Preventive Medicine Reports 30 (2022) 101997

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Short communication

Policies restricting flavors and non-cigarette tobacco product availability: A study of vape shops in San Francisco and Alameda Counties, California, USA

Vira Pravosud [a,*], Louisa M. Holmes [b], Lauren K. Lempert [a], Pamela M. Ling [a,c,*]

[a] University of California in San Francisco, Center for Tobacco Control Research and Education, 530 Parnassus Avenue, San Francisco CA 94143, USA
[b] The Pennsylvania State University, Departments of Geography and Demography, 302 Walker Building, University Park, PA 16802, USA
[c] University of California in San Francisco, Division of General Internal Medicine, Department of Medicine, School of Medicine, 505 Parnassus Avenue, San Francisco, CA 94143, USA

ARTICLE INFO

Keywords:
Flavored sales restrictions
Non-cigarette tobacco products
Vape shops

ABSTRACT

We examined flavored non-cigarette tobacco availability in brick-and-mortar vape shops in San Francisco (SF) and Alameda Counties, California (USA), comparing cities organized by flavored tobacco sales restriction policy. A total of 22 brick-and-mortar vape shops were identified and audited in October-November 2019; shops were located in SF City-County and nine cities in Alameda County. Fisher Exact Tests were used to assess differences in the availability of products between vape shops in cities *with* versus *without* comprehensive or partial flavored tobacco sales restrictions enacted before November 21, 2019 (n = 15 shops in six cities *with* policies vs n = 7 shops in four cities *without* policies). In the six cities *with* any flavored sales restrictions, fewer vape shops sold menthol/mint flavored JUUL pods (27% vs 71%, p = 0.074), candy/fruit (53% vs 100%, p = 0.051) and menthol/mint (53% vs 100%, p = 0.051) nicotine e-cigarette liquids compared to cities *without* flavored tobacco sales restrictions, but results were borderline significant. Tobacco-flavored JUUL pods (47% vs 71%, p = 0.381), tobacco-flavored nicotine e-cigarette liquids (67% vs 100%, p = 0.135), and flavored e-cigarette liquids *without* nicotine (candy/fruit: 87% vs 71%, p = 0.565 and menthol/mint: 87% vs 57%, p = 0.274) were not included in the policies, and availability was not significantly different between cities *with* or *without* policies. Enactment of local policies was associated with lower flavored e-cigarette tobacco product availability but not tobacco-flavored or non-nicotine product availability; federal policies restricting sales of flavored tobacco products may reduce access to flavored e-cigarette products in vape shops.

1. Introduction

Electronic nicotine delivery systems (ENDS, colloquially known as electronic cigarettes – "e-cigarettes") are the most popular tobacco product among high school students in California (Zhu et al. 2019) and the U.S. overall (Arrazola et al. 2015). Many students cite the ease of obtaining ENDS, including at retail stores, with vape shops (stores that primarily sell ENDS products) being the most common retail source (Zhu et al. 2019). Vape shops offer a large variety of devices (Zhu et al. 2014), including pre-filled cartridges that may resemble cigarettes ("cig-a-like's"), "pod" e-cigarette devices, refillable pen-shaped e-cigarette, and advanced modifiable "mod" e-cigarettes that can be customized to preferences for battery size, temperature, or voltage. E-cigarettes are available in numerous flavors (Zhu et al. 2014), and offering a large selection of flavors, including unique or custom flavors, is a defining feature of vape shops (Sussman et al. 2014). Flavors of e-cigarette liquids increase appeal to youth, who are more likely to initiate tobacco use with flavored products (Ambrose et al. 2015). During 2016–2018, there was an increase in the number of e-cigarette users among California high school students, with the majority (86.4%) reporting use of flavored e-cigarettes, most commonly "fruit or sweet" (77.2%) and mint (16%) flavors (Zhu et al. 2019).

In the absence of federal and statewide restrictions on sales of flavored non-cigarette tobacco, San Francisco (SF; population size of 815,201 as of July 1, 2021 (U.S. Census Bureau)), a consolidated city-county in California (SF), enacted a comprehensive policy, effective

* Corresponding authors.
E-mail addresses: vira.pravosud@ucsf.edu (V. Pravosud), lmholmes@psu.edu (L.M. Holmes), Lauren.Lempert@ucsf.edu (L.K. Lempert), Pamela.Ling@ucsf.edu (P.M. Ling).

https://doi.org/10.1016/j.pmedr.2022.101997
Received 18 April 2022; Received in revised form 14 August 2022; Accepted 17 September 2022
Available online 19 September 2022

July 2018, prohibiting sales of all tobacco products with characterizing flavors other than tobacco; however, non-nicotine e-cigarettes and liquids are exempt from the state policy because they do not fit the definition of "tobacco products" under the policy (Vyas et al. 2021). In addition, some cities in neighboring Alameda County (population size of 1,648,556 as of July 1, 2021 (U.S. Census Bureau)) also adopted flavored sales restrictions between 2015 and 2018, but not all were comprehensive (Holmes, Lempert, and Ling 2022). Some local policies exempted menthol flavor (San Leandro), adult tobacco shops (Oakland), tobacco retailers that had operated before the city's flavored tobacco sales restrictions, effective July 2014 (Hayward), or retailers located within 600 feet of schools (Berkeley) (Holmes, Lempert, and Ling 2022). Compared to surveillance of conventional tobacco retailers (Rogers et al., 2021), fewer studies have investigated impacts of local flavored sales restrictions within the vape shop environment, which is likely due to the lack of sales surveillance of vape shops conducted by sales-tracking companies (Ali et al. 2022) or due to a low number of stores per jurisdiction. A study of a random sample of California licensed tobacco retailers in matched communities, while excluding SF, reported reduced availability of flavored e-cigarette products in localities with versus without flavored sales restrictions; but vape shops, tobacco shops and headshops were collapsed in one category due to small cell sizes (Andersen-Rodgers et al. 2021). After adjusting for flavored sales restrictions, Welwean et al. (2022) reported no differences in flavored non-cigarette tobacco availability for vape shops and tobacco shops combined. The current study aimed to compare flavored non-cigarette tobacco availability in brick-and-mortar vape shops in SF and Alameda County cities *with* versus *without* flavored sales restrictions in November 2019. The experience of the two California counties will inform other jurisdictions and countries that plan on adopting similar flavored tobacco sales policies.

2. Methods

2.1. Study design and data collection

According to the vape shop (vSTARS) surveillance tool (Counter Tobacco), "vape shops" were defined as stores that were exclusively or primarily selling e-cigarettes such as pen-shaped e-cigarettes, tanks, mods, e-hookahs, advanced systems and their accompanying components, e-cigarette liquids/juices or cartridges/pods; though not a requirement, these stores could have a vaping lounge or vaping bar included. Vape shops were identified using a keyword search (e.g., "vap*") of the complete list of licensed tobacco retailers in the two counties, which we obtained from the County Departments of Health and triangulated with a list of vape shops we had compiled for a prior study in 2015 (n = 67 self-identified stores on Yelp, with 32 vape shops that exclusively sold ENDS and 22 more stores that also carried other tobacco products) (Burbank, Thrul, and Ling 2016), wherein we visited and confirmed the operation and exclusive nature of each shop. We further used Yelp and Google searches and direct calls to the shops to verify the updated list in 2019. Three trained research assistants in pairs conducted in-person store audits via store observations (during October-November 2019) of 22 stores that were exclusively or primarily vape shops with physical addresses in San Francisco and nine Alameda County cities (see Fig. 1). Any discrepancies in the observational estimates were closely checked by one of the study's investigators, and then discussed and resolved through consensus.

2.2. Measures

The survey instrument included binary (yes/no) questions about store type (e.g., retail only or including a lounge/bar) and the presence

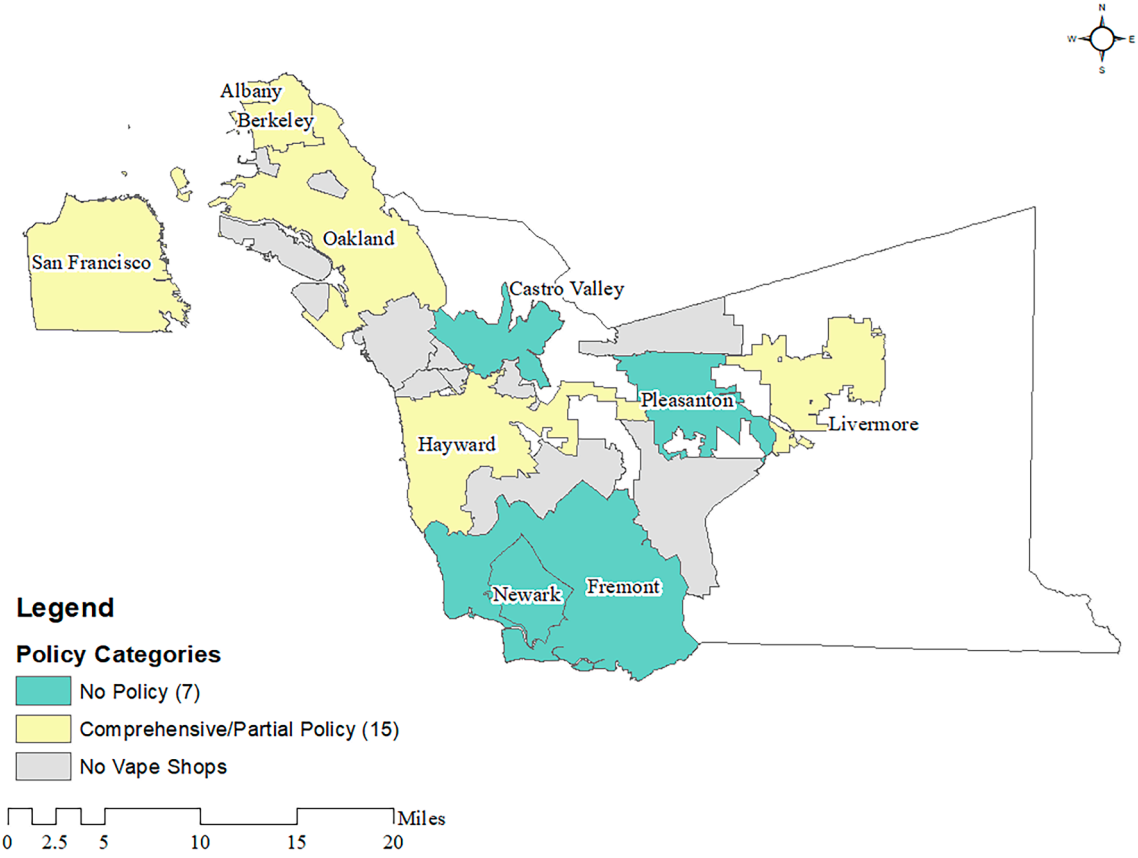

Fig. 1. Color-coded classification of San Francisco and Alameda County cities by flavored tobacco sales restrictions effective as of November 21, 2019; and the number of vape shops audited per flavor policy category.

of the minimum age-of-entry signage displayed on the store's exterior (effective June 9th, 2016, California's Tobacco 21 law increased the minimum tobacco sales age from 18 to 21 years old (Zhang et al. 2018)). The survey included questions about availability of types of ENDS devices (e.g., disposable or prefilled cig-a-likes, refillable pen-shaped e-cigarettes, mod/tank e-cigarettes, JUUL and non-JUUL pod e-cigarettes), and components: unflavored and flavored JUUL pods with three pre-specified categories including classic or Virginia tobacco, menthol or cool mint, and mango, crème, or cucumber flavors; flavored (non) nicotine e-cigarette liquids as well as nicotine salt and synthetic nicotine e-cigarette liquids in bottles. Similar to other surveys (Zhu et al. 2019), we measured availability of flavored e-cigarette liquids that were of fruit/candy, menthol/mint, and tobacco flavors (pre-specified categories).

2.3. Statistical analysis

We assessed frequencies and percentages of all products and used Fisher's Exact tests (because expected cells were ≤ 5) to determine significant ($p < 0.05$) differences in proportions of available products between the two policy groups (see Fig. 1): 15 vape shops located in six cities *with* comprehensive andpartial flavored sales restrictions enacted before November 21, 2019 (Albany, Livermore, SF and Berkeley, Hayward, Oakland, respectively) versus seven vape shops in four cities *without* flavored sales restrictions (Castro Valley, Fremont, Newark, and Pleasanton). All analyses were conducted using SAS software, version 9.4 (SAS Institute, Cary, NC).

2.3.1. Sensitivity analyses

Some stores could qualify for policy exemption based on sales data, which were not available. Hayward could exempt stores if they had sold flavored tobacco before the city flavored sales restriction, and Oakland could exempt stores if more than 60% of their revenue was from sales of tobacco products/paraphernalia (Holmes, Lempert, and Ling 2022). We conducted three sensitivity analyses (1) with the three Hayward stores and the two Oakland stores categorized in the non-policy group, (2) while excluding six stores located in cities with partial policies (Berkeley, Hayward and Oakland); and (3) comparing availability of products in cities with comprehensive versus partial versus non-policy groups. For the latter, we examined all pair-wise comparisons that were significant on alpha = 0.1 for global tests and performed multiple comparisons testing using the False Discovery Rate. However, because of the exploratory nature of the study, all results that reach statistical significance before multiple comparisons testing are important and can provide insights for further research.

3. Results

Most of the vape shops (n = 20, 91%) were retailers only; two stores had a vaping lounge/bar (Table 1). Most stores had a minimum age-for-entry signage displayed on the store's exterior (n = 20, 91%). Suspended from sales in 2018 (Myers 2019), the availability of fruit flavored JUUL pods was lower compared to mint/menthol-based flavors (18% vs 41%) that JUUL declared to stop selling on November 7, 2019 (Myers 2019), during our data collection period. Most vape shops carried flavored nicotine e-cigarette liquids (n = 17, 77%), and many shops (n = 18, 82%) carried flavored *non*-nicotine e-cigarette liquids in nine out of ten cities studied.

3.1. Product availability by flavor policies

Smaller proportions of vape shops sold menthol/mint-flavored JUUL pods (27% vs 71%, p = 0.074) as well as candy/fruit (53% vs 100%, p = 0.051) and menthol/mint nicotine e-cigarette liquids (53% vs 100%, p = 0.051) in cities *with* vs *without* policies; the results were borderline significant. While tobacco flavors were not included in the prohibitions, smaller proportion of stores sold tobacco-flavored JUUL pods (47% vs 71%, p = 0.381) and nicotine e-cigarette liquids (67% vs 100%, p = 0.135) in cities *with* vs *without* policies. However, the differences were not statistically significant.

Table 1
Product availability in vape shops located in San Francisco and Alameda Counties, California by flavored sales restriction policies effective as of November 21, 2019.

Product/ Characteristic	All (N = 22)	No Policy (N = 7 or 31.8%)	Comprehensive or Partial (N = 15 or 68.2%)	*P*
MINIMUM AGE SIGNAGE DISPLAYED	20 (90.9)	6 (85.7)	14 (93.3)	1.000
VAPING PRODUCTS SOLD	22 (100.0)	7 (100.0)	15 (100.0)	—
E-CIGARETTES				
Cig-a-likes	14 (63.6)	5 (71.4)	9 (60.0)	1.000
JUUL device	14 (63.6)	5 (71.4)	9 (60.0)	1.000
Pen-shaped e-cigarettes	16 (72.7)	4 (57.1)	12 (80.0)	0.334
Mods/tank e-cigarettes	19 (86.4)	7 (100.0)	12 (80.0)	0.523
Pod e-cigarettes (other than JUUL)	20 (90.9)	7 (100.0)	13 (86.7)	1.000
JUUL POD FLAVORS				
Classic or Virginia tobacco	12 (54.6)	5 (71.4)	7 (46.7)	0.381
Mango, crème, or cucumber	4 (18.2)	1 (14.3)	3 (20.0)	1.000
Menthol or cool mint	9 (40.9)	5 (71.4)	4 (26.7)	0.074
None	2 (9.1)	0 (0.0)	2 (13.3)	1.000
E-CIGARETTE LIQUIDS	20 (90.9)	7 (100.0)	13 (86.7)	1.000
Candy or fruit flavors *with* nicotine	15 (68.2)	7 (100.0)	8 (53.3)	0.051
Candy or fruit flavors *without* nicotine	18 (81.8)	5 (71.4)	13 (86.7)	0.565
Menthol/mint flavored *with* nicotine	15 (68.2)	7 (100.0)	8 (53.3)	0.051
Menthol/mint flavored *without* nicotine	17 (77.3)	4 (57.1)	13 (86.7)	0.274
Tobacco-flavored nicotine liquids	17 (77.3)	7 (100.0)	10 (66.7)	0.135
Tobacco-free nicotine liquids	5 (22.7)	1 (14.3)	4 (26.7)	1.000
Nicotine salt liquids	8 (36.4)	3 (42.9)	5 (33.3)	1.000

Numbers shown are frequencies (n) and column percentages (%). Numbers may not add up to 100% because of rounding or because "All that apply" option was used.
Cities without flavored sales restrictions as of November 21, 2019: Castro Valley, Fremont, Newark, Pleasanton. Cities with comprehensive or partial flavored sales restrictions: Albany, Livermore, and San Francisco; Berkeley, Hayward, and Oakland.
*–indicates statistically significant results ($p < 0.05$). P-values obtained from Fisher Exact Tests.

3.1.1. Sensitivity analyses

All three sensitivity analyses (Appendix Table 2) revealed consistent results of significantly lower availability of bottled nicotine liquids of candy/fruit and menthol/mint flavors in vape shops in cities with *comprehensive* versus *no* policies: (1st: 40% vs 92%, p's < 0.02; 2nd: 44% vs 100%, p's = 0.03; and 3rd: 44% vs 100%, p's = 0.03). The availability of menthol/cool mint JUUL pods was lower (11% vs 71%, p's = 0.04) in cities *with* versus *without* comprehensive polices in the second and third analyses. While there were no differences in product availability

Table 2
Product availability in vape shops located in cities of San Francisco and Alameda Counties, California by flavored sales restriction policies effective as of November 21, 2019: results of sensitivity analyses.

Product/ Characteristic	Sensitivity Analysis 1[a]			Sensitivity Analysis 2[b]			Sensitivity Analysis 3[c]			
	No Policy (N=12 or 54.5%)	Comprehensive or Partial (N=10 or 45.5%)	*P*	No Policy (N=7 or 33.8%)	Comprehensive (N=9 or 56.3%)	*P*	No Policy (N=7 or 31.8%)	Partial (N= 6 or 27.27)	Comprehensive (N=9 or 40.9%)	*P*
JUUL POD FLAVORS										
Classic or Virginia tobacco	8 (66.7)	4 (40.0)	0.391	5 (71.4)	3 (33.3)	0.315	5 (71.4)	4 (66.7)	3 (33.3)	0.357
Mango, crème, or cucumber	3 (25.0)	1 (10.0)	0.594	1 (14.3)	0 (0.0)	0.438	1 (14.3)	3 (50.0)[d]	0 (0.0)[d]	0.043[e]
Menthol or cool mint	7 (58.3)	2 (20.0)	0.099	5 (71.4)	1 (11.1)	0.035*	5 (71.4)[d]	3 (50.0)	1 (11.1)[d]	0.053[e]
None	0 (0.0)	2 (20.0)	0.195	0 (0.0)	2 (22.2)	0.475	0 (0.0)	0 (0.0)	2 (22.2)	0.312
E-CIGARETTE LIQUIDS										
Candy or fruit flavors *with* nicotine	11 (91.7)	4 (40.0)	0.020*	7 (100.0)	4 (44.4)	0.034*	7 (100.0)[d]	4 (66.7)	4 (44.4)[d]	0.050[e]
Candy or fruit flavors *without* nicotine	9 (75.0)	9 (90.0)	0.594	5 (71.4)	9 (100.0)	0.175	5 (71.4)	4 (66.7)	9 (100.0)	0.183
Menthol/mint flavored *with* nicotine	11 (91.7)	4 (40.0)	0.020*	7 (100.0)	4 (44.4)	0.034*	7 (100.0)[d]	4 (66.7)	4 (44.4)[d]	0.050[e]
Menthol/mint flavored *without* nicotine	8 (66.7)	9 (90.0)	0.323	4 (57.1)	9 (100.0)	0.063	4 (57.1)	4 (66.7)	9 (100.0)	0.071[e]
Tobacco-flavored nicotine liquids	11 (91.7)	6 (60.0)	0.135	7 (100.0)	6 (66.7)	0.213	7 (100.0)	4 (66.7)	6 (66.7)	0.304
Tobacco-free nicotine liquids	3 (25.0)	2 (20.0)	1.00	1(14.3)	2 (22.2)	1.00	1(14.3)	2 (33.3)	2 (22.2)	0.828
Nicotine salt liquids	6 (50.0)	2 (20.0)	0.204	3 (42.9)	2 (22.2)	0.596	3 (42.9)	3 (50.0)	2 (22.2)	0.545

Numbers shown are frequencies (n) and column percentages (%). Numbers may not add up to 100% because of rounding or because "All that apply" option was used.
a-Cities without flavored sales restrictions as of November 21, 2019: Castro Valley, Fremont, Newark, and Pleasanton as well as Hayward and Oakland (these cities could exempt stores based on sales data that were not available). Cities with comprehensive or partial flavored sales restrictions: Albany, Berkeley, Livermore, and San Francisco.
b-Cities without flavored sales restrictions as of November 21, 2019: Castro Valley, Fremont, Newark, Pleasanton. Cities with comprehensive flavored sales restrictions: Albany, Livermore, and San Francisco. Vape shops located in Berkeley, Hayward, and Oakland were excluded.
c-Cities without flavored sales restrictions as of November 21, 2019: Castro Valley, Fremont, Newark, Pleasanton. Cities with partial flavored sales restrictions: Berkeley, Hayward, and Oakland. Cities with comprehensive flavored sales restrictions: Albany, Livermore, and San Francisco.
d–indicates statistically significant results ($p<0.05$) for pair-wise comparisons using Fisher Exact Tests
e–indicates statistically significant results on alpha=0.1 ($p<0.10$). P-values obtained from global Fisher Exact Tests.
*–indicates statistically significant results ($p<0.05$). P-values obtained from Fisher Exact Tests
†–indicates statistically significant results after multiple comparisons testing using False Discovery Rate

between cities with *partial* versus *no* policies, we saw lower availability of mango, crème, or cucumber flavored JUUL pods in cities with *comprehensive* versus *partial* policies: 0% vs 50%, p = 0.04.

4. Discussion

In 2019, there were 22 brick-and-mortar stores that were exclusively or primarily vape shops in SF and Alameda Counties, a reduction from 32 vape shops, which exclusively sold ENDS and were located in the same area in 2016 (Burbank, Thrul, and Ling 2016), prior to the implementation of flavored sales restriction policies. Fewer stores in cities *with* versus *without* flavored sales restrictions sold fruit/candy and menthol/mint flavored bottled nicotine liquids. We observed lower availability of tobacco-flavored JUUL pods and bottled liquids in policy- versus non-policy cities, which suggests spillover effects (Venkataramani, Pollack, and Roberts 2017) of ordinances prohibiting all characterizing flavors other than tobacco. Flavored non-nicotine e-cigarette liquids, which can be combined with nicotine liquid and/or concentrate sold separately (Choi et al. 2021), were widely available in nine jurisdictions regardless of policy as these products are not "tobacco products" under state law. Even without nicotine, inhalation of aerosols with flavors can be toxic (Rao et al. 2022) and long-term health effects have yet to be investigated.

4.1. Limitations

First, this study has a cross-sectional design and a small number of observations (n = 22). However, this was not a sample but the census of all SF and Alameda County vape shops that were in business in 2019. A rapidly changing retail environment (Galimov et al. 2020; Lanza and Pittman 2019), especially during the lockdown period of the ongoing COVID-19 pandemic, when access to in-person service was limited and many brick-and-mortar stores were closed, resulting in some e-cigarette users switching to online stores (Gaiha, Lempert, and Halpern-Felsher 2020), may not generalize to the current situation or the retailers outside SF and Alameda Counties. Second, violations rates and the compliance of the vape shops with local flavor policies were not assessed. Third, the data did not capture the availability of nicotine concentrates or other unflavored nicotine liquids, which can be used for mixing with flavored zero-nicotine liquids.

4.2. Implications for tobacco regulatory policy

Consistent with previous studies (Andersen-Rodgers et al. 2021; Rogers et al., 2021; Welwean et al. 2022), our findings support the need for federal restrictions on sales of all flavored tobacco products, including bottled nicotine liquids and flavored non-nicotine e-cigarettes and liquids. In line with emerging research (Welwean et al. 2022), results of our sensitivity analyses indicate the importance of

comprehensive policies prohibiting sales of all flavored non-cigarette tobacco without exemptions for specific flavors (e.g., menthol/mint flavors) or retailer type (e.g., adult-only tobacco/vape shops). California State Senate Bill 793 prohibiting sales of all flavored tobacco products (except for premium cigars, hookah, loose leaf tobacco), including e-cigarettes, delivering nicotine or other "vaporized" liquids, and flavor enhancers was signed into law in August 2020 (Encyclopedia of American Politics 2022). However, the law is suspended pending a tobacco industry-sponsored referendum petition on the November 2022 general election ballot (Encyclopedia of American Politics 2022). If passed, this policy would expand on the 2020 Food and Drug Administration's (FDA's) enforcement prioritization restricting sales of flavored cartridge-based e-cigarettes, which exempts tobacco and menthol flavors, disposable e-cigarette devices, and liquids for refillable devices like those sold in vape shops (U.S. Food and Drug Administration, 2020).

Comprehensive federal restrictions on flavored tobacco sales would likely sustain the decline in youth e-cigarette use, observed in California (Yang et al. 2020) and nationally since 2020 (Wang et al. 2020). Federal policies would eliminate the issue of increased cross-locality purchasing that state or local flavored sales restrictions cannot address (Rogers et al., 2021); and substitution with exempt alternatives, including tobacco/menthol flavors and flavored non-nicotine e-cigarette liquids, which many vape shops in our study were carrying. An informal follow-up using a secret shopper's approach with a SF vape shop on January 6, 2022, revealed anecdotal evidence that the store sold flavored e-cigarette liquids without nicotine, which the store employee offered to mix with nicotine liquid sold separately. Because definitions of "tobacco products" vary across localities, non-nicotine e-cigarette liquids or products made with tobacco-free (e.g., synthetic) nicotine are not always included in flavored sales restrictions. At the time of the data collection in 2019, FDA did not have the authority to regulate zero-nicotine e-cigarette products or non-tobacco nicotine products. Effective April 14, 2022, products containing any nicotine, including synthetic nicotine, are under FDA's authority (U.S. Food and Drug Administration, 2022). However, zero-nicotine e-cigarettes and liquids are still unregulated. In the absence of comprehensive federal policies, the use of an expanded definition of tobacco products that would include e-cigarettes that deliver any nicotine (including tobacco-based and synthetic) or zero-nicotine liquids, and comprehensive local policies prohibiting sales of all flavored tobacco products will likely better discourage youth tobacco use.

4.3. Conclusions

The availability of flavored e-cigarette liquids containing nicotine was lower in vape shops located in SF and Alameda County cities *with* versus *without* flavored sales restrictions. Not prohibited by any policies, flavored e-cigarette liquids *without* nicotine, which can be combined with nicotine liquid sold separately, were widely available in nine out of ten jurisdictions studied. Comprehensive policies prohibiting sales of *all* flavored non-cigarette tobacco products will likely better discourage youth tobacco use.

Funding

This work was supported by the Tobacco Related Diseases Research Program grant 27IR-0042 and National Institutes of Health grant U54HL147127.

CRediT authorship contribution statement

Vira Pravosud: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Louisa M. Holmes:** Conceptualization, Methodology, Investigation, Data curation, Project administration, Funding acquisition, Visualization, Writing – review & editing. **Lauren K. Lempert:** Conceptualization, Methodology, Resources, Writing – review & editing. **Pamela M. Ling:** Conceptualization, Methodology, Writing – review & editing, Funding acquisition, Project administration, Supervision.

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.

Data availability

Data will be made available on request.

Acknowledgement

Support for VP and LL was provided by the FDA's Tobacco Center of Regulatory Science grant U54HL147127. Support for LH and PML was received from grant TRDRP 27IR-0042. The funding sources had no role in the design and conduct of the study; data analysis and interpretation; preparation, review, or approval of the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2022.101997.

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