The Tobacco
E-commerce Lab

Impact of Local Flavored Tobacco Bans and Demographic Factors on Vape Shops' E-Commerce Activity in San Diego County

Capstone Project Manuscript
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Links:

- The Tobacco E-commerce Lab
- GitHub Repository

Notes: This manuscript presents research conducted on tobacco e-commerce in collaboration with The Tobacco E-Commerce Lab at UC San Diego, under the mentorship of Dr. Eric Leas. The links below provide access to the lab website, as well as our GitHub repository containing the project's working code. Please note that our map-based data dashboard will soon be publicly available on the lab's website.

Contributions:
Jenna Brooks – (1) Conducted preliminary background research. (2) Led drafting and editing of manuscript and conference poster. (3) Assisted with dashboard embedding. (4) Contributed to interpretation of statistical results and created data visualizations. (5) Coordinated timelines, documented weekly meeting notes, and facilitated communication with the capstone host team. (6) Presented the project poster at UCSD's Public Health Research Day. (7) Collaborated on manual data filtering and content analysis.
Prosperity Land – (1) Conducted preliminary background research. (2) Led design and development of the interactive dashboard maps. (3) Repaired misaligned shapefile data. (4) Managed embedding, integration, and troubleshooting of dashboard functionality. (5) Contributed to drafting and editing the manuscript. (6) Presented the project poster at UCSD's Public Health Research Day. (7) Collaborated on manual data filtering and content analysis.
Nina Rice – (1) Initiated project proposal. (2) Led data acquisition and preparation through API pulls, data preparation, and shapefile management. (3) Conducted primary and exploratory statistical analyses, and created data visualizations. (4) Assisted with dashboard design. (5) Contributed to drafting and editing the manuscript and conference poster. (6) Coordinated timelines, documented weekly meeting notes, and facilitated communication with the capstone host team. (7) Presented the project poster at UCSD's Public Health Research Day. (8) Collaborated on manual data filtering and content analysis.

Abstract

Introduction: This capstone project explores how vape shops' use of e-commerce varies by local flavored tobacco bans and neighborhood demographics in San Diego County. The goal is to support enforcement efforts by understanding the relationship between flavor restrictions and use of e-commerce to reduce youth access to flavored tobacco products.

Methods: The sample consisted of 311 vape shops in San Diego County identified via Google Maps and Yelp APIs. Retailers were examined for e-commerce and delivery features. Census tract data on income, age, race/ethnicity, and Social Deprivation Index (SDI) were merged to assess demographic patterns. Logistic regression tested predictors of e-commerce presence.

Results: E-commerce was not significantly associated with flavor bans (OR = 1.07, 95% CI: 0.50–2.32, p = 0.855). However, higher median household income was associated with increased odds of e-commerce presence (OR = 1.11 per $10,000, 95% CI: 0.80–1.55, p = 0.034). In contrast, greater social deprivation (OR = 0.63, 95% CI: 0.40–0.99, p = 0.044) and a higher proportion of residents under age 21 (OR = 0.03, 95% CI: 0.00–1.14, p = 0.059) were linked to reduced odds. Race and ethnicity were not significantly associated with e-commerce presence, including percent White (OR = 0.99, 95% CI: 0.96–1.02, p = 0.494), percent Black (OR = 0.93, 95% CI: 0.86–1.02, p = 0.119), percent Hispanic (OR = 0.98, 95% CI: 0.95–1.01, p = 0.165), and percent Native American (OR = 0.65, 95% CI: 0.29–1.47, p = 0.303). Overall, 57.9% of delivery-enabled e-commerce retailers offered flavored products in jurisdictions with flavor bans.

Conclusions: Flavor bans did not appear to increase nor decrease the presence of vape shops utilizing e-commerce within restricted jurisdictions. However, a majority of delivery-enabled retailers located in banned areas still sold flavored products. Targeted enforcement efforts could help close this gap, and the data dashboard we created provides an accessible tool to support such actions.

1. Introduction

1.1 Background

As more tobacco retailers establish an online presence, e-commerce is an area of growing concern in the effort to enforce new tobacco regulations and ensure retailer compliance. Valued at $16.7 billion in 2023 in the U.S. alone, e-commerce is the fastest growing area of the tobacco industry (Leas, 2024).

As of December 2022, California's Flavored Tobacco Ban (SB-793) defined a tobacco retailer as "a place where tobacco is sold or a vending machine," without specifically referencing online sales or e-commerce, leaving a loophole for retailers to exploit (California Legislature,

2020; Tobacco-Related Disease Research Program, n.d.). San Diego County, however, is clear about online and delivery sales in its requirements for a Tobacco Retail License, stating that “All sales of tobacco products MUST be conducted in-person (no delivery or online sales) at the licensed location” (County of San Diego, 2024).

Since California’s ban on flavored tobacco (SB-793) was passed and voted on for approval in 2022, there is evidence that consumers are moving online. In the week after the flavor ban went into effect in California, Google searches to buy cigarettes online jumped 194% and vapes 162% higher than expected based on predictions from historical trends (Leas et al., 2023). Thus, increased restrictions on flavored vapes appear to drive higher online interest in vape products.

Both flavor bans and new restrictions on e-commerce indicate policy progress towards California’s Tobacco Endgame strategy, a public health campaign that seeks to eradicate the tobacco industry’s harm and influence in California by 2035 (Tobacco-Related Disease Research Program, 2023). New legislation AB-3218 now also regulates e-commerce, prohibiting online and delivery sales of illegal flavored tobacco products, however there is no existing compliance system to ensure retailers adherence to changing laws (California Legislature, 2024). Surveillance of retailer behavior is necessary to identify non-adherence and aid in enforcement.

The use of e-commerce and flavored tobacco products remain prevalent amongst youth, despite flavor bans. Youth and young adults (13 to 24 years) make up a large proportion of online sales, with their age range accounting for 40% of all online vape purchases (Gaiha, Lempert, & Halpern-Felsher, 2020). Flavored tobacco products are also highly popular amongst young populations, with 85.6% of all youth tobacco-user respondents reporting that they used flavored tobacco products (CA Youth Tobacco Survey, 2023).

Flavor bans also have yet to influence youth’s access to flavored tobacco products online. A study that made underage purchase and delivery attempts online showed no difference in success before and after the ban on flavored tobacco, suggesting that flavor bans had yet to affect online retailers (Donaldson et al., 2023). Moreover, surveys of youth reported that it would be fairly easy for them to buy flavored vapes, while only 22% of participants were aware of the statewide flavor ban (Chaffee et al., 2024). Furthermore, discreet packaging that obscures the contents of packages and lack of age ID verification upon delivery further exacerbate the issue of preventing youth access to flavored tobacco via online sales (Pearson, Davidson, Schillo, & Kreslake, 2025; Harati et al., 2024). Without adequate enforcement or adherence monitoring strategies, e-commerce remains a major loophole in efforts to curb flavored tobacco sales amongst highly vulnerable youth.

Despite efforts to curb tobacco usage across California, tobacco use remains disproportionately concentrated amongst low income communities due to targeted ads and economic disparities (Ramirez et al., 2024; Richardson et al., 2015; Tercyak et al., 2020).

A past study of nationwide tobacco retailers has shown that census tracts with greater proportions of residents living 150% below the federal poverty line (FPL) had greater odds of having a tobacco shop (Kong et al., 2021). Another study found that neighborhood tobacco retail density (TRD) increased by 14.4% in urban areas for every quartile increase in the proportion of families living in poverty, and by 5.7% for every quartile increase in the proportion of Black residents (Rodriguez et al., 2013). However, there has not yet been a study on neighborhood demographics and density of retailers using e-commerce. Our research seeks to add to existing literature on how demographics and policy might play a role in retailers' use of e-commerce to reach consumers.

1.2 Objective

We examined the extent to which flavor bans and area demographics were associated with retailers' use of e-commerce. We hypothesized that:

(1) Vape shops located in jurisdictions with local flavor bans are more likely to operate e-commerce platforms than those in jurisdictions without such bans.

(2) Tobacco e-commerce retailers are more likely to be located in census tracts with lower socioeconomic status and higher social deprivation, as well as places with more youth under 21.

In addition to these analyses, we deliver a user-friendly map-based data dashboard, displaying San Diego County's tobacco e-commerce retailers to law enforcement and policy makers to aid in the monitoring of retailers' adherence to legal regulations.

2. Methods

2.1 Sample

The retailer data consists of vape shops (n = 311) identified in San Diego County, collected by the Tobacco E-Commerce Lab at UC San Diego. Retailers were retrieved through map-based searches on Google Maps and Yelp APIs using consumer-facing queries such as "vape shop" and "vape store". All retailers in San Diego retrieved from these platforms were retained for analysis. The raw dataset included vape shop attributes such as shop name, address, geolocation (latitude and longitude) and links to websites. The dataset was manually audited and filtered to verify which vape shops with a website offered an e-commerce platform that allowed consumers to buy tobacco vaping products online for delivery. In addition, an in-depth content analysis of delivery enabled e-commerce platforms was performed to assess what types of vaping and flavored products retailers offered for sale online.

2.2 Measures

E-Commerce Status: Each vape shop was coded for the presence or absence of an e-commerce platform, defined as the ability to purchase tobacco products online or request delivery directly through the website.

Flavor Restriction Status: Vape shop locations were geocoded and cross-referenced against a database of San Diego County localities with active flavored tobacco sales restrictions (Campaign for Tobacco-Free Kids, n.d.). Each shop was binary coded as either within (1) or outside (0) a flavor-ban jurisdiction.

Product Type (Flavored Tobacco): Websites were manually audited to determine whether vape shops offered flavored tobacco products for sale. Flavored products included any explicitly labeled as mint, menthol, fruit, candy, dessert, or other non-tobacco flavors.

Demographic Factors: Vape retailers were spatially linked to census tract–level demographic data, including median household income per $10,000 increase, racial/ethnic composition (White, African American, Hispanic, and Native American), and population under age 21, as well as tract level scores from the Social Deprivation Index (SDI) (U.S. Census Bureau, n.d.; The Robert Graham Center, n.d.). The SDI, a composite index based on seven indicators of social disadvantage (e.g., poverty, education, housing), was used to assess neighborhood-level vulnerability.

2.3 Analysis

To assess whether local flavor restrictions were associated with the likelihood of a vape shop offering e-commerce, we conducted both chi-square tests of independence and logistic regression analysis. Final results are presented from logistic regression models.

Logistic regression was also used to estimate the odds of a vape shop offering e-commerce based on census tract–level demographic variables, including median household income, population under age 21, and Social Deprivation Index scores. Odds ratios for each predictor were calculated to quantify the strength and direction of these associations.

We fit a multivariate logistic regression model including the proportions of residents identifying as White, Black/African American, Hispanic, and Native American to assess whether racial composition predicted e-commerce presence.

We also examined whether retailers with delivery-enabled e-commerce were more likely to sell flavored tobacco products, particularly in jurisdictions with flavor bans. Descriptive statistics were used to assess policy adherence and findings were interpreted in light of regulatory enforcement challenges.

2.4 Map-Based Data Dashboard

Given that there is no existing program to ensure compliance, we developed a map-based data dashboard to visually represent retailer locations, e-commerce activity, and relevant policy and socioeconomic contextual factors. The dashboard was designed as a resource for researchers, public health officials, and law enforcement to support surveillance and monitoring policy adherence. Key features include interactive layers displaying local flavor restrictions, Social Deprivation Index scores, and tract-level demographic indicators such as median household income, proportions of youth, and racial/ethnic composition.

3. Results

3.1 Descriptive Findings

Of the 311 vape shops identified in San Diego County, 37 (11.9%) had e-commerce platforms. 20 (54.1%) of the shops offering e-commerce were located in the City of San Diego, with the remaining 17 (45.9%) shops distributed across 8 other incorporated municipalities (Lemon Grove, Oceanside, National City, Vista, Encinitas, Carlsbad, Chula Vista, & Escondido), as well as throughout unincorporated areas of the county. Vape shops offering e-commerce tended to be located in more socioeconomically advantaged neighborhoods. As shown in **Table 1**, census tracts containing shops with e-commerce had a higher median household income ($68,700 vs. $63,400), a lower Social Deprivation Index score (0.245 vs. 0.636), and a lower proportion of residents under age 21 (21.9% vs. 25.7%) compared to those without e-commerce vape retailers.

Table 1

Demographics by E-Commerce Presence: Median (IQR) and Wilcoxon Rank Sum Tests

	No E-commerce Present (n = 274)	Yes E-commerce Present (n = 37)	*p*-value (Wilcoxon)
Median Household Income	$63,400 ($49,500-$76,900)	$68,700 ($60,100-$85,000)	0.039 *
Social Deprivation Index (SDI)	0.636 (0.320-1.131)	0.245 (-0.277-0.864)	0.047 *
Residents Under 21 years	25.7% (19.5%–30.9%)	21.9% (17.4%–26.5%)	0.025 *

	No E-commerce Present (n = 274)	Yes E-commerce Present (n = 37)	*p*-value (Wilcoxon)
African American Residents	3.9% (2.2%–8.3%)	3.4% (1.5%-5.3%)	0.191
Hispanic Residents	29.9% (20.0%-56.9%)	23.9% (16.0%-41.7%)	0.064 .
White Residents	45.1% (18.4%-60.5%)	51.7% (33.6%-69.4%)	0.161
Native American Residents[1]	0.0% (0.0%-0.3%)	0.0% (0.0%-0.3%)	0.916

Note. Presented values are medians with interquartile ranges (IQR) in parentheses. Group differences were tested using the Wilcoxon rank sum test. * $p < 0.05$, . $p < 0.10$

[1] Native American resident median is 0 due to low representation across census tracts. Mean % Native American was 0.28% and 0.16% for non- and e-commerce tracts, respectively.

Figure 1 similarly displays that vape shops in higher-income, lower-deprivation, and lower-youth census tracts were more likely to offer online purchasing options. Higher-income areas have the highest prevalence of e-commerce (16.5%), compared to mid-income (12.5%) and low-income areas (6.7%). Retailers in areas with low deprivation (Low SDI) are more likely to have e-commerce (16.3%) than those in Mid SDI (10.6%) or High SDI (8.7%) areas. E-commerce prevalence is highest in areas with Low Youth (17.3%) and drops sharply in High Youth areas (6.8%). There is minimal difference between jurisdictions with a flavor ban (12.1%) and those without one (11.4%) in terms of e-commerce prevalence.

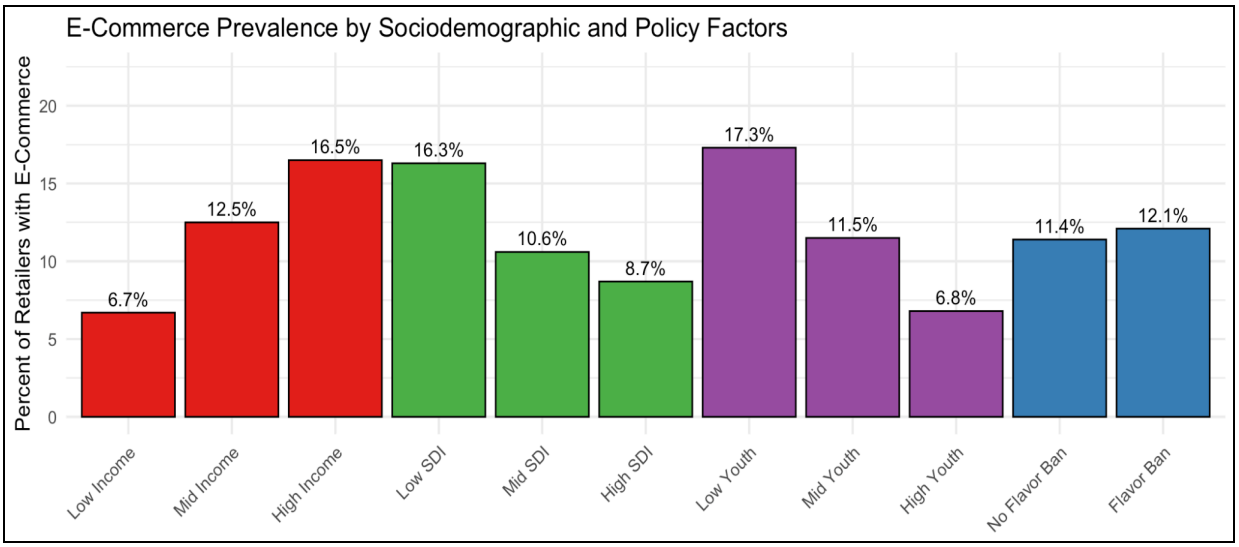

Figure 1. *Tertile chart demonstrating percentages of retailers with e-commerce platforms across key neighborhood and policy factors. Retailers in higher-income, lower-deprivation, and lower-youth census tracts were more likely to offer online purchasing options. Flavor bans showed minimal difference in e-commerce prevalence.*

A breakdown of e-commerce status, delivery options, and flavored tobacco product availability is shown in **Figure 2**. Of the 37 e-commerce vape shops, we focused only on the 25 shops that offered delivery services. An audit of delivery-enabled vape shops revealed that 19 of the 25 (76.0%) sold flavored tobacco products. As shown in **Figure 3**, 11 of those 19 (57.9%) were located in jurisdictions with local flavor bans, indicating nonconformity with local flavor restrictions.

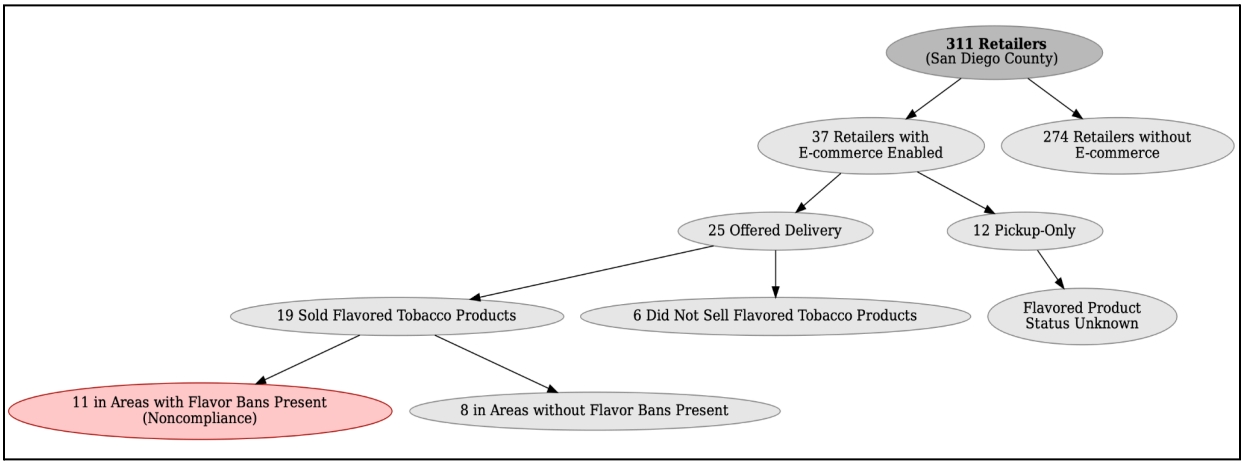

Figure 2. *This diagram illustrates the breakdown of 311 vape shops in San Diego County by e-commerce status, delivery options, flavored tobacco product availability, and local flavor ban policies.*

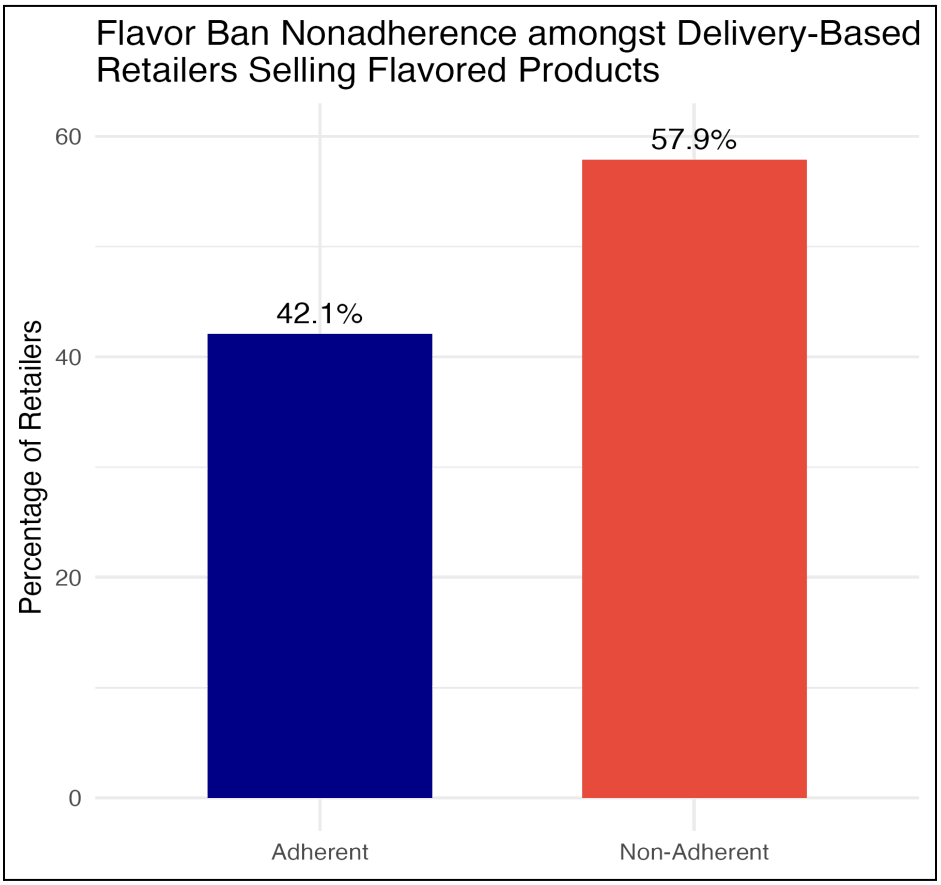

Figure 3. *Of the 19 vape shop retailers offering flavored products for delivery, 57.9% of those (n = 11) appeared to not be operating in adherence with local flavor bans.*

3.2 Logistic Regression Findings

To assess associations between flavor ban policy and retailer behavior, we conducted logistic regression analyses examining whether flavor ban status and demographic characteristics predicted the likelihood of a retailer offering e-commerce. Results are presented in **Table 2**. No statistically significant relationship was found between flavor ban presence and e-commerce activity (OR = 1.07, $p = 0.855$). However, median household income was positively associated with e-commerce presence (OR = 1.11 per $10,000 increase, $p = 0.034$ *). Higher SDI scores were associated with lower odds of e-commerce presence (OR = 0.63, $p = 0.044$ *), and a higher proportion of residents under 21 was marginally associated with reduced odds of e-commerce (OR = 0.03, $p = 0.059$).

Race and ethnicity were not significant predictors of e-commerce presence. Odds ratios were close to 1.0 for all four variables: percent White (OR = 0.99, $p = 0.494$), percent Black (OR = 0.93, $p = 0.119$), percent Hispanic (OR = 0.98, $p = 0.165$), and percent Native American (OR =

0.65, $p = 0.303$). These results indicate that racial and ethnic composition of census tracts did not meaningfully influence the likelihood of a retailer offering e-commerce.

Table 2

Predictors of E-Commerce Presence in San Diego County Vape Shops

Predictor	OR (95% CI)	*p*-value
Flavor Ban Present	1.07 (0.5, 2.32)	0.855
Median Household Income (per $10,000)	1.11 (0.8, 1.55)	0.034 *
Social Deprivation Index (SDI)	0.63 (0.4, 0.99)	0.044 *
Under Age 21 Proportion	0.03 (0.0, 1.14)	0.059 .
Percent White	0.99 (0.96, 1.02)	0.494
Percent Black (African American)	0.93 (0.86, 1.02)	0.119
Percent Hispanic	0.98 (0.95, 1.01)	0.165
Percent Native American	0.65 (0.29, 1.47)	0.303

Note. Odds ratios (ORs), 95% confidence intervals (CIs), and *p*-values from logistic regression models assessing factors associated with the presence of e-commerce functionality.

* $p < 0.05$, **.** $p < 0.10$

3.3 Dashboard Output

To support enforcement and public awareness, we developed an interactive dashboard that visualizes vape shop locations and makes this data accessible to stakeholders. The tool includes layered information on local flavor ban policies, neighborhood demographics, and social disadvantage (SDI). **Figure 4** displays a snapshot of the dashboard, which is publicly-accessible on The Tobacco E-Commerce Lab's website. It is intended to support public

health professionals, policy enforcement teams, and researchers in monitoring conformity and identifying areas of concern by providing them with critical data.

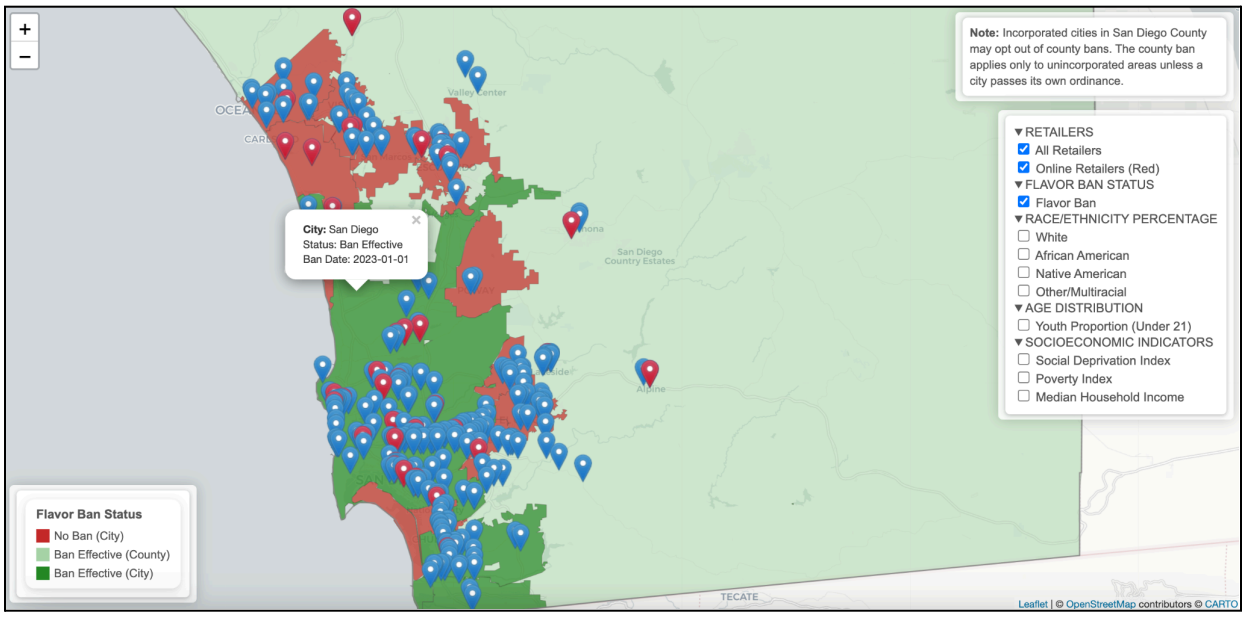

Figure 4. *Interactive dashboard of SD County vape shops. Blue pins represent brick-and-mortar retailers; red pins represent retailers with e-commerce. The map also displays flavor ban status and tract-level socioeconomic indicators.*

4. Discussion

We found that the prevalence of tobacco e-commerce was not significantly related to flavor ban policy but was correlated with higher income areas. Retailers in high-income census tracts were more likely to offer e-commerce options, while retailers in lower-income neighborhoods were less likely. We found that over half of the e-commerce retailers that offered online delivery services also sold flavored products. The majority of these retailers operated in jurisdictions with local flavor bans.

The absence of a significant relationship between local flavor bans and the presence of e-commerce retailers suggests that there are other factors influencing e-commerce presence. Therefore, we cannot determine whether flavor bans influence whether a vape shop chooses to offer products online. However, the observation that most delivery enabled e-commerce vape retailers in San Diego sold flavored products in jurisdictions with flavor restrictions suggests a substantial lapse in the enforcement of these policies within online marketplaces. Our findings

corroborate previous research highlighting the urgent need for stronger regulation of e-commerce tobacco sales.

In addition, we found that high income areas have a higher prevalence of e-commerce than low income areas. This contrasts with previous work that showed brick-and-mortar retailers clustering in low income neighborhoods, suggesting that e-commerce enforcement may need to focus on different demographic regions. There are a number of possible explanations for this disparity between e-commerce and brick-and-mortar vape shops. Retailers in high-income areas are more likely to have the resources to support and offer e-commerce or delivery capability that make it possible to create and sustain an online presence, while lower income areas may lack the resources they need to move their businesses online.

Note that these interpretations are speculative and need to be considered within the context of the study's limitations. First, our sample was restricted to San Diego County and does not represent state or nationwide trends. Compared to national averages, San Diego County has a higher proportion of Hispanic/Latino residents (35.0% vs. 19.5%), and a lower percentage of Black or African American residents (5.6% vs. 13.7%) (ACLU of Northern California, 2023; U.S. Census Bureau, 2024). Median household income in San Diego County is 30.2% higher than the national average ($102,300 vs. $78,500 as of 2023) (USAFacts, 2025). These comparisons underscore San Diego's demographic diversity and economic complexity, however it may not replicate statewide or nationwide trends. Second, we used manual site auditing of online retail sites and may have missed product listings or third-party delivery services. Third, while the Social Deprivation Index gives us a useful composite score, it can still mask the effect of individual demographic influences.

Despite these limitations, our findings have strong implications for tobacco control interventions. Our evidence suggests a need for more effective surveillance systems that track policy adherence. The map-based dashboard is a useful tool for investigating violations and supporting enforcement. A follow-up study is currently underway to measure retailers' adherence across the entire state of California, which will further illuminate where policy interventions are succeeding and where gaps persist.

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