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Assessing Social Vulnerability and FDA Tobacco Retailer Compliance Inspections and Violations in Los Angeles County, CA (2021–2023)

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Abstract

Introduction: Tobacco control policies aim to limit access, reduce initiation, and mitigate tobacco-related harms, particularly among youth. However, the effectiveness of these policies relies on consistent enforcement to ensure widespread compliance and achieve their intended public health impacts. Socioeconomic vulnerability and neighborhood characteristics have been shown to influence retailer compliance, although existing studies often primarily focus on compliance violations instead of inspections. This study uses Los Angeles (LA) County, California to explore the associations between compliance inspections, violations, and neighborhood social vulnerability.

Methods: We identified inspection and violation data from the Food and Drug Administration (FDA) Tobacco Compliance Check Outcomes database for Los Angeles County, CA (January 1, 2021 to December 31, 2023) and linked these data to census tract level data from the 2022 Centers for Disease Control and Prevention Social Vulnerability Index (SVI). All analyses were conducted at the census-tract level, with separate multivariable models adjusted for tobacco retailer density, and used to examine the relationship between inspections, violations, and neighborhood social vulnerability.

Findings: Neighborhood-level social vulnerability significantly predicted the likelihood of tobacco retailer inspections, but not violations. Census tracts with greater socioeconomic vulnerability and housing vulnerability had higher odds of inspections, while census tracts with higher proportions of racial/ethnic minority residents were less likely to undergo compliance inspections.

Conclusion: The uneven distribution of FDA compliance inspection efforts in socially vulnerable neighborhoods highlights systemic inequities. The results underscore the importance of utilizing equitable enforcement frameworks that leverage tools like SVI to pinpoint high-need areas, optimize resource allocation, and support comprehensive tobacco policy implementation.

Implications: This study reveals disparities in Food and Drug Administration compliance inspections with a concentration of inspections identified in socioeconomically vulnerable areas and gaps in predominantly racial/ethnic minority communities. No direct link was found between social vulnerability and violations, suggesting heightened retailer compliance may stem from successful outreach, past regulatory scrutiny, or other factors. Leveraging the Centers for Disease Control and Prevention Social Vulnerability Index can strengthen tobacco control enforcement in high-need areas, ensuring inspections are more equitable and targeted where enforcement gaps and tobacco access remain most pronounced.

Introduction

In 2025, tobacco use continues to be the leading cause of preventable disease and death in the United States (U.S.).¹ Use of tobacco and nicotine products is widely recognized to have harmful effects,² as are the individual, social, and environmental factors that contribute to tobacco use and related disparities.³ The tobacco retail environment is an important contextual factor that exposes communities to marketing and product access.³ Despite increased online sales,^{4,5} brick-and-mortar retailers continue to be a common source of tobacco sales, including for youth,⁶ emphasizing the need for rigorous tobacco control policy enforcement.

The U.S. Food and Drug Administration (FDA) plays a central role in tobacco policy enforcement through its compliance check inspections, established under the 2009 Family Smoking Prevention and Tobacco Control Act. Inspections assess a range of potential violations, including unlawful

marketing practices, sales to underage individuals, and other regulatory infractions.⁷ While enforcement is crucial to policy effectiveness, it is often overlooked in tobacco control research.^{8–10} Protecting Americans from tobacco-related disease and reducing youth access to tobacco products are key public health goals of these inspections, yet tobacco policy effectiveness is contingent on adequate enforcement¹¹ and differential enforcement across jurisdictions could result in uneven public health impacts.¹²

Under the Family Smoking Prevention and Tobacco Control Act, the FDA collaborates with state contractors to conduct compliance check inspections at tobacco retailers.¹³ The FDA advises states to prioritize inspections in areas at high risk for regulatory violations, such as those with elevated youth smoking rates, cigarette access, and concentrations of racial/ethnic minority populations.¹⁴ However, states are not mandated to use probability-based sampling strategies and sampling

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methods used by states are not made publicly available. Consequently, compliance inspection protocols likely vary by state,¹⁵ resulting in compliance rates ranging from 60% to 90% and influenced by factors such as enforcement practices, store type, and location.^{16–18} These inconsistencies, compounded by limited data availability,^{15,19} highlights a critical gap in practice and potentially leaves at-risk neighborhoods with unequal protections.

California has long been a leader in tobacco control and prevention efforts, yet the burden of tobacco use persists – 1 in 10 adults²⁰ and 17% of youth report using tobacco,²¹ with significant disparities in smoking prevalence, particularly in lower income areas.²² While overall statewide tobacco use decreased from 14.6% to 11.4% between 2017 and 2022, use among historically marginalized populations (ie, youth, lower income, and racial/ethnic minorities) continues to be a public health concern as these groups have higher levels of tobacco use compared to the overall population.²³ These patterns may be impacted by inequities in FDA compliance inspections. In California, retailers must obtain a tobacco retail license from the California Department of Tax and Fee Administration (CDTFA) to legally sell tobacco products,²⁴ and compliance inspections are primarily conducted by the state Department of Public Health Food and Drug Branch. Inspections typically involve undercover operations in which minor decoys (ages 18–20) attempt to purchase tobacco products, assess whether retailers properly ask for identification, and collect sale refusal information.²⁵ Non-compliant retailers face escalating fines and potential license revocation under the California STAKE Act as well as at the federal level through the FDA. In 2023, the Synar Tobacco Purchase Survey found retailer violation rates for illegal sales to minors ranged from 11.9% to 33% across California, based on a total of 1209 inspections. Los Angeles (LA) County recorded the highest violation rate at 33% ($n = 324$).²³ However, no additional information was provided regarding the factors that contributed to the high rate.

Between 2021 and 2023, LA County accounted for nearly one-third (32.4%) of all FDA tobacco compliance inspections in California ($n = 6594$), exceeding the second and third highest counties: San Diego (10.9%) and San Bernardino (7.3%). Los Angeles County is among the most populated counties in the U.S. with a total population of 10 million residents representing 27% of the state's total population and spanning 4000+ square miles.²⁶ LA County encompasses urban and suburban communities characterized by diverse racial/ethnic, socioeconomic, linguistic, and cultural backgrounds.²⁷ The high concentration of inspections, paired with LA County's previous high violation rate and demographic diversity, makes it an ideal study setting to examine enforcement activities and equity concerns.

While prior research has explored disparities in Tobacco 21 (T21) violations,^{15,17} the federal law enacted in December 2019 that raised the minimum age for purchasing tobacco products from 18 to 21,²⁸ fewer studies have investigated how tobacco retailer compliance inspection patterns themselves intersect with neighborhood characteristics such as racial/ethnic composition, income, and social vulnerability. A 2016 study analyzed FDA compliance inspection data and found that tobacco retailers in neighborhoods with higher proportions of Black, Latino, and low-income residents were more likely to sell tobacco to minors, highlighting inequities in retailer compliance based on racial/ethnic composition, poverty, and segregation.²⁹ The study underscores a lack of

consistent and comprehensive research on the influence of neighborhood characteristics, such as deprivation levels or racial/ethnic composition, on retailer compliance.²⁹ Furthermore, while disparities in tobacco access and use among lower income and racial/ethnic communities are well known,^{30,31} less is known about how broader FDA enforcement, measured through retailer compliance inspections and violations, intersects with neighborhood social vulnerability. Research in Columbus, Ohio found that even under strong enforcement conditions, retailer compliance with T21 was significantly influenced by contextual factors, including neighborhood poverty.¹⁷ Building on this insight, the present study explores how neighborhood-level social vulnerability may relate to FDA tobacco retailer compliance inspections and violations, conceptualized as key enforcement strategies for tobacco control policy.

Methods

This study focuses on LA County, California as the study setting to conduct a census-tract level ecological analysis using cross-sectional data from 2021 to 2023. We examine the relationship between FDA tobacco retailer compliance inspections, violations, and neighborhood social vulnerability characteristics.

FDA Tobacco Compliance Inspections

To assess tobacco retailer compliance inspections, we used publicly available data from the FDA Tobacco Compliance Check Outcomes database, capturing inspections conducted in Los Angeles County between January 1, 2021, and December 31, 2023. While inspections are recorded by fiscal year (October 1 to September 30), calendar years were used for clearer alignment with public health surveillance data sources, facilitating more accurate comparisons. The FDA Tobacco Compliance Check Outcomes database includes retailer name, address, inspection decision (ie, “no violations observed”, “warning letter”, “civil money penalty”, “no- tobacco- sale order”), whether a minor was involved, whether a sale to minor was found, and decision date. Warning letters are issued to retailers upon their first violation. Civil money penalties are issued after a second violation, and no- tobacco- sale orders are issued after “repeated violations”, defined ≥ 5 violations over a 36-month period.³² Calendar years were reconciled by assigning inspections based on their decision date. The dataset includes only records with documented outcomes, and no missing data were present for the variables analyzed.

Center for Disease Control and Prevention Social Vulnerability Index

Neighborhood social vulnerability predictor variables were obtained from the Centers for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI), which indicates the relative vulnerability of each U.S. census tract and is used to identify at-risk communities. SVI has been widely used in health research,³³ including a study assessing FDA compliance outcomes in Oklahoma.³⁴ CDC SVI 2022 uses data from the 2018–2022 American Community Survey (ACS) to capture community vulnerability through 16 indicators grouped into four themes. These include socioeconomic status (below 150% poverty level, unemployment, housing cost burden, lack of health insurance and lack of high school

diploma); household characteristics (individuals over 65, individuals under 17, disability, single-parent households, limited English proficiency); racial and ethnic minority status (residents excluding non-Hispanic White); and housing and transportation factors (multiunit, mobile homes, crowded housing, lack of vehicle access, and group quarters).³⁵ Each census tract is given a percentile rank ranging from 0 to 1, with higher values indicating greater vulnerability. There is a percentile rank for each social factor, as well as the four themes, and overall. To aid with interpretability, we rescaled each percentile rank by multiplying by 10 so that a 1-unit change equates to a full decile on the original scale, a method used elsewhere.³⁶

Data Preparation and Cleaning

Of the 6593 FDA compliance inspections that were conducted at brick-and-mortar tobacco retailers across California from 2021 to 2023, Los Angeles County emerged as the primary inspection site accounting for roughly 1/3 of all inspections conducted in the state ($n=2076$, 31.5%). Inspections fluctuated during the 3-year period with 1219 inspections conducted in 2021, followed by 3014 in 2022 and 2360 in 2023. To account for retailers with multiple observations of tobacco retailers, records were matched by address, a method consistent with other studies,^{37,38} resulting in a final sample size of $n=1794$ unique tobacco retailers. Tobacco retailer addresses were batch geocoded in ArcGIS Pro 3.4. Each geocoded retailer contained a Federal Information Processing Standard (FIPS) code which was subsequently used to link with SVI census-tract level information for 2476 LA County census tracts.

Measures

Inspection and violation totals were independently summed for each retailer based on address-level matching. Two binary outcome variables were created to reflect distinct outcomes of interest: retailers with one or more inspections were coded as 1 and retailers without an inspection were coded as 0. Inspection violations were also reclassified into a binary variable based on whether any violation outcome was present. Violation outcomes included warning letters, civil monetary penalties, and no-tobacco-sale orders. All outcomes were summed per retailer to indicate either no violation (0) or at least one violation (1). SVI scores served as the primary predictors and were analyzed at the census tract level. These included the overall composite score, four thematic domains, and 16 individual social factors. Finally, retailer density was calculated as the number of licensed tobacco retailers in 2022 divided by the total population in a census tract, based on 2022 SVI population estimates. The state's 2022 cigarette and tobacco products licensed retailer list was selected to reflect retailer activity at the midpoint of the outcome study period (2021–2023). Further, this timing aligns with SVI estimates in our dataset (2018–2022), supporting temporal consistency across datasets and enhancing the interpretability of tract-level comparisons. This variable was included as a covariate in the multivariable models to account for its known influence on tobacco-related disparities.³⁹

Statistical Analysis

All statistical analyses were conducted using Stata v.18.⁴⁰ Descriptive analyses examined the frequency of compliance inspections and violations, distribution of SVI characteristics

across census tracts, and average number of tobacco retailers per tract based on the state's 2022 licensed retailer list. Social vulnerability measures (ie, SES, household composition, racial/ethnic minority status, etc.) were analyzed to identify trends and their impact on inspection patterns. For each census tract, overall SVI scores and theme scores were analyzed. Summary statistics, including means, standard deviations and ranges, were calculated to provide a comprehensive overview of social vulnerability distributions. Variation in SVI scores were assessed to identify patterns or disparities among sampled census tracts.

Bivariate logistic regressions were used to descriptively examine the association between compliance inspections, overall SVI, themes, and social factors with all census tracts combined. A similar process was used to examine the association between violations and SVI variables. We used separate multivariable logistic regression models to assess relationships between SVI neighborhood characteristics and having at least one compliance inspection or at least one violation. This approach was chosen to allow for clearer understanding of the contribution of each SVI variable.

Results

Population and SVI Characteristics across Census Tracts in LA County, CA

LA County has a significant Hispanic/Latino population, comprising 48.7% of the total population.²⁷ Each census tract had an average of 3982 total residents and 1347 households. When examining SVI themes, patterns reveal social vulnerabilities (see Table 1). Of note, 23.1% of the population falls below 150% of the federal poverty line, 34.5% face housing cost burdens, and 20.5% lack a high school diploma. Household characteristics show 20.5% are children (<17 years). Additionally, 74.8% of the population identify as non-White, highlighting racial/ethnic diversity.

Tobacco Retailer Environment and Distribution of FDA Compliance Inspections and Violations

Between 2021 and 2023, 89.5% of tobacco retailers ($n=1611$) in LA County underwent one inspection and only 7.9% ($n=142$) of retailers had a violation. Each census tract had an average of 2.2 (SD = 2.4) tobacco retailers. Of the 2476 census tracts in the sample, 36.5% ($n=910$) had at least one tobacco retailer compliance inspection, and 5.2% ($n=130$) had at least one violation. Figures 1 and 2 below show a hot spot map with the color gradient representing the density of compliance inspections and violations.

SVI and Tobacco Retailer Inspections

To provide descriptive context, bivariate analyses were conducted to explore associations between census tract-level social vulnerability and the likelihood of having at least 1 compliance inspection. Bivariate models reveal that higher overall SVI was significantly associated with *greater* odds of a census tract having an inspection (OR: 1.06, CI: 1.03–1.09). Among the four SVI themes, higher vulnerability scores for SES (OR: 1.06, CI: 1.03–1.09) and housing type and transportation (OR: 1.12, CI: 1.09–1.15) were similarly associated with *greater* odds of a census tract having an inspection. In contrast, higher vulnerability scores for higher proportion of racial/ethnic minority residents (OR: 0.96, CI:

Table 1. 2022 CDC Social Vulnerability Index (SVI) Data and Population Characteristics of Census Tracts in Los Angeles County, California (n = 2476)

Population characteristics		Mean n (SD) Range
	Total population	4013 (1407.6) 5–12 794
	# of households	1358 (537.6) 0–5511
	# of tobacco retailers ^a	2.2 (2.4) 0–21
Race/ethnic group	Hispanic/Latino persons	48.7 (28.4) 0–99.8
	Asian	14.5 (15.9) 0–88.3
	Black/African American persons	7.6 (11.8) 0–90.6
	Two or more races	3.1 (3.0) 0–42.9
	Other race	0.5 (1.1) 0–19.4
	Native Hawaiian or Other Pacific Islander	0.2 (0.7) 0–12.5
	American Indian	0.2 (0.6) 0–8.9
SVI Theme and Social Factor/s	SVI Social Factor	Mean % (SD) Range
Theme 1: SES	Below 150% poverty	23.1 (13.9) 0–100
	Unemployed	7.1 (4.0) 0–44.6
	Housing cost burden	34.5 (13.8) 0–77.8
	No high school diploma	20.5 (15.8) 0–100
	No health insurance	9.1 (6.4) 0–57.1
Theme 2: Household characteristics	Aged 65 & older	14.5 (6.7) 0–77.8
	Aged 17 & younger	20.5 (7.0) 0–72.7
	Civilians with a disability	10.7 (4.5) 0–59.3
	Single parent households	6.3 (5.4) 0–100
	Limited English proficiency	12.5 (9.9) 0–65.2
Theme 3: Racial & ethnic minority status	All races and ethnicities, except White	73.7 (24.3) 0–100
Theme 4: Housing type & transportation	Multiunit structures	25.0 (26.2) 0–100
	Mobile homes	1.7 (5.7) 0–96.6
	Crowded housing	12.3 (10.6) 0–65.3
	No vehicle	8.8 (8.9) 0–83
	Group quarters	2.2 (8.9) 0–100

^aVariable calculated using California's 2022 cigarette and tobacco products licensed retailer list.

0.93–0.99) were significantly associated with *lower* odds of a census tract having an inspection.

Multivariable models were estimated adjusting for tobacco retailer density. In adjusted models, census tracts with higher overall social vulnerability had *greater* odds of having an inspection (OR: 1.04, CI:1.01–1.07). Thematic results for multivariable models were generally consistent with bivariate results. To further explore potential drivers of vulnerability,

we examined individual SVI factors. [Table 2](#) presents these results, which offer insights into the relationship between specific social factors and tobacco retailer inspections. In unadjusted models, several factors including poverty, housing cost burden, lack of health insurance, disability, multiunit housing, vehicle absence, and group quarters were associated with *greater* odds of inspection. Conversely, higher vulnerability scores for youth (≤ 17 years) and higher

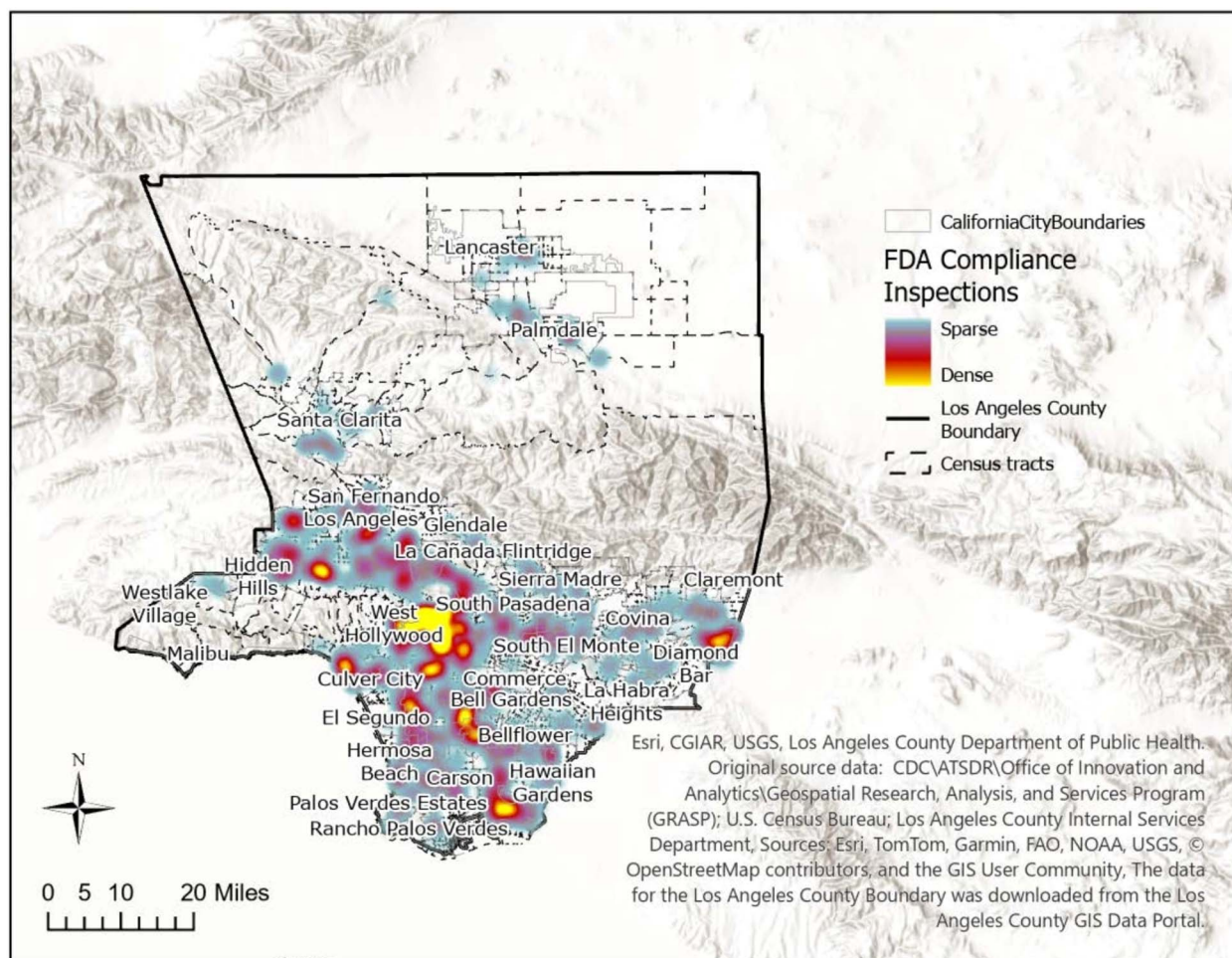


Figure 1. Geographic density of FDA tobacco compliance checks in Los Angeles County, CA, 2021–2023.

proportion of racial/ethnic minority residents were associated with *lower* odds. After adjusting for tobacco retailer density, multivariable models found that only a subset of individual factors remained significantly associated with inspection likelihood. These included lack of health insurance (OR: 1.07, CI:1.02–1.12), multiunit structures (OR: 1.05, CI:1.01–1.09), mobile homes (OR: 1.03, CI:1.01–1.06), and group quarters (OR: 1.04, CI:1.01–1.06). Notably, census tracts with higher proportions of racial/ethnic minority residents (OR: 0.85, CI:0.80–0.90) continued to show *lower* odds of having at least 1 inspection, even after adjusting for tobacco retailer density.

SVI and Tobacco Retailer Inspection Violations

To provide descriptive context, bivariate analyses were conducted to explore associations between census tract-level social vulnerability and the likelihood of having at least 1 violation identified during a retailer inspection. Unadjusted models indicated that higher overall SVI was significantly associated with *greater* odds of a census tract having a violation (OR: 1.10, CI: 1.03–1.17). Among individual themes, only higher vulnerability scores for SES (OR: 1.1, CI: 1.03–1.18) and housing type and transportation (OR: 1.10, CI:1.03–1.18) were significantly associated with *greater* odds of a violation. When examining individual SVI factors and their association with violations, bivariate models

reveal that census tracts with higher vulnerability scores for: below 150% poverty, housing cost burden, civilians with a disability, limited English proficiency, and vehicle absence were associated with greater odds of having a violation. Higher vulnerability scores for youth (ages ≤ 17) were associated with *lower* odds of violations in those census tracts. These findings were not consistent in the multivariable models where, after adjusting for tobacco retailer density, only overall SVI remained statistically significant with the likelihood of having at least 1 violation (OR: 1.09, CI:1.02–1.17). None of the four themes or individual factors remained statistically significant in their association with the odds of having a violation (see Table 3).

Discussion

This study offers insight into how social vulnerability intersects with tobacco retailer inspections and violations, while elucidating key factors that may contribute to disparities in tobacco control enforcement. Retailers in census tracts with higher overall social vulnerability, particularly SES and housing/transportation, were more likely to have a compliance inspection but not a violation. However, retailers in neighborhoods with a greater proportion of racial/ethnic minority residents were less likely to have an inspection, further highlighting potential systemic biases in enforcement and resource allocation.

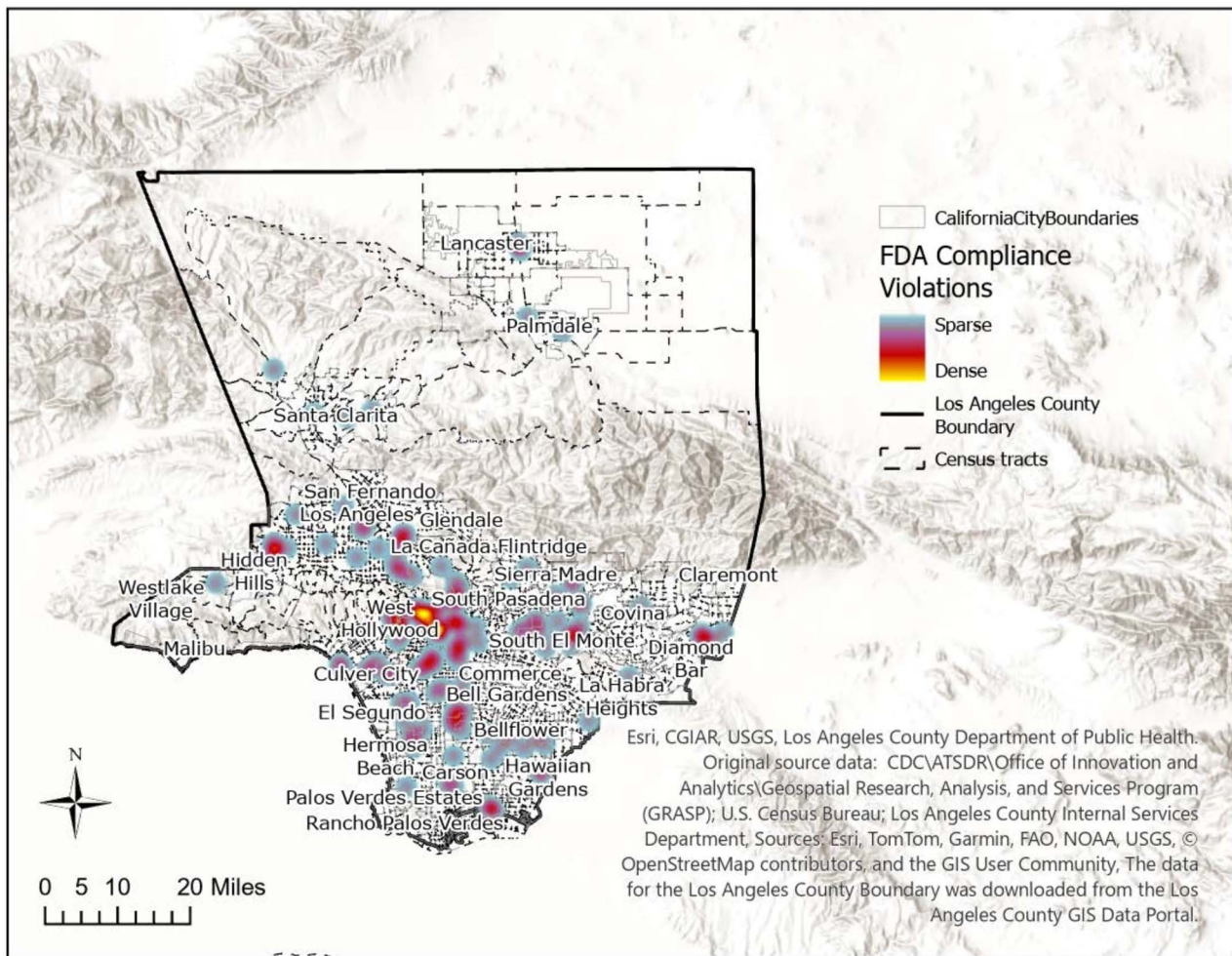


Figure 2. Geographic density of FDA tobacco compliance violations in Los Angeles County, California, 2021–2023.

These patterns reveal an enforcement gap and highlight the need to improve compliance oversight and strengthen enforcement in historically marginalized communities. While tobacco retailer density is disproportionately high in many historically marginalized communities, a pattern shaped by decades of targeted industry tactics,^{31,39} this measure should not alone dictate enforcement priorities. Tobacco control enforcement practices should also account for the social vulnerability and structural inequities faced by historically marginalized communities. For example, over-policing and uneven inspection practices, risk exacerbating existing harms¹⁵ if not grounded in equity. Equitable enforcement, defined as the fair and consistent application of tobacco control laws across all communities, regardless of SES, racial or ethnic composition, or other demographic characteristics,⁴¹ can serve as a framework to advance public health and ensure effective tobacco policy implementation. Research reveals that enforcement practices, such as issuing no-tobacco-sale orders to retailers repeatedly selling to minors, are underutilized, significantly weakening efforts to curb youth access to tobacco products.⁴² This underutilization not only perpetuates disparities but also stalls progress toward achieving equitable health outcomes. Additionally, evidence indicates that retailers are more likely to sell tobacco products to Black and Latino minors.²⁹ These patterns of underenforcement and disproportionate exposure underscore the need to examine how structural factors, such

as neighborhood-level social vulnerability, shape inspection practices and access to tobacco control resources.

Overall social vulnerability and SES emerged as a significant predictor for retailers in census tracts having an inspection, with a similar pattern observed for lack of health insurance. Results underscore the importance of equity-driven approaches, including the allocation of resources such as free or low-cost cessation programs, community-based counseling, and accessible quitline services to address systemic tobacco disparities.^{43,44} Although California currently spends 63.7% (FY 2025) of the CDC's recommended budget for tobacco prevention,⁴⁵ leveraging the unused portion of this funding on these activities could drive meaningful progress. Similarly, within the housing type and transportation theme, individual factors such as multiunit structures, mobile homes, and group quarters demonstrated significant associations with inspections. These often denote high-density residential areas, which may amplify concerns about regulatory violations, leading to a focus on these neighborhoods during inspections. However, a lack of association with violations could indicate that retailers in these neighborhoods may be more compliant, possibly due to effective outreach, heightened scrutiny from previous regulatory experiences, or other unknown factors. Another viable reason for the lack of association with violations might be the implementation of protocols that reduce the likelihood of identifying violations. This approach may be shaped by the

Table 2. Associations Between Census Tract-Level Social Vulnerability Index (SVI) Measures and FDA Tobacco Retailer Inspections (n = 2476 census tracts with 1794 retailers)

	At least 1 inspection	
	Unadjusted ^a OR (95% CI)	Adjusted ^b OR (95% CI)
Overall SVI	1.06*** (1.03–1.09)	1.04** (1.01–1.07)
Theme 1: SES	1.06*** (1.03–1.09)	1.11*** (1.05–1.17)
Below 150% poverty	1.06*** (1.03–1.09)	0.98 (0.92–1.05)
Unemployed	1.04 (1.00–1.07)	1.01 (0.99–1.05)
Housing cost burden	1.08*** (1.05–1.12)	1.03 (0.96–1.09)
No high school diploma	1.01 (0.98–1.03)	1.03 (0.95–1.11)
No health insurance	1.05*** (1.02–1.08)	1.07** (1.02–1.12)
Theme 2: Household characteristics	0.99 (0.96–1.01)	0.98 (0.94–1.02)
Aged 65 & older	0.99 (0.96–1.02)	0.99 (0.95–1.04)
Aged 17 & younger	0.93*** (0.91–0.96)	0.97 (0.93–1.01)
Civilians with a disability	1.05** (1.01–1.08)	1.01 (0.97–1.05)
Single parent households	1.00 (0.97–1.03)	1.02 (0.98–1.06)
English language proficiency	1.02 (0.99–1.05)	1.03 (0.96–1.09)
Theme 3: Racial & ethnic minority status	0.96*** (0.93–0.99)	0.86*** (0.83–0.90)
All races and ethnicities, except White	0.96** (0.93–0.99)	0.85*** (0.80–0.90)
Theme 4: Housing type & transportation	1.12*** (1.09–1.15)	1.10*** (1.06–1.15)
Multiunit structures	1.12*** (1.09–1.15)	1.05* (1.01–1.09)
Mobile homes	1.01 (0.99–1.04)	1.03* (1.01–1.06)
Crowded housing	1.02 (0.99–1.05)	1.03 (0.97–1.09)
No vehicle	1.09*** (1.06–1.12)	1.01 (0.97–1.05)
Group quarters	1.05*** (1.03–1.08)	1.04** (1.01–1.06)

Bolded values indicate statistical significance (* $p < .05$; ** $p < .01$; *** $p < .001$). ^aFor the unadjusted models, each independent variable was entered into a separate bivariate regression model to test its association with each outcome—whether a tobacco retailer had at least one inspection or at least one violation. ^bFor the adjusted models, multivariable regressions incorporating SVI social factors were conducted separately for each outcome—whether a tobacco retailer had at least one inspection or at least one violation and adjusted for tobacco retailer outlet density (TRO density).

Synar Amendment, which encourages states to keep retailer violation rates below 20% to preserve federal funding for substance abuse prevention programs.⁴⁶ Future research should examine the impact of regulatory outreach and motivations behind targeting specific areas during inspections, as well as the broader role of enforcement strategies in high-density and socioeconomically vulnerable neighborhoods. Such studies could assess whether disparities in inspection strategies align with equitable enforcement practices and identify ways to inform and refine these strategies.

Interestingly, neighborhoods with a higher proportion of racial/ethnic minority residents were *less* likely to have retailer inspections. This finding is particularly noteworthy in the context of LA County, known for its racial/ethnic diversity. Such disparities in inspection patterns may stem from

systemic factors, including unequal resource allocation, implicit biases, lack of policy buy-in, or competing priorities among enforcement agents.^{47,48} This is particularly relevant for law enforcement officers tasked with enforcing tobacco control policies, as such challenges could result in compliance monitoring gaps and undermine the effectiveness of tobacco control efforts. Educating law enforcement agents on the public health significance of tobacco control policies may be needed.

Alternatively, the discrepancy may highlight the need for greater implementation infrastructure and resources tailored to the unique needs and contexts of racially/ethnically diverse neighborhoods. In this regard, the role of enforcement agents is important, not only in conducting inspections but also in providing support to retailers to ensure adequate policy

Table 3. Associations Between Census Tract-Level Social Vulnerability Index (SVI) Measures and FDA Tobacco Retailer Violations (n = 2476 census tracts with 1794 retailers)

	At least 1 violation	
	Unadjusted ^a OR (95% CI)	Adjusted ^b OR (95% CI)
Overall SVI	1.10** (1.03–1.17)	1.09** (1.02–1.17)
Theme 1: SES	1.10** (1.03–1.18)	1.12 (1.00–1.25)
Below 150% poverty	1.12** (1.05–1.20)	1.06 (0.91–1.17)
Unemployed	1.02 (0.96–1.09)	0.98 (0.92–1.06)
Housing cost burden	1.13** (1.05–1.20)	1.09 (0.95–1.24)
No high school diploma	1.03 (0.97–1.10)	0.88 (0.76–1.03)
No health insurance	1.07 (1.00–1.14)	1.05 (0.95–1.24)
Theme 2: Household characteristics	1.04 (0.98–1.11)	1.00 (0.92–1.08)
Aged 65 & older	1.01 (0.95–1.08)	0.99 (0.90–1.09)
Aged 17 & younger	0.91** (0.85–0.98)	0.91 (0.82–1.00)
Civilians with a disability	1.13*** (1.06–1.21)	1.08 (0.99–1.17)
Single parent households	1.00 (0.94–1.06)	0.99 (0.92–1.08)
English language proficiency	1.08* (1.01–1.15)	1.08 (0.94–1.23)
Theme 3: Racial & ethnic minority status	1.02 (0.96–1.09)	0.93 (0.85–1.02)
All races and ethnicities, except White	1.02 (0.96–1.09)	0.99 (0.89–1.10)
Theme 4: Housing type & transportation	1.10** (1.03–1.18)	1.05 (0.97–1.14)
Multiunit structures	1.06* (1.00–1.13)	0.94 (0.86–1.03)
Mobile homes	1.01 (0.96–1.06)	1.02 (0.97–1.08)
Crowded housing	1.04 (0.98–1.10)	1.01 (0.89–1.14)
No vehicle	1.13*** (1.06–1.21)	1.04 (0.95–1.14)
Group quarters	1.05 (0.99–1.10)	1.01 (0.96–1.07)

Bolded values indicate statistical significance (* $p < .05$; ** $p < .01$; *** $p < .001$). ^aFor the unadjusted models, each independent variable was entered into a separate bivariate regression model to test its association with each outcome—whether a tobacco retailer had at least one inspection or at least one violation. ^bFor the adjusted models, multivariable regressions incorporating SVI social factors were conducted separately for each outcome—whether a tobacco retailer had at least one inspection or at least one violation and adjusted for tobacco retailer density (TRO density).

implementation. Interventions such as retailer education and technical assistance may improve compliance by equipping retailers with the knowledge and tools needed to adhere to regulations.^{15,17} Agents can engage with retailers to address barriers to compliance, get buy-in, and build trust by demonstrating their commitment to equitable enforcement.^{15,49} Furthermore, involving community stakeholders in shaping enforcement strategies, as well as investing in culturally competent approaches, can further enhance efforts to address unique challenges, ultimately bridging gaps in enforcement and improving compliance outcomes. Future studies should examine the impact of retailer and community engagement and culturally tailored enforcement practices on compliance behaviors, as well as explore innovative methods to bridge disparities in tobacco policy enforcement.

Study limitations include a focus on one county, which may affect generalizability. The study setting was selected since, notably, approximately one-third of all statewide compliance inspections occurred in Los Angeles County, reflecting a concentration of inspection activity. The skew underscores the need to align inspection distribution with community-level indicators of public health risk, such as retailer density, enforcement history, and/or tobacco use prevalence, rather than concentrating inspections in select regions alone. This approach would enable a more accurate assessment of how population density, demographic composition, and other factors influence inspection and violation patterns. Second, although store type is a known factor in compliance,³⁴ FDA inspection data do not include this detail. To address this gap, we manually categorized 1794 unique retailers using outlet

names and online directories (eg, Google, Yelp), identifying 12 store types. Convenience stores (ie, stores stocking a limited supply of foods or household goods) comprised nearly half the sample (46.5%, $n = 834$), followed by tobacco/vape shops (ie, stores that primarily sell tobacco, hookah, and/or e-cigarettes) (21.3%, $n = 382$) and alcohol stores (ie, stores that primarily sell alcohol) (16.2%, $n = 291$). Smaller sample sizes for remaining store types (eg, pharmacies, discount stores) limited our ability to conduct robust subgroup analyses. Third, inspection activity was concentrated in a limited number of census tracts. Of the 2476 tracts in our dataset, only 903 (36.5%) had any inspected retailers, and just 129 (5.2%) had recorded a violation. Accordingly, our analyses focused on main effects of neighborhood-level vulnerability. Fourth, while FDA compliance data offers valuable insights into enforcement patterns, there are also limitations, including the variability in sampling strategies across states which underscore the need for methodological transparency and complementary data sources. Finally, while SVI data is a valuable tool, relying on it alone may not capture all dimensions of social vulnerability relevant to tobacco control enforcement, and future research should incorporate environmental factors, youth tobacco and vape/e-cigarette use, access to cessation resources, and tobacco policy coverage.

Despite these limitations, this study provides critical insights into how neighborhood social vulnerability intersects with FDA tobacco retailer compliance inspections and violations, emphasizing the importance of equity-driven approaches in tobacco control enforcement. A key study strength is the use of a robust dataset to conduct nuanced analyses of both aggregated themes and individual factors related to neighborhood social vulnerability.

Study findings support several policy and practice recommendations. Since compliance inspections at tobacco retailers is both time- and resource-intensive, and federal enforcement efforts often face funding constraints and other challenges,^{15,19} leveraging empirical data to guide inspection priorities is essential. In the current trend of declining FDA enforcement,⁵⁰ integrating SVI data into compliance sampling can help agencies identify communities that may be underserved by existing enforcement and disproportionately burdened by tobacco access. To ensure this approach promotes equity rather than reinforcing surveillance disparities, SVI-informed sampling should be paired with strategies that promote community engagement, transparency, and accountability. For example, equity audits could be used to assess the distribution of FDA inspections and violations, while culturally responsive training for public health and enforcement personnel may improve community engagement and effectiveness in socially vulnerable communities. Tailoring retailer policy education programs to reflect neighborhood-specific challenges could further enhance compliance and trust. By aligning enforcement efforts with community context and need, agencies can improve compliance outcomes, reduce tobacco-related disparities, and ensure that enforcement of tobacco control policies is both an equitable and sustainable practice that advances fair access to public health protections.

Author Contributions

Ana Laura Herrera (Conceptualization [lead], Data curation [lead], Formal analysis [lead], Investigation [lead], Methodology [lead], Visualization [lead], Writing—original draft [lead], Writing—review

& editing [equal]), and Denise Diaz Payán (Funding acquisition [lead], Resources [lead], Software [lead], Visualization [supporting], Writing—original draft [supporting], Writing—review & editing [equal])

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Declaration of Interests

The authors declare that they do not have competing interests.

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Disclaimer

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Not required.

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Not applicable.

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Data Availability

The raw data are openly available in the FDA Compliance Check Inspections of Tobacco Product Retailers database at Compliance Check Inspections of Tobacco Product Retailers ([fda.gov](https://www.fda.gov/compliance-check-inspections-of-tobacco-product-retailers)) and the Social Vulnerability Index database at The Centers for Disease Control and Prevention and Agency for Toxic Substances and Disease Registry ([atsdr.cdc.gov](https://www.cdc.gov/atsdr)). Derived data supporting the findings of this study are available from the corresponding author [A.L.H.] on request.

References

1. American Lung Association. State of Tobacco Control 2025 Report.; 2025:1–138. Accessed April 2, 2025. <https://www.lung.org/content/sotc/2025/ala-state-of-tobacco-control-2025.pdf>
2. National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health. *The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General*. Centers for Disease Control and Prevention (US); 2014: Accessed July 16, 2024.
3. Centers for Disease Control and Prevention. *Surgeon General's Report: Eliminating Tobacco-Related Disease and Death: Addressing Disparities*. Public Health Service: Office of the Surgeon General; 2024:1–837 Accessed December 5, 2024.
4. Jensen JLK, Rebentisch K, Tripp HL, Merten JW. Price, convenience, the buying experience, and other motivations for purchasing tobacco and e-cigarettes online. *Tob Induc Dis*. 2022;20:74. <https://doi.org/10.18332/tid/152138>.
5. King JL, Merten JW, Nicksic NE. Who purchases tobacco online? Findings from waves 1 and 4 of the population assessment of

- tobacco and health study. *Tob Regul Sci*. 2021;7(3):155–169. <https://doi.org/10.18001/trs.7.3.1>.
6. Henes A, Coats EM, Hein R, *et al*. Youth and young adult access to Flavored vaping products following a sales restriction in New York state: a mixed methods approach. *Health Promot Pract*. 2024;26(5):902–912. <https://doi.org/10.1177/15248399241296115>.
7. Gitner S. Tobacco and Nicotine Products: FDA Inspections and Enforcement. FDLI, Introduction to Tobacco and Nicotine; 2021. Accessed September 8, 2025. <https://www.fdpi.org/wp-content/uploads/2021/10/Gitner-Seth.pdf>
8. Chriqui JF, Asada Y, Smith NR, Kroll-Desrosiers A, Lemon SC. Advancing the science of policy implementation: a call to action for the implementation science field. *Transl Behav Med*. 2023;13(11):820–825. <https://doi.org/10.1093/tbm/ibad034>.
9. Hafez AY, Gonzalez M, Kulik MC, Vijayaraghavan M, Glantz SA. Uneven access to smoke-free Laws and Policies and its effect on health equity in the United States: 2000–2019. *Am J Public Health*. 2019;109(11):1568–1575. <https://doi.org/10.2105/AJPH.2019.305289>.
10. Brownson RC, Mazzucca-Ragan S, Jacob RR, *et al*. Understanding health equity in public health practice in the United States. *J Public Health Manag Pract*. 2023;29(5):691–700. <https://doi.org/10.1097/PHH.0000000000001763>.
11. U.S. Food and Drug Administration. The 5 Ws of Undercover Buy Compliance Check Inspections. 2025. <https://www.youtube.com/watch?v=4umeG6hoOVg>
12. Colston DC, Xie Y, Patrick ME, *et al*. Tobacco 21 laws may reduce smoking and tobacco-related health disparities among youth in the U.S. *Prev Med Rep*. 2022;27:101762. <https://doi.org/10.1016/j.pmedr.2022.101762>.
13. Federal Drug Administration. FDA Tobacco Retail Inspection Contracts. 2023. Accessed December 5, 2024. <https://www.fda.gov/tobacco-products/retail-sales-tobacco-products/fda-tobacco-retail-inspection-contracts>
14. General Services Administration. Compliance and Enforcement Tobacco Retail Inspections Program, Solicitation Number: FDA-16-Tobacco-1143096. 2015. Accessed November 4, 2024. <https://www.fbo.gov/spg/HHS/FDA/DCASC/FDA-16-Tobacco-1143096/listing.html>
15. Woolsey S, Ramos AK, Samson K, *et al*. Strengthening tobacco 21 implementation and enforcement to reduce tobacco-related health disparities: a stakeholder engagement project. *Tob Prev Cessat*. 2023;9:20. <https://doi.org/10.18332/tpc/163299>.
16. Silver D, Macinko J, Giorgio M, Bae JY, Jimenez G. Retailer compliance with tobacco control laws in new York City before and after raising the minimum legal purchase age to 21. *Tob Control*. 2016;25(6):624–627. <https://doi.org/10.1136/tobaccocontrol-2015-052547>.
17. Roberts ME, Klein EG, Ferketich AK, *et al*. Beyond strong enforcement: understanding the factors related to retailer compliance with tobacco 21. *Nicotine Tob Res*. 2021;23(12):2084–2090. <https://doi.org/10.1093/ntr/ntab093>.
18. Raskind IG, Lee JGL, Henriksen L. Underage sales of tobacco in dollar stores and top grocery stores, 2015–2020, U.S. *Am J Prev Med*. 2023;65(2):313–316. <https://doi.org/10.1016/j.amepre.2023.02.014>.
19. Carey N, Lanteri L, Hawkins SS. A review of the landscape of state tobacco 21 laws: key components, research challenges, and future directions. *Drug Alcohol Depend Rep*. 2024;12:100236. <https://doi.org/10.1016/j.dadr.2024.100236>.
20. Big Cities Health Coalition. Innovative Policies to Reduce Tobacco Use in Big Cities: Los Angeles County. 2020. Accessed December 5, 2024. <https://www.bigcitieshealth.org/reduce-tobacco-use-big-cities/>
21. Clodfelter R, McCarl-Dutra L, Bradfield B, Russell S, Levine B, von Jaglinsky A. California Youth Tobacco Survey: 2023 Results. 2024. Accessed October 17, 2024. https://www.cdph.ca.gov/Programs/CCDPHP/DCDIC/CTCB/CDPH%20Document%20Library/ResearchandEvaluation/SurveyInstrumentsTrainingManualsAndProtocols/CYTS2023AnnualReport_FINAL.pdf
22. Los Angeles County Health Survey. Smoking Status of Adults (Ages 18 Years and Older). 2023. Accessed December 5, 2024. <http://www.lapublichealth.org/ha/LACHSDDataTopics2023.htm>
23. California Department of Public Health, California Tobacco Prevention Program. *California Tobacco Facts and Figures* 2024. California Department of Public Health; 2024:1–69 Accessed November 8, 2024.
24. California Department of Tax and Fee Administration. Cigarette & Tobacco Products Licensing Registration and Renewal Information. Accessed April 30, 2025. <https://www.cdtfa.ca.gov/taxes-and-fees/cig-n-tob-prod-lic-reg.htm>
25. California Department of Public Health. Office of Youth Tobacco Enforcement. Accessed April 30, 2025. <https://www.cdph.ca.gov/Programs/CEH/DFDCS>
26. About – COUNTY OF LOS ANGELES. Accessed September 24, 2024. <https://lacounty.gov/government/about-la-county/about/>
27. U.S. Census Bureau QuickFacts: Los Angeles County, California. Accessed December 5, 2024. <https://www.census.gov/quickfacts/table/losangelescountycalifornia/RHI725223>
28. United States of America. *Further Consolidated Appropriations Act, 2020*. Vol 387a.; 2019.
29. Lee JGL, Landrine H, Torres E, Gregory KR. Inequities in tobacco retailer sales to minors by neighborhood racial/ethnic composition, poverty, and segregation, USA, 2015. *Tob Control*. 2016;25(E2):e142–e145. <https://doi.org/10.1136/tobaccocontrol-2016-053188>.
30. Martin-Gall V, Neil A, Macintyre K, *et al*. Tobacco retail availability and smoking-a systematic review and meta-analysis. *Drug Alcohol Rev*. 2024;43(7):1718–1732. <https://doi.org/10.1111/dar.13936>.
31. Lee JGL, Henriksen L, Rose SW, Moreland-Russell S, Ribisl KM. A systematic review of Neighborhood disparities in point-of-sale tobacco marketing. *Am J Public Health*. 2015;105(9):e8–e18. <https://doi.org/10.2105/AJPH.2015.302777>.
32. Federal Drug Administration. Advisory and Enforcement Actions Against Industry for Selling Tobacco Products to Underage Purchasers. FDA. 2024. Accessed December 5, 2024. <https://www.fda.gov/tobacco-products/compliance-enforcement-training/advisory-and-enforcement-actions-against-industry-selling-tobacco-products-underage-purchasers>
33. Higginbotham JK, Segovia LM, Rohm KL, Anderson CM, Breitenstein SM. Social vulnerability index and health outcomes in the United States: a systematic review. *Fam Community Health*. 2025;48(2):81–96. <https://doi.org/10.1097/FCH.0000000000000421>.
34. Sedani AE, Chen S, Beetch JE, Martinez SA, Dao HDN, Campbell JE. Inequalities in tobacco retailer compliance violations across the state of Oklahoma, 2015–2019. *J Community Health*. 2022;47(4):658–665. <https://doi.org/10.1007/s10900-022-01091-7>.
35. Centers for Disease Control and Prevention. CDC/ATSDR SVI 2022 Documentation. 2024. Accessed June 12, 2025. <https://www.atsdr.cdc.gov/place-health/media/pdfs/2024/10/SVI2022Documentation.pdf>
36. Karmakar M, Lantz PM, Tipirneni R. Association of Social and Demographic Factors with COVID-19 incidence and death rates in the US. *JAMA Netw Open*. 2021;4(1):e2036462. <https://doi.org/10.1001/jamanetworkopen.2020.36462>.
37. Jenkins C, Schwartz E, Onnen N, Craigmile PF, Roberts ME. Variations in tobacco retailer type across community characteristics: place matters. *Prev Chronic Dis*. 2022;19:E75. <https://doi.org/10.5888/pcd19.210454>.
38. Fischer AJ, Krogh JD, Boyle M, *et al*. Weak age restriction enforcement and retailer proliferation reveal limits in tobacco control policy. *Ann Am Thorac Soc*. 2025;22(10):1512–1521. <https://doi.org/10.1513/AnnalsATS.202501-095OC>.
39. Glasser AM, Onnen N, Craigmile PF, Schwartz E, Roberts ME. Associations between disparities in tobacco retailer density and

- disparities in tobacco use. *Prev Med*. 2022;154:106910. <https://doi.org/10.1016/j.ypmed.2021.106910>.
40. Stata. 2023.
 41. ChangeLab Solutions. Equitable Enforcement. Accessed March 5, 2025. <https://www.changelabsolutions.org/policy-process-evaluation-equity/enforcement>
 42. Hemmerich N, Jenson D, Bowrey BL, Lee JGL. Underutilisation of no-tobacco-sale orders against retailers that repeatedly sell to minors, 2015-2019, USA. *Tob Control*. 2022; 31(e2):e99–e103. <https://doi.org/10.1136/tobaccocontrol-2020-056379>.
 43. Reisinger SA, Kamel S, Seiber E, Klein EG, Paskett ED, Wewers ME. Cost-effectiveness of community-based tobacco dependence treatment interventions: initial findings of a systematic review. *Prev Chronic Dis*. 2019;16:E161. <https://doi.org/10.5888/pcd16.190232>.
 44. Fiore M, Baker T. 10 million calls and counting: progress and promise of tobacco Quitlines in the United States. *Am J Prev Med*. 2021;60(3 Suppl 2):S103–S106. <https://doi.org/10.1016/j.amepre.2020.06.021>.
 45. Campaign for Tobacco-Free Kids. A State-by-State Look at the 1998 Tobacco Settlement 26 Years Later. Campaign for Tobacco-Free Kids. 2024. Accessed April 17, 2025. <https://www.tobaccofreekids.org/what-we-do/us/statereport/california>
 46. SAMHSA. Revision to the Substance Abuse and Mental Health Services Administration (SAMHSA) Synar Guidance on Tobacco Regulation for the Substance Abuse Prevention and Treatment Block Grant (SABG). Accessed April 17, 2025. <https://www.samhsa.gov/sites/default/files/synar-guidance-tobacco-21.pdf>
 47. Bonorris S, Salerno M, Shanske D, et al. *Challenges in Enforcing Local Flavored Tobacco Restrictions*. Public Law Research Institute, UC Hastings College of Law; 2019:1–74.
 48. Jacobson PD, Wasserman J. The implementation and enforcement of tobacco control laws: policy implications for activists and the industry. *J Health Polit Policy Law*. 1999;24(3):567–598. <https://doi.org/10.1215/03616878-24-3-567>.
 49. Watts MH, Michel KH, Breslin J, Tobin-Tyler E. Equitable enforcement of pandemic-related public health Laws: strategies for achieving racial and health justice. *Am J Public Health*. 2021;111(3):395–397. <https://doi.org/10.2105/AJPH.2020.306112>.
 50. Exclusive: FDA enforcement actions plummet under Trump | Science | AAAS. Accessed April 2, 2025. <https://www.science.org/content/article/exclusive-fda-enforcement-actions-plummet-under-trump>