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Young People's E-Cigarette Risk Perceptions, Policy Attitudes, and Past-Month Nicotine Vaping in 30 U.S. Cities

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Abstract

Background: This study examined young people's e-cigarette risk perceptions, policy attitudes, and past-month nicotine vaping in 30 US cities in relation to city e-cigarette retail policy.

Methods: Participants ages 13–20 were recruited online September–November 2020 (N=900, approximately 30 per city). Cities (median population=688,531) were in 23 states. Ever e-cigarette users were oversampled. A multilevel generalized estimating equations (GEE) model compared past-month nicotine vaping as a function of local e-cigarette retail policy. Among ever-users, multilevel bivariate GEE models examined associations of participant characteristics with past-month vaping (yes/no) and, among past-month nicotine vapers, purchase of vaping products at a retail location (yes/no).

Results: The sample (age M=17.7 [SD=1.8]) was 60.2% female and 29.3% Black. Minimal city-level variation was observed in e-cigarette risk perceptions or policy attitudes (ICCs<0.001). Nearly half the sample (44.6%) reported ever e-cigarette use; 11.8% reported past-month nicotine vaping. Past-month nicotine vaping was associated with older age, being non-Hispanic white, living with someone who vapes, having friends who vape, greater exposure to retail e-cigarette ads, lower e-cigarette risk perceptions, and lower perceived efficacy of flavored tobacco policy. Among ever-users, past-month nicotine vaping was not significantly associated with city e-cigarette flavor policy ($p=.784$). Most participants reporting past-month nicotine vaping purchased products in-store (58.5%).

Conclusions: Among young people surveyed in US cities, e-cigarette risk perceptions and policy attitudes showed minimal between-city variation. Past-month vaping among ever-users did

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EAV: conceptualization; formal analysis; investigation; writing – original draft; project administration; funding acquisition. LH: conceptualization; writing – reviewing & editing; supervision; funding acquisition. NS: formal analysis; writing – reviewing & editing. JJP: conceptualization; writing – reviewing & editing; supervision; funding acquisition.

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Conflict of Interest

JJP has provided consultation to pharmaceutical and technology companies that make medications and other treatments for quitting smoking and has served as an expert witness in lawsuits against the tobacco companies. All other authors have no financial disclosures.

not differ significantly by local flavor policies. A majority of past-month users, regardless of city policies, reported underage access to flavored products in retail locations.

Keywords

e-cigarette; vaping; youth; tobacco retail policy; flavored tobacco

1. Introduction

Given surges in electronic cigarette (e-cigarette) use among young people in the U.S. and concerns about vaping-related lung injury, federal policy raised the minimum retail tobacco product sales age to 21 in 2019 (U. S. Food and Drug Administration, 2019) and in early 2020 prioritized enforcement against the sale of unapproved flavored, cartridge-based e-cigarette products (excluding tobacco- and menthol-flavored products) (U.S. Food and Drug Administration, 2020). Individual states and local jurisdictions also have passed retail policies to restrict the sale of e-cigarettes and/or flavored tobacco, including flavored e-cigarettes (Kong and King, 2020). For example, in 2019, San Francisco banned direct and online sales of e-cigarettes without Food and Drug Administration (FDA) Marketing Orders (San Francisco Department of Public Health, 2020). To date, no e-cigarette company has received FDA Marketing Orders, effectively resulting in a ban on e-cigarette sales for now in San Francisco. Other jurisdictions (e.g., New York state) (New York State Senate, 2020) prohibit the sale of flavored nicotine vaping products.

National youth e-cigarette prevalence in 2020 shows a decline from 2019 to 2018 levels, which were deemed epidemic (Gottlieb, 2018; U.S. Department of Health and Human Services, 2018). An estimated 19.6% of high school students reported past-month e-cigarette use in early 2020, prior to the COVID-19 pandemic shelter-in-place policies (Food and Drug Administration, 2020). Among the 3.6 million students with past-month e-cigarette use, more than 80% used flavored products (Food and Drug Administration, 2020). Although banning sales of e-cigarettes and/or flavored tobacco may reduce adult smokers' options, such policies may also help combat the epidemic of youth e-cigarette use (Hall et al., 2015).

Non-tobacco flavored e-liquids are a primary driver of young people's experimentation with e-cigarettes. In the 2019 National Youth Tobacco Survey, middle and high school students reported flavors as one of their primary reasons for use (Wang et al., 2019). The majority of youth e-cigarette ever-users initiated e-cigarette use with a non-tobacco flavored product (Ambrose et al., 2015). Further, initiation of e-cigarette use with non-tobacco flavored e-liquids is associated with more rapid progression in e-cigarette use frequency (Audrain-McGovern et al., 2019). Flavors appear to increase the reinforcing potential of e-cigarettes, both in conjunction with and independent of nicotine exposure (Kroemer et al., 2018). Hence, restrictions on non-tobacco flavored e-cigarette sales have gained attention in an effort to dissuade young people's e-cigarette use and the development of nicotine-containing e-cigarette dependence.

In the U.S., it is against the law for retailers to sell tobacco products, including e-cigarettes, to people under 21 years of age. Nonetheless, underage consumers in the U.S. frequently purchase vaping products at both brick-and-mortar stores and online stores. In a qualitative

study, underage young adults in southern California reported buying vaping products from stores by using fake IDs and by frequenting retailers they knew did not have strict age verification. Age restrictions on online sales were evaded by using websites without strict verification, by using online delivery services (e.g., Postmates), and by shipping products to an overage friend's home (Schiff et al., 2021). Online age verification is often easy to circumvent. Of the warning letters FDA sent to online retailers selling vaping products in 2018, 29% pertained to selling vaping products to minors (Nguyen et al., 2020). States must enforce the minimum sales age in order to receive full funding from the Substance Abuse and Mental Health Services Administration (Hill, 2020). However, many jurisdictions implemented the minimum sales age prior to the federal law. Policy enforcement is likely stronger in jurisdictions that had enforcement measures in place prior to implementation of the federal law. In addition, the odds of sales violations vary by neighborhood demographics (Dai et al., 2020). Youth who frequently visit convenience stores (D'Angelo et al., 2020) and other retailers that sell tobacco (Trapl et al., 2020) are at increased risk of subsequent e-cigarette use. Stricter retail restrictions, especially restrictions on the non-tobacco flavored products that young people prefer, may therefore decrease young people's tobacco use. Restrictions on flavored products may also discourage young people's e-cigarette use via their potential impact on risk perceptions. Research indicates adolescents view non-tobacco flavored e-cigarettes as less harmful than tobacco e-cigarettes (Ford et al., 2016; Pepper et al., 2016), and current use of non-tobacco flavored e-cigarettes is associated with lower risk perceptions (Cooper et al., 2016; Dai and Hao, 2016).

In sum, flavors increase the appeal of e-cigarettes to young people and may alter their judgment of the risks of e-cigarette use. If flavored e-cigarette sales were further restricted, youth may perceive e-cigarettes as more harmful and may be less likely to initiate use. Prior to the widespread popularity of e-cigarettes, flavored tobacco restrictions in New York City were followed by a decrease in reported flavored tobacco product use among youth (Farley and Johns, 2017). Moreover, research conducted in Massachusetts (Kingsley et al., 2019a; Kingsley et al., 2019b) and Minnesota (Brock et al., 2019) found that restricting the sale of flavored tobacco products (including e-cigarettes, but excluding menthol) to adult-only stores successfully decreased flavored tobacco product availability (Brock et al., 2019; Kingsley et al., 2019a; Kingsley et al., 2019b). Similarly, California youth and young adults who lived in a jurisdiction that restricted flavored tobacco sales were significantly less likely than their peers in other jurisdictions to obtain vaping products from brick-and-mortar retail sources (Gaiha et al., 2021). Reducing youth access to tobacco products can have profound effects on youth tobacco use. A national study estimated that tenth graders' odds of current daily smoking declined 2% for each 1% increase in average retailer compliance with age restrictions (DiFranza et al., 2009). Recent evidence from Massachusetts (Hawkins et al., 2021; Kingsley et al., 2019a) also suggests that restricting the sale of flavored tobacco products reduces youth flavored tobacco product use, including e-cigarette use. Among young adults in Southern California, those living in jurisdictions with weaker tobacco retail licensing policies were more likely to endorse flavors as a reason for e-cigarette use compared to those in jurisdictions with stronger policies (Hong et al., 2019). Lastly, a few studies have evaluated the effects of San Francisco's e-cigarette sales ban on young people's tobacco use. Following the ban, young adults obtained a greater

proportion of their e-cigarettes online or through the mail, or from retailers outside the city, yet flavored e-cigarette use still decreased overall. Combustible cigarette smoking significantly increased, raising concerns that many young adults may have switched to cigarettes when e-cigarettes were less available (Yang et al., 2020). Moreover, a difference-in-difference analysis suggested increased odds of cigarette smoking among San Francisco high school students compared to other districts (Friedman, 2021). Nonetheless, most prior research suggests positive effects of flavored e-cigarette sales restrictions on youth tobacco use. While informative, these studies did not assess the impact of flavored tobacco retail policy on youth e-cigarette risk perceptions.

The present study assessed e-cigarette risk perceptions, attitudes toward flavored tobacco policy, and past-month nicotine vaping (i.e., use of an e-cigarette that contains nicotine) in a sample of young people in 30 major U.S. cities. Ten of the 30 cities prohibit flavored e-cigarette sales. We hypothesized that young people surveyed in the 10 cities with flavored e-cigarette sale restrictions versus the 20 cities without such restrictions would perceive e-cigarettes as riskier, have stronger beliefs in the effectiveness of flavored tobacco policy, and, among ever e-cigarette users, be less likely to report past-month nicotine vaping. We also examined demographic differences to characterize young people in the sample reporting past-month nicotine vaping and past-month retail purchasing of nicotine vaping products.

2. Methods

2.1 Participants and Procedure

Young people (age 13–20) were recruited between August 21, 2020 and November 9, 2020 from 30 U.S. cities that are part of the Advancing Science & Practice in the Retail Environment (ASPiRE) consortium. The cities¹ (median population = 688,531) are located in 23 states. At the origin of the ASPiRE project, 27 cities were members of the Big Cities Health Coalition (BCHC, 2017), two cities were added for representation in the southeast (Memphis, New Orleans), and Providence was added for early adoption of novel retail policies.

Using Qualtrics Research Services, recruitment efforts targeted approximately 30 participants per city, roughly balanced on age group (50% age 13–17 vs. 50% age 18–20) and ever e-cigarette use (50% yes and 50% no). Recruitment quotas were adjusted as needed to ensure enrollment of approximately 30 participants per city. After a brief online screener, eligible participants completed an online survey of their e-cigarette perceptions and use behavior. Participants were compensated in the form of e-rewards money or points that can be exchanged for gift cards or bank transfers.

¹Atlanta, GA, Baltimore, MD, Boston, MA, Charlotte, NC, Chicago, IL, Cleveland, OH, Dallas, TX, Denver, CO, Detroit, MI, Fort Worth, TX, Houston, TX, Kansas City, MO, Las Vegas, NV, Los Angeles, CA, Memphis, TN, Miami, FL, Minneapolis, MN, New Orleans, LA, New York, NY, Oakland, CA, Philadelphia, PA, Phoenix, AZ, Portland, OR, Providence, RI, Sacramento, CA, San Antonio, TX, San Diego, CA, San Francisco, CA, Seattle, WA, and Washington, D.C.

2.2 Measures

2.2.1 Policy coding.—E-cigarette policies (including temporary restrictions) in each city at the time of data collection were derived from the Campaign for Tobacco-Free Kids (Campaign for Tobacco Free Kids, 2020b) and supplemented with media sources to determine policy effective dates. Cities were categorized as having a sales restriction on flavored e-cigarettes or no sales restriction on flavored e-cigarettes, based on state and local policies. Dates of state and local Tobacco 21 laws (where applicable) were obtained from the Campaign for Tobacco-Free Kids (Campaign for Tobacco Free Kids, 2020a) and from the Preventing Tobacco Addiction Foundation (Preventing Tobacco Addiction Foundation, 2021). State e-cigarette tax was obtained from the Centers for Disease Control and Prevention State Tobacco Activities Tracking and Evaluation (STATE) System (Centers for Disease Control and Prevention, 2021). Chicago has a city-level e-cigarette tax (The Civic Federation, 2016) and was therefore coded as having an e-cigarette tax. A variable was created to reflect cities' state or local laws raising the minimum legal sales age for tobacco to 21 before the federal law, because such cities likely have stronger infrastructure for enforcing the federal Tobacco 21 law. Cities were coded as 0 (no Tobacco 21 law prior to the federal law), 1 (either state or local law prior to the federal law), or 2 (both state and local laws prior to the federal law).

2.2.2 E-cigarette Risk Perceptions, Policy Attitudes, and Past-Month Nicotine Vaping.—A 3-item measure assessed e-cigarette risk perceptions: 1) “How much do you think people harm themselves when they use e-cigarettes?” (1 = no harm; 4 = a lot of harm), 2) “In your opinion, is using e-cigarettes risky for one’s health?” (1 = not at all, 3 = yes), 3) “How risky are e-cigarettes?” (1 = not at all risky, 5 = very risky) (Katz et al., 2020). E-cigarette risk perceptions were scored as a composite measure ($\alpha = .78$) according to published scoring guidelines (Katz et al., 2020), with scores ranging from 0.78 (low perceived risk) to 3 (high perceived risk). Four items measured policy attitudes: “Eliminating the sale of *flavored e-cigarettes / flavored tobacco* will help prevent youth from using tobacco products;” “The sale of *flavored e-cigarettes / flavored tobacco* should not be allowed” (1 = strongly disagree; 4 = strongly agree) (Feld et al., under review). The four policy attitudes items were averaged (Cronbach’s $\alpha = .81$). All participants self-reported lifetime use of a vaping device to consume: nicotine, flavor without nicotine, CBD, marijuana, or other/unknown, selecting all that apply or indicating never having used a vaping device. For each selected substance, participants reported whether they had vaped the substance in the past 30 days (yes/no). Participants with past-month nicotine vaping reported all past-month flavor use (fruit, menthol, mint/ice/frost, candy/dessert/other sweets, tobacco, other). Participants who reported past-month e-cigarette use were categorized as ever e-cigarette users.

2.2.3. Retail Purchasing and Perceived Access.—Participants with past-month flavor use reported where they had obtained flavored e-liquid, selecting all applicable options: vape, smoke, or head shop; another type of store; online store or website; family member; used a friend’s device; gave someone money to buy products; other (Feld et al., under review). Participants were considered to have purchased vaping products in-store if they reported purchasing from a vape/smoke/head shop and/or “another type of store.”

Among all participants, two items measured ease of purchasing flavored vaping products and flavored e-liquid (1 = very hard, 4 = very easy) (Feld et al., under review).

2.2.4 Demographic characteristics.—Participants self-reported their age, race/ethnicity (categorized into non-Hispanic white, Black, other or unknown, multiple), gender (male/man, female/woman, transgender or other gender identity), sexual identity (heterosexual/straight, gay/lesbian, bisexual, something else), family finances (live comfortably, meet needs with a little left over, just meet basic expenses, don't meet basic expenses), and city of residence.

2.3 Analyses

For each of the three outcome variables (risk perceptions, policy attitudes, and past-month nicotine vaping), null models were estimated to determine whether there was significant between-city variance in each outcome. For outcomes with significant variation between cities, generalized estimating equations (GEE) tested differences in the outcome as a function of city-level e-cigarette flavor policy, with individuals clustered by city. Bivariate analyses tested associations between those outcome measures and potential covariates at both the city level (adult smoking prevalence, median household income, e-cigarette tax, Tobacco 21 policy, located in Texas [yes/no], located in California [yes/no]) and individual level (age, gender identity, sexual identity, race/ethnicity, family finances). Location in California and Texas were tested as potential city-level covariates because we sampled from multiple cities in California and Texas, where state-level tobacco policy and enforcement may be a confounder. City-level and individual-level covariates that were significantly related to an outcome in bivariate analyses were included in the adjusted GEE model examining that outcome.

Among ever-vapers, GEE models, with participants clustered by city, also examined associations of participant characteristics with past-month nicotine vaping (yes/no) and, among past-month nicotine vapers, purchase of vaping products at a brick-and-mortar retail location (yes/no). Each characteristic was tested in relation to past-month nicotine vaping and in-store purchasing in separate GEE models. Because these analyses were exploratory, we did not adjust for multiple comparisons.

3. Results

3.1 Participant Characteristics

The sample (N=900, age M=17.7 [SD=1.8]) was 60.2% female identifying as 29.3% Black, 27.6% multiracial/multiethnic, 23.6% non-Hispanic White, and 19.6% other race/ethnicity. Most participants (74.1%) were heterosexual; 15.0% were bisexual, 4.9% were gay or lesbian, and 6.0% were another sexual identity. Over half (57.0%) reported their family lived comfortably. With purposeful oversampling, 44.6% of participants reported ever using an e-cigarette; 11.8% reported vaping nicotine in the past month (26.4% of participants who reported ever vaping). A minority (30.0%) lived in a city with a state or local policy prohibiting retail sales of non-tobacco flavored e-cigarettes at the time of data collection. E-cigarette perceptions reflected moderately high perceived risk of e-cigarettes (M=2.50,

SD=.51, range = .78–3.00). Participants reported moderately strong beliefs that flavored tobacco sales should not be allowed and that retailer policies to prohibit flavored tobacco product sales are effective in preventing youth tobacco use ($M=2.75$, $SD=.75$, range = 1–4). Participant characteristics by city-level e-cigarette policy are presented in Table 1.

3.2 Associations of City-Level E-Cigarette Policy with Individual Perceptions and Behavior

Risk perceptions and policy attitudes had intraclass correlation coefficients (ICCs) < 0.001 , indicating that participants' city of residence did not account for a meaningful portion of the variance in risk perceptions or policy attitudes. Hence, tests of city-level e-cigarette policy on risk perceptions and policy attitudes were not run. Among ever-vapers, a null model of past-month nicotine vaping estimated a between-city variance of 0.27. Therefore, analyses of past-month nicotine vaping accounted for clustering by city. Adjusting for participants' age and race/ethnicity, which were significantly associated with past-month nicotine vaping among ever-vapers in bivariate analyses, e-cigarette flavor policy was not associated with the likelihood of past-month nicotine vaping among ever-vapers ($B=.07$, $p=.784$). Full GEE model results are presented in Supplemental Table 1.

3.3 Characteristics of Young People with Past-Month Nicotine Vaping

Participant characteristics are presented by past-month vaping nicotine vaping among those who had ever vaped ($n=401$), in Table 2. Full results from all GEE models are presented in Supplemental Table 2. On average, young people who vaped nicotine in the past month were significantly older than those who had not ($B=.19$, $p=.016$). Likelihood of past-month nicotine vaping also differed by race/ethnicity (Wald chi-square = 16.36, $p < .001$). Specifically, compared to non-Hispanic white participants, Black participants ($B = -1.36$, $p < .001$) were less likely to have vaped nicotine. Gender (Wald chi-square = 1.32, $p = .517$), sexual identity (Wald chi-square = 1.45, $p = .694$), and family finances (Wald chi-square = 1.78, $p = .411$) were not associated with past-month nicotine vaping among ever-vapers.

Past-month nicotine vaping was more likely among participants who had ever vaped marijuana ($B = .50$, $p = .029$), but not flavor-only e-liquid ($B = .10$, $p = .689$) or CBD ($B = -.06$, $p = .828$). Past-month nicotine vaping was also more likely among those with lower harm perceptions ($B = -.85$, $p < .001$). Participants who vaped nicotine were significantly more likely to see vaping ads in convenience stores, supermarkets, or gas stations ($B = .63$, $p = .018$), but did not reach statistical significance for ad exposure in smoke/vape/head shops ($B = .56$, $p = .069$) or online ($B = .44$, $p = .060$). Having more friends with past-month nicotine vaping ($B = .47$, $p < .001$) and cannabis vaping ($B = .19$, $p = .004$), living with someone who vapes ($B = .89$, $p < .001$), and positive vaping attitudes of important others ($B = -.28$, $p = .004$) each was associated with a greater likelihood of vaping nicotine in the past month.

Likelihood of past-month vaping was not associated with perceived ease of accessing flavored vaping products ($B = -.19$, $p = .449$) or flavored e-liquid ($B = .10$, $p = .701$). Participants with greater self-perceived addiction to e-cigarettes were more likely to report

past-month vaping ($B = .04, p < .001$), and those with stronger beliefs in the effectiveness of flavored tobacco policy were less likely to report vaping ($B = -.77, p < .001$).

3.4 Characteristics of Young People with Past-Month Nicotine Vaping who Purchased Vaping Products In-Store

Among participants with past-month nicotine vaping, a null model of in-store purchasing estimated a between-city variance of 0.25; therefore, GEE models accounted for clustering by city. Full results from all GEE models are presented in Supplemental Table 3. A majority of young people with past-month nicotine vaping purchased vaping products in retail stores (58.5%, $n=62$). Young people who did versus did not purchase vaping products in-store did not significantly differ in age, race/ethnicity, gender identity, sexual identity, family finances, lifetime cannabis vaping, lifetime flavor-only e-liquid vaping, e-cigarette risk perceptions, exposure to vaping ads in any venue, friends' past-month nicotine or cannabis vaping, living with someone who vapes, positive vaping attitudes of important others, perceived ease of accessing vaping products, self-perceived addiction to e-cigarettes, or policy attitudes (p -values $> .05$). Young people who purchased in-store were more likely to use fruit-flavored (71.0% vs. 50.0%; $B = .89, p = .030$) and menthol-flavored (40.3% vs. 20.5%; $B = .97, p = .034$) vaping products than those who did not purchase in-store. Likelihood of using mint/ice/frost ($B = .50, p = .223$), candy/dessert/sweets ($B = .48, p = .285$), and tobacco ($B = -.67, p = .167$) flavored products did not differ between those who did versus did not purchase vaping products in-store. In addition to purchasing vaping products in stores, participants reported using friends' vaping products (30.2%), giving someone money to purchase vaping products (20.8%), buying vaping products online (17.0%), or receiving vaping products from family (8.5%).

4. Discussion

Tobacco retail policies prohibiting flavored e-cigarette sales (or all e-cigarettes, as is the case for San Francisco) may benefit young people by decreasing access to kid-friendly products; however, the influence of such policy on young people's e-cigarette risk perceptions is unknown. Contrary to hypotheses, local e-cigarette flavor policy was not associated with e-cigarette risk perceptions, policy attitudes, or past-month nicotine vaping among young people in 30 U.S. cities. Young people who reported past-month nicotine vaping had lower harm perceptions and viewed flavored tobacco policy as less effective, compared to those without past-month nicotine vaping. More than half of young people with past-month nicotine vaping reported purchasing vaping products at a retail location, including vape/smoke/head shops that are restricted to adults in some cities.

To our knowledge, this study was the first to examine associations between city-level tobacco retail policy and individual young people's e-cigarette risk perceptions. We proposed that risk perceptions are a plausible means by which tobacco retail policy could decrease underage e-cigarette use. Adolescents' e-cigarette risk perceptions are sensitive to societal changes, such as the 2019 outbreak of e-cigarette and vaping-associated lung injury (EVALI) (Moustafa et al., 2021), and higher risk perceptions are associated with lower likelihood of e-cigarette use (Dai and Hao, 2016). If flavored products were not widely

available for purchase, use of such products may seem less normative and less acceptable, thereby increasing support for flavored tobacco policy and decreasing susceptibility to use among non-users. However, this study did not find support for a link between e-cigarette flavor policy and young people's thoughts about e-cigarettes.

Current events may have increased young people's risk perceptions across cities. Data were collected after the 2019 EVALI outbreak and during the COVID-19 pandemic. Prior to COVID-19, a prospective cohort survey of Philadelphia high school students found that youth with past-month nicotine vaping prior to the EVALI outbreak had a greater increase in risk perceptions during the outbreak than youth who had not vaped (Moustafa et al., 2021). Findings suggest that personal relevance of EVALI may have influenced young people's response to new information about the risks of vaping. Moreover, a May 2020 U.S. survey of young people (age 13–24) found that 25% of participants who decreased or quit their nicotine vaping cited concerns about lung health as a reason for decreasing vaping (Gaiha et al., 2020). Results of the present study should be interpreted in the context of the unique time period in which data were collected, during which the importance of respiratory health was highly salient to young people.

Lack of associations between e-cigarette flavor policy and e-cigarette risk perceptions, policy attitudes, and past-month vaping do not indicate that e-cigarette retail policy is ineffective. New evidence from Massachusetts showed that local flavored tobacco sales restrictions were associated with reduced likelihood of vaping among youth (Hawkins et al., 2021). Policy must be consistently and effectively enforced in order to prevent underage access to products. A 2016–2018 investigation of the FDA compliance inspection database found widespread sales of vaping products to minors, especially flavored products and especially in urban areas (Dai et al., 2020). Policy may not impact young people's risk perceptions if it is not consistently enforced. Young people may evade restrictions by purchasing products online or outside their city of residence, and retailers may sell flavorings and nicotine separately. In this study, data were collected during the COVID-19 pandemic, when tobacco control resources were redirected to manage the pandemic. Additionally, e-cigarette flavor policy may impact young people through mechanisms other than risk perceptions. Simply decreasing access may discourage youth use, without strong effects on perceptions of e-cigarettes. Importantly, all participants were under age 21, the legal age to purchase vaping products nationally. Federal policy may have had a stronger effect on vaping-related perceptions and behavior than local flavor policy, though the current study cannot address questions of the relative strength of federal and local policies.

Characteristics of young people who vaped nicotine in the past month were largely consistent with the extant literature. Consistent with a systematic review of the demographic characteristics of youth who vape, past-month nicotine vapers in this study were older and were more likely to be non-Hispanic white than Black, with no clear pattern regarding socioeconomic status (Hartwell et al., 2016). Contrary to the systematic review, males were not more likely to vape nicotine (Hartwell et al., 2016). A recent study found greater prevalence of ever vaping among sexual minority youth, but consistent with the present study, past-month vaping was not associated with sexual identity (Garcia et al., 2021). Current vaping was associated with greater likelihood of exposure to e-cigarette ads in

convenience stores, supermarkets, and gas stations. Consistent with this finding, a systematic review concluded that exposure to e-cigarette marketing is associated with e-cigarette use among young people (Collins et al., 2018). Also consistent with prior research (Barrington-Trimis et al., 2015), young people with current vaping reported greater use of e-cigarettes and approval of e-cigarettes in their social environments. As expected, participants with current nicotine vaping had lower harm perceptions and believed less strongly in the effectiveness of flavored tobacco policy, although they did not differ in perceived ease of accessing vaping products.

Notably, half of participants with past-month nicotine vaping reported purchasing flavored products from a vape, smoke, or head shops, despite being under the legal vaping age. This finding is consistent with the International Tobacco Control Policy Evaluation Project Youth Tobacco and Vaping Survey. Vape shops were the most common purchase location of vaping products among underage users in the U.S, with more than half (58.5%) of underage, past-year users reporting purchasing vaping products from a vape shop in the past year (Braak et al., 2020). Taken together, findings suggest that U.S. youth are able to access vaping products at specialty shops. In this study, a sizable proportion of youth with past-month vaping (24.5%) reported purchasing vaping products from a store that was not a vape, smoke, or head shop. Adolescents who regularly visit convenience stores regularly or stop at retail stores before or after school are more likely to use e-cigarettes, potentially due to point-of-sale marketing exposure (D'Angelo et al., 2020; Trapl et al., 2020). Convenience stores greatly outnumber vape shops in metropolitan areas (Berg et al., 2020) and both may expose youth to vaping ads and purchase opportunities. In this study, youth in cities both with and without a sales restrictions on flavored e-cigarettes reported purchasing vaping products from retail sources. Those who purchased vaping products from a store were more likely to use fruit- and menthol-flavored vaping products than those who did not purchase their products in the retail environment, suggesting that fruit- and menthol-flavored products were appealing and available in stores. Compared to the 2020 National Youth Tobacco Survey, fewer participants with past-month vaping in this study received their vaping products from a friend (57.1% of high school students and 58.9% of middle school students vs. 30.2% in this study), and more participants purchased vaping products from vape shops (50.9% in this study vs. 17.5% of high school students and 9.1% of middle school students) and online (17.0% in this study vs. 5.4% of high school students and 8.4% of middle school students) (Wang et al., 2021). Discrepancies may be due to all participants in this study residing in urban areas, as well as slight differences in item wording (e.g., “vape shop” versus “vape, smoke, or head shop”) and differences in age group (i.e., middle and high school students versus young people age 13–20).

4.1 Limitations and Future Directions

This study oversampled e-cigarette users in order to examine interactions between e-cigarette use and policy. Therefore, this study could not examine differences in lifetime e-cigarette use prevalence by policy. Future research could examine lifetime e-cigarette use prevalence in addition to risk perceptions and policy attitudes. All survey measures in this study were self-reported and are subject to bias. Other data sources, such as the FDA compliance inspection database (Dai et al., 2020), are needed to fully understand

underage purchasing of vaping products. This study did not assess participants' awareness of e-cigarette flavor policy in their city. Future research could examine whether policy differentially affects young people who are aware versus unaware of the policy. Although the sample was diverse in geographic location, gender, and race/ethnicity, it is not representative of adolescents in the urban United States. This study focused on e-cigarette use because of its popularity among young people. Future research could examine e-cigarette risk perceptions in association with use of other tobacco products (e.g., cigarettes).

4.2 Conclusions

In a sample of young people from 30 U.S. cities, e-cigarette flavor policy was not associated with young people's e-cigarette risk perceptions, attitudes toward flavored tobacco product policy, or likelihood of past-month nicotine vaping. More than half of young people with past-month nicotine vaping reported purchasing vaping products from vape, smoke, or head shops, suggesting widespread underage access to specialty shops. Flavored e-cigarette policy must be consistently enforced to decrease underage access to flavored vaping products.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- E-cigarette flavor policies may affect young people's perceptions of e-cigarettes.
- We examined vaping perceptions and behavior among young people in 30 U.S. cities.
- Most young people with past-month nicotine vaping purchased products in-store.
- Local policies were not associated with vaping perceptions or behavior.
- Enforcement of flavored e-cigarette policy may have varied across cities.

Table 1.

Participant characteristics by city-level e-cigarette flavor policy, N=900

	Flavored E-Cigarette Sales Ban (n=10 cities, 270 participants)	No E-Cigarette Flavor Ban (n=20 cities, 630 participants)	Full Sample (N=900 participants)
Age	17.90 (1.80)	17.66 (1.79)	17.73 (1.80)
Race/ethnicity			
Non-Hispanic white	51 (18.9%)	161 (25.6%)	212 (23.6%)
Black	76 (28.1%)	188 (29.8%)	264 (29.3%)
Multiple races/ethnicities	67 (24.8%)	181 (28.7%)	248 (27.6%)
Other or unknown race/ethnicity	76 (28.1%)	100 (15.9%)	176 (19.6%)
Ever e-cig use (yes/no)	122 (45.2%)	279 (44.3%)	401 (44.6%)
Gender			
Male/man	106 (39.3%)	208 (33.0%)	314 (34.9%)
Female/woman	146 (54.1%)	396 (62.9%)	542 (60.2%)
Transgender or other gender identity	18 (6.7%)	26 (4.1%)	44 (4.9%)
Sexual identity			
Heterosexual (straight)	199 (73.7%)	468 (74.3%)	667 (74.1%)
Gay or lesbian	12 (4.4%)	32 (5.1%)	44 (4.9%)
Bisexual	44 (16.3%)	91 (14.4%)	135 (15.0%)
Something else or unsure	15 (5.6%)	39 (6.2%)	54 (6.0%)
Family finances (n=894)			
Live comfortably	148 (55.4%)	362 (57.7%)	510 (57.0%)
Meet needs with a little left over	62 (23.2%)	142 (22.6%)	204 (22.8%)
Just meet or don't meet basic expenses	57 (21.3%)	123 (19.6%)	180 (20.1%)
Substances vaped (in lifetime)			
Nicotine	59 (21.9%)	159 (25.2%)	218 (24.2%)
In past 30 days (N/% yes)	30 (11.1%)	76 (12.1%)	106 (11.8%)
Flavor-only	36 (13.3%)	106 (16.8%)	142 (15.8%)
CBD	32 (11.9%)	88 (14.0%)	120 (13.3%)
In past 30 days (N/% yes)	9 (3.3%)	27 (4.3%)	36 (4.0%)
Cannabis	71 (26.3%)	178 (28.3%)	249 (27.7%)
In past 30 days (N/% yes)	33 (12.2%)	74 (11.7%)	107 (11.9%)
Other/unknown	9 (3.3%)	8 (1.3%)	17 (1.9%)
E-cig risk perceptions (n=897)	2.51 (.51)	2.49 (.51)	2.50 (.51)
E-cig marketing exposure [†]			
Internet (n=877)	118 (44.9%)	265 (43.2%)	383 (43.7%)
Convenience store, supermarket, or gas station (n=897)	172 (65.2%)	395 (64.2%)	567 (64.5%)
Smoke or vape shop (n=562)	125 (74.4%)	270 (68.5%)	395 (70.3%)
Social environment			
Close friends (0–5) with past-month e-cigarette use (n=870)	1.50 (1.59)	1.59 (1.63)	1.56 (1.62)

	Flavored E-Cigarette Sales Ban (n=10 cities, 270 participants)	No E-Cigarette Flavor Ban (n=20 cities, 630 participants)	Full Sample (N=900 participants)
Close friends (0–5) with past-month marijuana vaping (n=865)	1.80 (1.69)	1.78 (1.78)	1.79 (1.75)
Household member vapes (yes/no)	41 (15.2%)	114 (18.1%)	155 (17.2%)
Close others' attitudes toward vaping (1 = very positive, 5 = very negative)	3.54 (1.10)	3.46 (1.14)	3.48 (1.13)
Ease of access (N/% somewhat or very easy)			
Flavored vaping products	151 (72.9%)	340 (71.9%)	491 (72.2%)
Flavored e-liquid	133 (70.0%)	309 (69.6%)	442 (69.7%)
Perceived e-cig addiction (0–100%) ^{&}	33.65% (32.14%)	31.13% (32.85%)	31.79% (32.61%)
Past-month flavor use [€]			
Fruit	18 (60.0%)	48 (63.2%)	66 (62.3%)
Menthol	9 (30.0%)	25 (32.9%)	34 (32.1%)
Mint, ice, or frost	9 (30.0%)	32 (42.1%)	41 (38.7%)
Candy, dessert, or other sweets	7 (23.3%)	23 (30.3%)	30 (28.3%)
Tobacco	6 (20.0%)	16 (21.1%)	22 (20.8%)
Other	10 (33.3%)	22 (28.9%)	32 (30.2%)
Source of flavored e-liquid [€]			
Vape, smoke, or head shop	17 (56.7%)	37 (48.7%)	54 (50.9%)
In the city/town of residence (N/% yes)	11 (64.7%)	28 (75.7%)	39 (72.2%)
Another type of store	8 (26.7%)	18 (23.7%)	26 (24.5%)
Online store or website	6 (20.0%)	12 (15.8%)	18 (17.0%)
Family member	1 (3.3%)	8 (10.5%)	9 (8.5%)
Used a friend's	11 (36.7%)	21 (27.6%)	32 (30.2%)
Gave someone money to buy them	7 (23.3%)	15 (19.7%)	22 (20.8%)
Policy attitudes (1 = strongly disagree, 4 = strongly agree)	2.80 (.77)	2.73 (.74)	2.75 (0.75)

[†] N/% sometimes, most of the time, or always, among those who use/visit each outlet

[&] Among participants who have ever used an e-cigarette (n=401 ever-users, n=209 responded)

[€] Among participants who vaped nicotine in the past 30 days (n=106)

Table 2.

Participant characteristics by past-month nicotine vaping among those who had ever vaped (n=401)

	No past-month vaping (n=293)	Past-month Vaping (n=106)	All ever-vapers (N=401)
Age*	17.9 (1.6)	18.4 (1.5)	18.1 (1.6)
Race/ethnicity***			
Non-Hispanic white	65 (22.2%)	40 (37.7%)	105 (26.2%)
Non-Hispanic Black	95 (32.4%)	15 (14.2%)	111 (27.7%)
Other or unknown	50 (17.1%)	16 (15.1%)	66 (16.5%)
Multiple	83 (28.3%)	35 (33.0%)	119 (29.7%)
Gender			
Male/man	91 (31.1%)	39 (36.8%)	130 (32.4%)
Female/woman	187 (63.8%)	61 (57.5%)	250 (62.3%)
Transgender or other gender identity	15 (5.1%)	6 (5.7%)	21 (5.2%)
Sexual identity			
Heterosexual (straight)	194 (66.2%)	73 (68.9%)	269 (67.1%)
Gay or lesbian	20 (6.8%)	6 (5.7%)	26 (6.5%)
Bisexual	61 (20.8%)	18 (17.0%)	79 (19.7%)
Something else or unsure	18 (6.1%)	9 (8.5%)	27 (6.7%)
Family finances (n=396)			
Live comfortably	148 (51.0%)	61 (58.7%)	210 (53.0%)
Meet needs with a little left over	72 (24.8%)	22 (21.2%)	95 (24.0%)
Just meet or don't meet basic expenses	70 (24.1%)	21 (20.2%)	91 (23.0%)
Substances vaped (in lifetime)			
Flavor-only	96 (32.8%)	37 (34.9%)	134 (33.4%)
CBD	75 (25.6%)	26 (24.5%)	101 (25.2%)
In past 30 days (N/% yes)	22 (7.5%)	10 (9.4%)	32 (8.0%)
Cannabis*	135 (46.1%)	62 (58.5%)	198 (49.4%)
In past 30 days*** (N/% yes)	49 (16.7%)	45 (42.5%)	94 (23.7%)
E-cig risk perceptions*** (n=398)	2.39 (.53)	2.13 (.55)	2.32 (.55)
E-cig marketing exposure [†]			
Internet (n=389)	119 (41.6%)	53 (52.5%)	174 (44.7%)
Convenience store, supermarket, or gas station* (n=389)	181 (63.5%)	78 (76.5%)	260 (66.8%)
Smoke or vape shop (n=322)	163 (72.4%)	78 (82.1%)	243 (75.5%)
Social environment			
Close friends (0–5) who vaped in past month*** (n=396)	1.85 (1.61)	3.11 (1.53)	2.19 (1.68)
Close friends' cannabis vaping** (n=392)	2.26 (1.74)	2.84 (1.74)	2.42 (1.76)
Household vaping (N/% yes)***	68 (23.2%)	45 (42.5%)	113 (28.2%)
Close others' attitudes***	3.27 (1.16)	2.92 (1.05)	3.17 (1.14)
Ease of access (N/% somewhat or very easy)			
Flavored vaping products (n=360)	174 (68.2%)	66 (64.1%)	241 (66.9%)

	No past-month vaping (n=293)	Past-month Vaping (n=106)	All ever-vapers (N=401)
Flavored e-liquid (n=346)	158 (64.5%)	66 (66.7%)	226 (65.3%)
Perceived e-cig addiction (0–100%) ^{***} (n=209)	14.16% (23.58%)	48.48% (31.21%)	31.79% (32.61%)
Past-month flavor use [€]			
Fruit	-	66 (62.3%)	-
Menthol	-	34 (32.1%)	-
Mint, ice, or frost	-	41 (38.7%)	-
Candy, dessert, or other sweets	-	30 (28.3%)	-
Tobacco	-	22 (20.8%)	-
Other	-	32 (30.2%)	-
Source of flavored e-liquid			
Vape, smoke, or head shop	-	54 (50.9%)	-
In the city/town of residence (N/% yes)	-	39 (72.2%)	-
Another type of store	-	26 (24.5%)	-
Online store or website	-	18 (17.0%)	-
Family member	-	9 (8.5%)	-
Used a friend's	-	32 (30.2%)	-
Gave someone money to buy them	-	22 (20.8%)	-
Policy attitudes ^{***}	2.60 (.70)	2.21 (.76)	2.50 (0.74)

[†] N/% sometimes, most of the time, or always, among those who use/visit each outlet

* p < .05

** p < .01

*** p < .001