario. Another major concern highlighted was access to flavored e-cigarettes despite restrictions (e.g., online, across state lines). Collectively, findings suggest that implications of flavored e-cigarette sales restrictions are complex, with the potential for both reductions in e-cigarette use and unintended consequences among young adults, including continued use of flavored e-cigarettes or switching to cigarettes, and retail and consumer circumvention of restrictions. Thus, it remains crucial for policymakers to weigh the potential for both public health benefits and consequences given increased momentum toward implementing e-cigarette sales restrictions.

Funding details

This work was supported by the US National Cancer Institute (R01CA215155-01A1; PI: Berg; R01CA215155-04S1; PI: Le). Dr. Berg is also supported by other US National Institutes of Health funding, including the National Cancer Institute (R01CA239178-01A1; MPIs:

Berg, Levine; R01CA179422-01; PI: Berg), the Fogarty International Center (R01TW010664-01; MPIs: Berg, Kegler), the National Institute of Environmental Health Sciences/Fogarty (D43ES030927-01; MPIs: Berg, Caudle, Sturua), and the National Institute on Drug Abuse (R01DA054751-01A1; MPIs: Berg, Cavazos-Rehg). Dr. Romm is supported by the National Institute on Drug Abuse (F32DA055388-01; PI: Romm; R25DA054015; MPIs: Obasi, Reitzel).

Ethical approvals

Institutional Review Board approvals were obtained from Emory University and George Washington University.

CRediT authorship contribution statement

Katelyn F. Romm: Conceptualization, Methodology, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. **Lisa Henriksen:** Conceptualization, Writing – review & editing, Funding acquisition. **Jidong Huang:** Writing – review & editing. **Daisy Le:** Writing – review & editing, Supervision, Project administration, Funding acquisition. **Michelle Clausen:** Investigation, Writing – review & editing. **Zongshuan Duan:** Writing – review & editing. **Caroline Fuss:** Investigation, Writing – review & editing. **Breesa Bennett:** Investigation, Writing – review & editing. **Carla J. Berg:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- American Lung Association, 2022. State of Tobacco Control, 2018. Retrieved from <https://www.lung.org/local-content/ca/state-of-tobacco-control/2018/state-of-tobacco-control-2018>. Published 2018. Accessed January 12, 2022.
- Barrington-Trimis, J.L., Leventhal, A.M., 2018. Adolescents' use of "pod mod" e-cigarettes - urgent concerns. *N. Engl. J. Med.* 379 (12), 1099–1102.
- Berg, C.J., Duan, X., Getachew, B., Pulvers, K., Crawford, N.D., Sussman, S., Ma, Y., Jones-Harrell, C., Henriksen, L., 2021. Young adult e-cigarette use and retail exposure in 6 US metropolitan areas. *Tobacco Regul. Sci.* 7 (1), 59–75.
- Boys, A., Marsden, J., Stillwell, G., Hatchings, K., Griffiths, P., Farrell, M., 2003. Minimizing respondent attrition in longitudinal research: practical implications from a cohort study of adolescent drinking. *J. Adolesc.* 26 (3), 363–373.
- Buckell, J., Marti, J., Sindelar, J.L., 2018. Should flavours be banned in cigarettes and e-cigarettes? evidence on adult smokers and recent quitters from a discrete choice experiment. *Tob. Control.*
- Campaign for Tobacco Free Kids, 2021. States and localities that have restricted the sale of flavored tobacco products. Retrieved from <https://www.tobaccofreekids.org/assets/factsheets/0398.pdf>. Published 2021. Accessed December 31, 2021.
- Campaign for Tobacco Free Kids, 2022. Electronic cigarettes: an overview of key issues. Retrieved from <https://www.tobaccofreekids.org/assets/factsheets/0379.pdf>. Accessed January 12, 2022.
- Cornelius, M.E., Wang, T.W., Jamal, A., Loretan, C.G., Neff, L.J., 2020. Tobacco product use among adults - United States, 2019. *MMWR Morb. Mortal Wkly. Rep.* 69 (46), 1736–1742.
- Dai, H., Leventhal, A.M., 2019. Prevalence of e-cigarette use among adults in the United States, 2014–2018. *JAMA* 322 (18), 1824–1827.
- Eval Academy, 2022. How to "quantify" qualitative data. Retrieved from <https://www.evalacademy.com/articles/how-to-quantify-qualitative-data#:~:text=The%20key%20to%20quantifying%20qualitative,those%20particular%20words%20were%20chosen>. Accessed January 12, 2022.
- Felicione, N.J., Cummings, K.M., Gravely, S., et al., 2021. "Don't know" responses for nicotine vaping product features among adult vapers: Findings from the 2018 and 2020 ITC Four Country Smoking and Vaping Surveys. *Int. J. Environ. Res. Public Health.* 18 (15).
- Freitas-Lemos, R., Stein, J.S., Tegge, A.N., et al., 2021. The illegal experimental tobacco marketplace i: effects of vaping product bans. *Nicotine Tob. Res.* 23 (10), 1744–1753.
- Gravely, S., Smith, D.M., Liber, A.C., et al., 2021. Responses to potential nicotine vaping product flavor restrictions among regular vapers using non-tobacco flavors: findings from the 2020 ITC Smoking and Vaping Survey in Canada, England and the United States. *Addict. Behav.* 2021 (125).
- Hammond, D., Reid, J.L., Burkhalter, R., et al., 2021. Trends in e-cigarette brands, devices and the nicotine profile of products used by youth in England, Canada and the USA: 2017–2019. *Tob. Control.*
- Harrell, M.B., Weaver, S.R., Loukas, A., Creamer, M., Marti, C.N., Jackson, C.D., Heath, J. W., Nayak, P., Perry, C.L., Pechacek, T.F., Eriksen, M.P., 2017. Flavored e-cigarette use: characterizing youth, young adult, and adult users. *Prev Med Rep.* 5, 33–40.
- Truth Initiative, 2021. Flavored tobacco use among youth and young adults. Retrieved from <https://truthinitiative.org/research-resources/emerging-tobacco-products/flavored-tobacco-use-among-youth-and-young-adults>. Published 2021. Accessed January 12, 2022.
- ITC Project, 2020. *ITC Four Country Smoking and Vaping Survey, Wave 3 (4CV3, 2020) Preliminary Technical Report*. University of Waterloo, Waterloo, ON, Canada; Medical University of South Carolina: Charleston, SC, USA; Cancer Council Victoria: Melbourne, Australia; The University of Queensland: Queensland, Australia; King's College London: London, UK.
- Landry, R.L., Groom, A.L., Vu, T.-H., Stokes, A.C., Berry, K.M., Kesh, A., Hart, J.L., Walker, K.L., Giachello, A.L., Sears, C.G., McGlasson, K.L., Tompkins, L.K., Mattingly, D.T., Robertson, R.M., Payne, T.J., 2019. The role of flavors in vaping initiation and satisfaction among U.S. adults. *Addict. Behav.* 99, 106077.
- National Center for Chronic Disease Prevention and Promotion, 2016. Publications and Reports of the Surgeon General. *In E-Cigarette Use among Youth and Young Adults: A Report of the Surgeon General*. Atlanta (GA).
- Ontario Chamber of Commerce, 2019. Guiding policy principals for tobacco and vaping products. Retrieved from <https://occ.ca/wp-content/uploads/Guiding-Policy-Principles-for-Tobacco-and-Vaping-Products.pdf>. Published 2019. Accessed January 12, 2022.
- Posner, H., Romm, K., Henriksen, L., Bernat, D., Berg, C.J., 2021. Reactions to sales restrictions on flavored vape products or all vape products among young adults in the US. *Nicotine Tob Res.* 24 (3), 333–341.
- Public Health Law Center, 2022. Commercial Tobacco and Marijuana. Retrieved from <https://www.publichealthlawcenter.org/topics/commercial-tobacco-control/commercial-tobacco-and-marijuana>. Published 2020. Accessed January 12, 2022.
- Public Health Law Center, 2022. U.S. E-Cigarette Regulations – 50 State Review (2019). Retrieved from <https://www.publichealthlawcenter.org/resources/us-e-cigarette-regulations-50-state-review>. Published 2019. Accessed January 12, 2022.
- Romberg, A.R., Miller Lo, E.J., Cuccia, A.F., Willett, J.G., Xiao, H., Hair, E.C., Vallone, D. M., Marynak, K., King, B.A., 2019. Patterns of nicotine concentrations in electronic cigarettes sold in the United States, 2013–2018. *Drug Alcohol Depend.* 203, 1–7.
- Russell, C., McKegany, N., Dickson, T., Nides, M., 2018. Changing patterns of first e-cigarette flavor used and current flavors used by 20,836 adult frequent e-cigarette users in the USA. *Harm Reduct J.* 15 (1), 33.
- Sandelowski, M., Voils, C.I., Knafl, G., 2009. On quantizing. *J. Mix Methods Res.* 3 (3), 208–222.
- Soneji, S.S., Knutzen, K.E., Villanti, A.C., 2019. Use of flavored e-cigarettes among adolescents, young adults, and older adults: findings from the Population Assessment for Tobacco and Health study. *Public Health Rep.* 134 (3), 282–292.
- Tong, A., Sainsbury, P., Craig, J., 2007. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int. J. Qual. Health Care.* 19 (6), 349–357.
- US Food and Drug Administration, 2022. FDA finalizes enforcement policy on unauthorized flavored cartridge-based e-cigarettes that appeal to children, including fruit and mint. Retrieved from <https://www.fda.gov/news-events/press-announcements/fda-finalizes-enforcement-policy-unauthorized-flavored-cartridge-based-e-cigarettes-appeal-children>. Published 2020. Accessed January 12, 2022.
- US Food and Drug Administration, 2022. FDA permits marketing of e-cigarette products, marking first authorization of its kind by the agency. Retrieved from <https://www.fda.gov/news-events/press-announcements/fda-permits-marketing-e-cigarette-products-marking-first-authorization-its-kind-agency>. Published 2021. Accessed May 15, 2022.
- Vogel, E.A., Prochaska, J.J., Ramo, D.E., Andres, J., Rubinstein, M.L., 2019. Adolescents' e-cigarette use: increases in frequency, dependence, and nicotine exposure over 12 months. *J. Adolesc. Health* 64 (6), 770–775.
- Wang, T.W., Neff, L.J., Park-Lee, E., Ren, C., Cullen, K.A., King, B.A., 2020. E-cigarette use among middle and high school students - United States, 2020. *MMWR Morb. Mortal Wkly. Rep.* 69 (37), 1310–1312.
- Yang, Y., Lindblom, E.N., Salloum, R.G., Ward, K.D., 2020. The impact of a comprehensive tobacco product flavor ban in San Francisco among young adults. *Addict. Behav. Rep.* 11.
- Zare, S., Nemati, M., Zheng, Y., 2018. A systematic review of consumer preference for e-cigarette attributes: Flavor, nicotine strength, and type. *PLoS One.* 13 (3) e0194145.
- Zhu, S.-H., Sun, J.Y., Bonnevie, E., Cummins, S.E., Gamst, A., Yin, L.u., Lee, M., 2014. Four hundred and sixty brands of e-cigarettes and counting: implications for product regulation. *Tob Control* 23 (suppl 3), iii3–iii9.