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Longitudinal Trends in Tobacco and Vape Retail Density in California (2015-2019)

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Longitudinal Trends in Tobacco and Vape Retail Density in California (2015-2019)

A thesis submitted in partial satisfaction of the requirements for the Master's degree

in

Public Health

by

Vidya Lakshmi Purushothaman

Committee in charge:

Professor David Strong, Chair  
Professor Raphael Cuomo  
Professor Eric Leas

2020



The thesis of Vidya Lakshmi Purushothaman is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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Chair

University of California San Diego

2020

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ABSTRACT OF THE THESIS

Longitudinal Trends in Tobacco and Vape Retail Density in California (2015-2019)

by

Vidya Lakshmi Purushothaman

Master's in Public Health

University of California San Diego, 2020

Professor David Strong, Chair

Identifying the changes in the retail density of specialized tobacco and/or vape shops and general tobacco vendors can help inform effective policy approach to reduce the availability of tobacco. Data on licensed tobacco retailers within California from 2015-2019 was obtained from the California Department of Tax and Fee Administration. Store type was categorized and annotated using Yelp, a crowd-sourcing business directory service. Geolocations were

aggregated at the county level for visualizing and analyzing trends in tobacco retail density. Repeated measures ANOVA and mixed effects model were used to analyze the longitudinal trend in retail density before and after adjusting for covariates describing each region such as age, gender, income, race and ethnicity. The number of active tobacco retailer licenses increased from 19,825 in 2015 to 25,635 in 2019. The highest percent increase in tobacco retailer licenses (9.1%) was observed in 2017. The retail density of specialized tobacco storefronts was highest in Los Angeles, San Diego, and Riverside counties. We observed a significant increase in the number of active licenses for non-specific and specialized tobacco storefronts after controlling for the size of populations within each region. This time effect was significant for increase in the number of active licenses for only non-specific stores after adjusting for covariates. Regional density of retailers was associated with population characteristics including higher percentages of females, lower median household income, and higher proportion of Hispanic residents. Monitoring the distribution of tobacco retail density and associated sociodemographic factors for change over time can help identify the type, location, and point-of-sale marketing exposures to tobacco products.

## **Chapter 1: Background**

Tobacco retail outlet density is a major driving force behind tobacco use. Apart from contributing towards higher smoking rates(1) among youth(2,3) as well as adults(4), retail access to tobacco products can increase exposure to industry marketing, promotion of newer tobacco products and discourage cessation attempts.(5) Proximity to tobacco retail outlet has been associated with higher smoking prevalence and number of storefronts can influence the perception of product availability and easy access.(6)

In California, every retailer who sells cigarettes or tobacco products to public directly is required to obtain a cigarette and tobacco retailer's license from the California Department of Tax and Fee Administration (CDTFA) and renew it annually(7) (In accordance with the California Cigarette and Tobacco Products Licensing Act of 2003). In June, 2016 the state law expanded the definition of tobacco product to include: “Any product containing, made, or derived from tobacco or nicotine that is intended for human consumption, Any electronic smoking or vaping device that delivers nicotine or other vaporized liquids, Any component, part, or accessory of a tobacco product, whether or not sold separately.”(7) The annual retailer license listing is publicly available(8) and can be utilized to analyze the trends in the tobacco retailer density as well as explore demographic and socioeconomic factors that influence the retailer landscape.

Over the years, the tobacco product landscape has expanded to include a diverse number of new products including Electronic Nicotine Delivery Systems (ENDS). While seventy percent of the adults who are current smokers use cigarettes, the proportion of youth and young adults using electronic cigarettes (e-cigarettes) has increased.(9,10) The diversity in the number of tobacco products has also led to an increase in the number of specialized stores that exclusively

sell tobacco and/or vape products. It is important to examine if there are significant differences in the retail density trends between specialized tobacco and/or vape store and non-specific stores selling tobacco products.

Prior research has examined the trends in the overall tobacco retail density in response to license regulations within Philadelphia(11) and other tobacco retail density studies have examined the effect of tobacco retail density and proximity on smoking prevalence while identifying various sociodemographic factors such as age, income, race/ethnicity that can influence the association.(2,12–14) The current study will examine the longitudinal trends in the retail density of both specialized tobacco and/or vape shops and non-specific stores selling tobacco products at the county level within California. The study also aims to identify important sociodemographic factors associated with tobacco retail density such as lower median household income, higher proportion of racial and ethnic minorities, higher proportion of youth, young adults. Restricting tobacco retailer density and regulating the number of licenses within a location at a socioeconomic disadvantage can reduce disproportionate clustering and health disparities.

## References

1. Chuang YC, Cubbin C, Ahn D, Winkleby MA. Effects of neighbourhood socioeconomic status and convenience store concentration on individual level smoking. *J Epidemiol Community Health*. 2005 Jul;59(7):568–73.
2. Novak SP, Reardon SF, Raudenbush SW, Buka SL. Retail tobacco outlet density and youth cigarette smoking: A propensity-modeling approach. *Am J Public Health*. 2006 Apr;96(4):670–6.
3. Leatherdale ST, Strath JM. Tobacco retailer density surrounding schools and cigarette access behaviors among underage smoking students. *Ann Behav Med*. 2007;33(1):105–11.
4. Golden SD, Kuo TM, Kong AY, Baggett CD, Henriksen L, Ribisl KM. County-level associations between tobacco retailer density and smoking prevalence in the USA, 2012. *Prev Med Reports*. 2020 Mar 1;17:101005.
5. Reitzel LR, Cromley EK, Li Y, Cao Y, Mater R Dela, Mazas CA, et al. The effect of tobacco outlet density and proximity on smoking cessation. *Am J Public Health*. 2011 Feb 1;101(2):315–20.
6. Wakefield M, Germain D, Durkin S, Henriksen L. An experimental study of effects on schoolchildren of exposure to point-of-sale cigarette advertising and pack displays. In: *Health Education Research*. Health Educ Res; 2006. p. 338–47.
7. California Cigarette & Tobacco Products Licensing Act of 2003 – Retailer License [Internet]. [cited 2020 Nov 10]. Available from: <https://www.cdtfa.ca.gov/taxes-and-fees/spctretailers.htm>
8. Cigarette & Tobacco Products Licensing Registration and Renewal Information [Internet]. [cited 2020 Nov 10]. Available from: <https://www.cdtfa.ca.gov/taxes-and-fees/cig-n-tob-prod-lic-reg.htm>
9. Gentzke AS, Creamer M, Cullen KA, Ambrose BK, Willis G, Jamal A, et al. Vital Signs: Tobacco Product Use Among Middle and High School Students — United States, 2011–2018. *MMWR Morb Mortal Wkly Rep*. 2019 Feb 15;68(6):157–64.
10. Creamer MR, Wang TW, Babb S, Cullen KA, Day H, Willis G, et al. Tobacco Product Use and Cessation Indicators Among Adults — United States, 2018. *MMWR Morb Mortal Wkly Rep*. 2019 Nov 15;68(45):1013–9.
11. Lawman HG, Henry KA, Scheeres A, Hillengas A, Coffman R, Strasser AA. Tobacco retail licensing and density 3 years after license regulations in Philadelphia, Pennsylvania (2012–2019). Vol. 110, *American Journal of Public Health*. American Public Health Association Inc.; 2020. p. 547–53.

12. Lovato CY, Hsu HCH, Sabiston CM, Hadd V, Nykiforuk CIJ. Tobacco point-of-purchase marketing in school neighbourhoods and school smoking prevalence: A descriptive study. *Can J Public Heal.* 2007;98(4):265–70.
13. Lee JGL, Henriksen L, Rose SW, Moreland-Russell S, Ribisl KM. A systematic review of neighborhood disparities in point-of-sale tobacco marketing. Vol. 105, *American Journal of Public Health.* American Public Health Association Inc.; 2015. p. e8–18.
14. Johns M, Sacks R, Rane M, Kansagra SM. Exposure to tobacco retail outlets and smoking initiation among New York city adolescents. Vol. 90, *Journal of Urban Health.* Springer; 2013. p. 1091–101.

## **Chapter 2: Manuscript**

### **Introduction**

In spite of decreasing trends in smoking prevalence(1), smoking remains the leading cause of preventable death.(2) Understanding the variation in the tobacco retailer density can help in boosting the tobacco control effects. A closer proximity to tobacco retailer outlets can reduce the likelihood of smoking cessation(3), as well as increase access and marketing exposure among vulnerable populations such as youth.

Tobacco retail density within a given geographical location refers to the number of retailers in the area which in turn directly influences the product availability and ease of access. Prior studies have observed that this retail density is associated with various socio-demographic factors such as income, age distribution, proportion of racial minorities within the community. Retail density was found to be associated with smoking among young adults and adolescent smoking. Neighborhood poverty was found to be significantly associated with both tobacco retail density and smoking prevalence after adjusting for other sociodemographic factors.(4) While multiple studies have observed a significant association between tobacco retail density and racial/ethnic minority population in a given community(5,6), a prior study investigating this association in Boston observed no significant differences in the density of tobacco retail outlets across communities differing in racial/ethnic population. Reducing the retail density of stores selling tobacco and/or vape products can serve as an effective tobacco control strategy since the number of stores and the associated marketing can directly influence smoking prevalence and access to tobacco products.(7)

Over 22,000 retailers are currently licensed to sell tobacco products in the state of California(8), excluding individual sellers, wholesalers and distributors. However, the tobacco retail landscape has continued to expand with time to include specialized stores such as vape shops which cater to the desires of individuals who may prefer to try new and diverse types of tobacco products in the market.(9) While these specialized stores potentially offer a greater range of tobacco products, non-specific stores such as convenience stores or grocery stores that sell tobacco products often are the point-of-sale locations for an average smoker to procure products due to ease of access and proximity. The storefront type can be broadly categorized into (i) specialized storefronts (vape shops, smoke shops); and (ii) non-specialized storefronts (grocery stores, gas stations, convenience stores). Yelp! is a crowd-sourcing business listing website(10) that provides business information, location, store ratings, service/product availability and categorizes the store as vape shop, tobacco shop, grocery store etc. This classification can be leveraged to explore the tobacco retail landscape to identify the factors that characterize tobacco retailers and their chosen locations which may inform tobacco control policy.

While various studies have examined the association between tobacco retail density and socio demographic factors, monitoring tobacco retail density for change over time using online descriptions with Yelp can help identify the type, location, and likely point-of-sale marketing exposures to tobacco products. Identifying the changes in the retail density of specialized tobacco and/or vape shops and general tobacco vendors can help connect trends in the density of retail markets to neighborhood characteristics and inform effective policy approaches to reduce the availability of tobacco. This study aims to compare and analyze the longitudinal trend in retail density between specialized storefronts and non-specific tobacco retailers taking into

consideration other socio-demographic factors that influence the tobacco retail density at the county level within California.

## **Methods**

### *Data Collection*

A list of licensed tobacco retailers from 2015- 2020 was obtained in the month of June 2020 from the California Department of Tax and Fee Administration (CDTFA).(8) The list provides detailed information on retailers who are licensed to sell tobacco and vaping products within the State of California. Information from this list includes: (a) license number; (b) owner name; (c) doing business as (“DBA”) name; (d) retailer address; (e) date of license commencement; and (f) date of license expiry. Since the list of retailers for the year 2020 was partial, the data was filtered to include active licenses from 2015-2019 for further data analyses. The licenses obtained from CDTFA were cross-referenced using Yelp! for store categorization. Scripts written in Python(11), a computer programming language, were used to scrape the store categories listed on Yelp! (a crowd-sourcing business listing website) based on store names and addresses. Businesses on Yelp! are automatically assigned one of the various business categories listed based on Yelp users or the data curation teams. Up to three categories that best describe the storefront can also be added by the business owners who claim the store on Yelp.(12,13) Based on the Yelp! categories, the retailers were then classified using the scraper into (i) Specialized stores (stores labelled as tobacco and/or vape stores) and (ii) Non-specific stores (convenience/grocery stores etc., that are licensed to sell tobacco and/or vape products). The specialized stores were further classified into (i) Tobacco specific stores (labelled as tobacco store under category with no mention of vape); (ii) Vape specific stores (labelled as vape store under category with no mention of tobacco); (iii) Tobacco and Vape stores (those that sell both).

Microsoft Bing API (Application Programming Interface) was used to obtain latitude and longitude for each of the retailer address. Data for population, age, gender, race, ethnicity, median household income for the years 2015-2019 were obtained from the American Community Survey at the county level(14) for the state of California.

### *Analysis*

A total of 31,251 retailer licenses were provided by the CDTFA for the years 2015-2019 out of which 26,371 licenses were cross-referenced using Yelp! based on the store name and address on the CDTFA listing for store categorization. Based on the license commencement and expiration dates, the total number of active licenses and new licenses issued in every store category were identified for each year from 2015 – 2019. Using the latitude and longitude data obtained for the retailer addresses, the point coordinates for each store category were plotted on a California base map for counties using ArcGIS v10.7.1 (Esri: Redlands, CA). The point coordinates were further aggregated to obtain the county specific total number of retailers under each store category for years 2015 - 2019. Choropleth maps were produced for each of the store categories to visualize the change in retailer density over time within different counties of California. The aggregated data of retailer count at the county level for each year was exported to conduct further longitudinal statistical analysis.

Retailer density for each store category for each year were summarized using means, standard deviations and matrix scatter plots were produced to examine patterns of change in retail density over time. Repeated measures ANOVA was used to examine if the retail density for each of the years significantly differed from the previous year and to identify any significant linear or quadratic effect. A mixed-effects linear regression model was used to determine if the

retailer count significantly changed over time using a random effect to account for repeated assessments of each county. County population for each year was also included in all models to normalize the store count. Spaghetti plots and line plots were produced to visualize the change in total retailer count and change in retailer count over time within each county for all store categories. Further, the model was adjusted for other covariates which included county-level proportions of gender, age, and race/ethnicity groups and median household income. All statistical analyses were conducted using SPSS version 27. A *p* -value of < 0.05 was considered statistically significant.

## **Results**

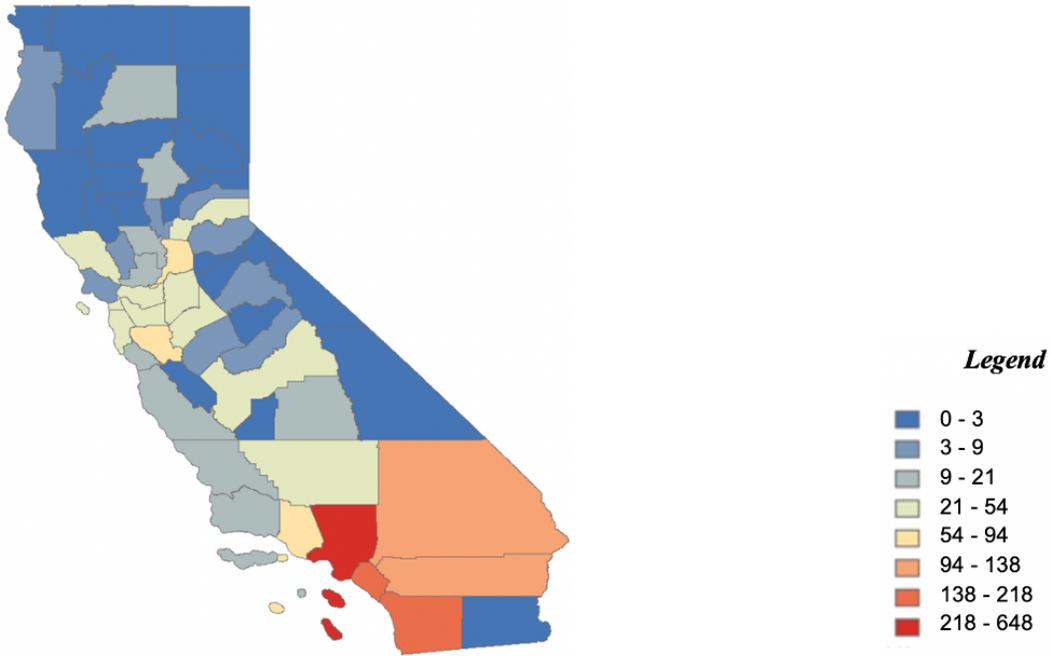
A total of 26,371 retailers that were licensed to sell tobacco and/or vape products from 2015 – 2019 in California were cross-referenced using Yelp. The number of active licenses during a given year increased from 19,825 in 2015 to 25,635 in 2019. The highest percent increase in tobacco retailer licenses (9.1%) was observed in 2017. The highest percent increase in active licenses for tobacco specific (13.8%) and vape specific storefronts (105 %) were observed in the year 2016. A total of 8306 new licenses were issued from 2015 – 2019. The highest number of new licenses (2,226) was issued in the year 2017 (see **Table 1**). After aggregating the point coordinates to obtain store count for different counties within California, the retail density was highest in the most populous counties such as Los Angeles, San Diego, and Riverside for specialized tobacco and/or vape storefronts (see **Figure 1**). Line graphs plotted for sum of active licenses from 2015 – 2019 exhibited an increasing trend for both specialized and non-specific tobacco retailers. However, the trend in the number of new licenses issued each year varied for each store category (see **Figure 2**).

**Table 1:** Number of active and new tobacco retailer licenses that are specialized and non-specific storefronts (2015 – 2019).

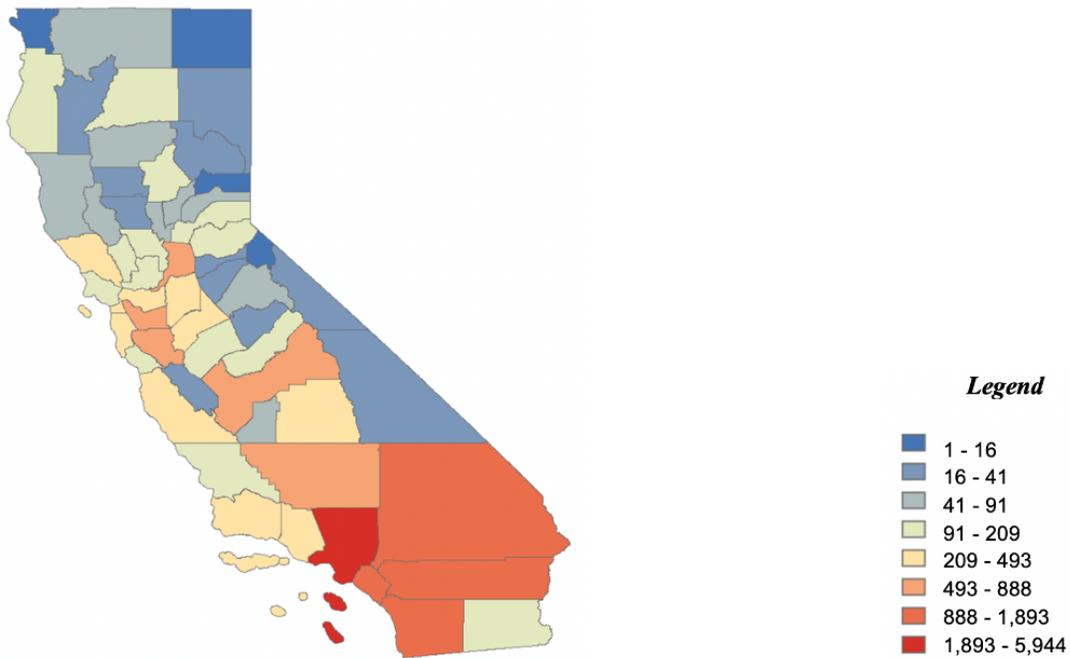
License Category	Year	Specialized Storefronts			Non-Specific Storefronts	Total
		Overall	Tobacco Specific	Vape Specific		
		N (% change)	N (% change)	N (% change)	N (% change)	N (% change)
Active Licenses	2015	950	585	100	17,925	19,825
	2016	1,202 (26.5)	666 (13.8)	205 (105.0)	18,757 (4.6)	21,161 (6.7)
	2017	1,521 (26.5)	747 (12.2)	366 (78.5)	20,044 (6.9)	23,086 (9.1)
	2018	1,827 (20.1)	842 (12.7)	452 (23.5)	21,249 (6.0)	24,903 (7.9)
	2019	2,054 (12.4)	907 (7.7)	496 (9.7)	21,527 (1.3)	25,635 (2.9)
New Licenses	2015	183	95	18	1,474	1,840
	2016	268 (46.45)	86 (-9.47)	109 (505.6)	1,550 (5.16)	2,086 (13.37)
	2017	332 (23.88)	88 (2.33)	161 (47.71)	1,562 (0.77)	2,226 (6.71)
	2018	340 (2.41)	112 (27.27)	97 (-39.75)	1,675 (7.23)	2,355 (5.80)
	2019	305 (-10.29)	98 (-12.50)	63 (-35.05)	1,085 (-35.2)	1,695 (-28.03)

% change not included for the year 2015

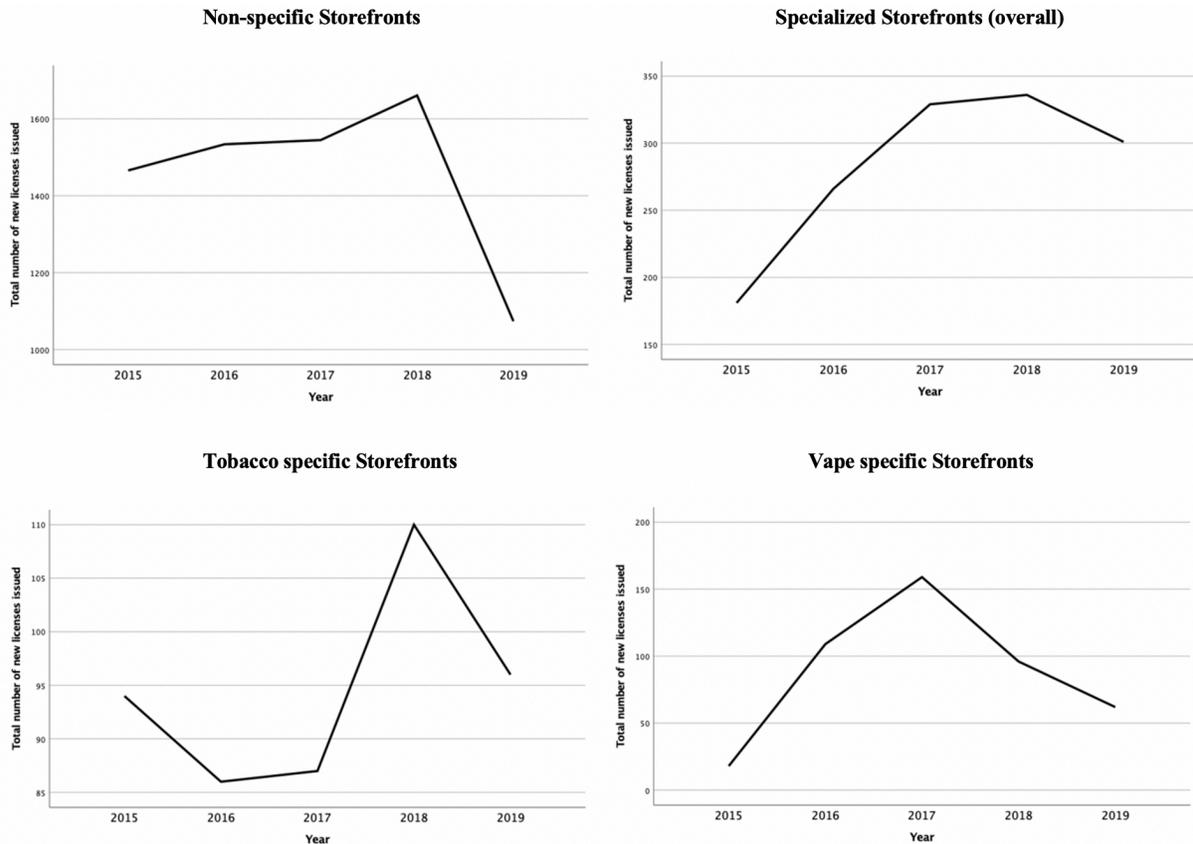
**a) Specialized Tobacco and/or Vape Storefronts**



**b) Non-Specific Storefronts**



**Figure 1:** Tobacco retail density (active licenses for the year 2019) in California at the county level (not normalized for population).



**Figure 2:** Number of new tobacco retail licenses issued from 2015 – 2019 in the state of California.

Repeated measures ANOVA demonstrated a significant quadratic effect for new licenses issued from 2015 to 2019 for both specialized tobacco and/or vape stores and non-specific stores. However, for active licenses issued from 2015 to 2019, both specialized and non-specific stores exhibited significant linear effect and quadratic effect was not statistically significant (see **Table 2**). Significant changes from previous year for each store category for the number of active and new retailer licenses are listed in Table 2.

**Table 2:** Repeated measures ANOVA (RMA) for active and ne tobacco retail licenses (2015 – 2019).

License Category	RMA Contrast	Non-specific		Specialized Tobacco and/or Vape		Vape-Specific		Tobacco-Specific	
		F*	<i>p-value</i>	F*	<i>p-value</i>	F*	<i>p-value</i>	F*	<i>p-value</i>
Active Licenses	Linear Effect	10.39	<b>0.002</b>	7.53	<b>0.008</b>	8.24	<b>0.006</b>	7.47	<b>0.008</b>
	Quadratic Effect	3.83	0.06	0.65	0.42	8.32	<b>0.006</b>	0.72	0.40
	2016 vs 2015	9.03	<b>0.004</b>	10.90	<b>0.002</b>	12.67	<b>0.001</b>	6.73	<b>0.01</b>
	2017 vs 2016	10.72	<b>0.002</b>	8.77	<b>0.004</b>	8.91	<b>0.004</b>	11.32	<b>0.001</b>
	2018 vs 2017	10.30	<b>0.002</b>	7.42	<b>0.009</b>	8.14	<b>0.006</b>	7.15	<b>0.01</b>
	2019 vs 2018	10.39	<b>0.002</b>	7.04	0.10	7.40	<b>0.009</b>	6.81	<b>0.01</b>
New Licenses	Linear Effect	16.39	<b>&lt; 0.001</b>	2.94	0.09	1.49	0.23	0.56	0.46
	Quadratic Effect	8.64	<b>0.005</b>	7.07	<b>0.01</b>	8.60	<b>0.005</b>	0.05	0.83
	2016 vs 2015	1.63	0.21	8.41	<b>0.005</b>	10.73	<b>0.002</b>	0.26	0.61
	2017 vs 2016	0.63	0.43	4.47	<b>0.04</b>	5.18	<b>0.03</b>	0.04	0.85
	2018 vs 2017	1.93	0.17	2.18	0.15	0.002	0.097	0.94	0.34
	2019 vs 2018	10.69	<b>0.002</b>	0.72	0.40	7.16	<b>0.01</b>	0.04	0.85

\*F-statistic

The mixed effects linear regression model demonstrated a significant change from 2015 – 2019, where the number of active licenses under all store categories increased with time ( $p < 0.05$ ) after adjusting for differences in county populations (see **Table 3**). The highest effect estimate was observed among non-specific stores ( $17.94 \pm 5.81$ ,  $p = 0.003$ ). For the number of new licenses issued, a significant increase over time was observed over time for tobacco or vape storefronts whereas non-specific tobacco vendors showed a significant decreasing trend over time (see **Table 3**).

After including covariates (age, gender, race, ethnicity, median household income, county population) in the mixed effects linear regression, the time effect was significant for increase in the number of active licenses for non-specific tobacco retailer stores ( $p = 0.003$ ). However, after adjusting for covariates the time effect for the change in number of active licenses for specialized tobacco and/or vape stores was no longer statistically significant and only exhibited a trend towards significance ( $p = 0.09$ ). In addition, other significant covariates are listed in the table for each store category (see **Table 4**). Median household income had a significant inverse association with the retail density for both non-specific as well as specialized tobacco storefronts. While Hispanic population had a significant positive association with retail density for both non-specific and specialized tobacco retail density, AIAN (American Indian Alaskan Native) population had a significant positive association only with non-specific tobacco retail density.

**Table 3:** Mixed effects linear regression model for active and new tobacco retail licenses (2015 – 2019).

License Category	Store Category	Fixed Effects				Variance (county)			
		Effect	Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value	
Active Licenses	Specialized	Year	5.05	1.85	<b>0.008</b>	13.87	4.06	<b>0.001</b>	
		Population	1.52	0.04	< <b>0.001</b>				
	Vape Specific	Year	1.84	0.63	<b>0.005</b>	22.89	4.34	< <b>0.001</b>	
		Population	0.01	0.02	0.52				
	Tobacco Specific	Year	1.46	0.54	<b>0.009</b>	11.13	3.22	< <b>0.001</b>	
		Population	1.23	0.03	< <b>0.001</b>				
	Non-Specific	Year	17.94	5.81	<b>0.003</b>	1719.58	335.91	< <b>0.001</b>	
		Population	42.31	0.38	< <b>0.001</b>				
	New Licenses	Specialized	Year	0.52	0.28	0.07	3.73	0.86	< <b>0.001</b>
			Population	0.53	0.02	< <b>0.001</b>			
Vape Specific		Year	0.12	0.11	0.29	-	-	-	
		Population	0.27	0.01	< <b>0.001</b>				
Tobacco Specific		Year	0.04	0.07	0.60	< 0.001	0.01	0.94	
		Population	0.31	0.01	< <b>0.001</b>				
Non-Specific		Year	-1.26	0.48	<b>0.009</b>	25.98	10.31	<b>0.01</b>	
		Population	3.96	0.07	< <b>0.001</b>				

Population divided by 100,000 to scale up the estimates

**Table 4:** Mixed effects linear regression model for active tobacco retailer licenses adjusting for covariates (2015 – 2019).

Model	Parameter	Specialized Tobacco and/or Vape Stores			Non-Specific Stores		
		Estimate	SE	<i>p</i> -value	Estimate	SE	<i>p</i> -value
Random Effect	Variance	164.28	45.72	< <b>0.001</b>	1914.60	619.72	<b>0.002</b>
Fixed Effects	Intercept	11.35	6.91	0.11	33.75	22.49	0.14
	Year	0.81	0.47	0.09	4.43	1.46	<b>0.003</b>
	Population	-9.52	5.71	0.11	-26.87	19.30	0.18
	Male population	57.68	29.82	0.06	152.00	98.01	0.13
	Female Population	108.57	25.78	< <b>0.001</b>	374.40	85.18	< <b>0.001</b>
	15-19 years population	-286.04	59.58	< <b>0.001</b>	-1161.44	187.43	< <b>0.001</b>
	20-24 years population	-181.63	33.68	< <b>0.001</b>	-333.14	108.02	<b>0.003</b>
	25-34 years population	21.75	31.53	0.49	36.74	100.64	0.72
	35-44 years population	-277.95	32.58	< <b>0.001</b>	-434.13	101.36	< <b>0.001</b>
	45-54 years population	-86.00	38.01	<b>0.03</b>	-436.54	120.11	< <b>0.001</b>
	White population	7.15	5.36	0.18	12.79	16.68	0.44
	African American population	3.54	12.92	0.78	-55.37	41.50	0.19
	Asian population	11.87	8.15	0.15	2.25	25.68	0.93
	AIAN* population	-96.50	93.75	0.31	901.36	294.98	<b>0.003</b>
	NHPI** population	-147.99	122.52	0.23	-388.52	405.20	0.34
Hispanic Population	11.10	4.31	<b>0.01</b>	49.14	14.05	<b>0.001</b>	
Median Household Income	-36.91	12.83	<b>0.005</b>	-99.30	41.74	<b>0.02</b>	

#Independent variables divided by 100,000 to scale up the estimates \*American Indian Alaskan Native \*\*Native Hawaiian Pacific Islander

## Discussion

This is the first study to use Yelp data to categorize over 25,000 tobacco retail licenses within California into specialized tobacco and/or vape stores and non-specific stores, followed longitudinal analysis. This study establishes the increasing trend in the overall tobacco retail density in the state from 2015 to 2019. While there have been differences in the annual percent changes, the overall number of active licenses have increased for both specialized and non-specific tobacco retailers. The highest increase in the total number of new licenses was observed in 2016 and the highest increase in the total number of active licenses was observed in 2017 which confirms to the state law expanding the definition of tobacco product in June 2016 to include: “Any product containing, made, or derived from tobacco or nicotine that is intended for human consumption, Any electronic smoking or vaping device that delivers nicotine or other vaporized liquids, Any component, part, or accessory of a tobacco product, whether or not sold separately.”(15) The highest increase in the number of vape-specific storefronts was observed in 2016 (505%) which is in accordance with the above law expansion. The stores which may have been selling vaping products without a CDTFA license prior to this was mandated to obtain a tobacco retailer license to continue selling vaping and other tobacco products.

The second key finding of this study was the significant increase in the number of active licenses issued for specialized tobacco and/or vape on longitudinal analysis after normalizing for county population. Increasing retail density of specialized tobacco and/or vape stores may influence alternative tobacco product use. Prior research has observed that living in neighborhoods with higher tobacco retail density was associated with higher odds of initiating alternative tobacco use among adolescents.(16) The number of active licenses showed a significant increasing trend for both specialized and non-specific tobacco retail stores. Retail

store tobacco advertising has shown to be a risk factor for smoking initiation among adolescents.(17) The odds of tobacco use initiation increased with the frequency of visiting convenience, grocery stores that contained cigarette advertising.

Median household income was inversely associated with the retail density of both specialized tobacco and/or vape stores as well as non-specific storefronts in the adjusted longitudinal model. This key finding confirms with the existing literature on socioeconomic inequities associated with tobacco retail density.(18) Previous studies have observed disproportionate distribution of tobacco retail outlets within socioeconomically disadvantaged neighborhoods.(6,19) Existing research have observed inequalities in the tobacco retailer density by race and ethnicity. Higher percentage of Hispanic and African Americans was found to be positively correlated with tobacco retail density.(20) However, another ecological study using data from large sample of 97 U.S. counties found no association with Hispanic population.(18) This sociodemographic inequity in the tobacco retail landscape can hasten health disparities within minority and low-income neighborhoods. Licensing policies can be used to curb clustering of tobacco retail outlets within these neighborhoods to reduce tobacco use and initiation.

### *Strengths and limitations*

This study provides additional evidence related to increasing tobacco retail density within California using a longitudinal study design and compares the growth in retail density of specialized and non-specific tobacco stores. Also, the study advances the existing literature on factors associated with tobacco retailer landscape. This study cross-referenced the CDTFA tobacco retailer license listing using Yelp to categorize retailers into specialized tobacco and/or

vape storefronts and non-specific tobacco storefronts. This delineation helped in observing the longitudinal trends specific to each store category. Over 25,000 tobacco retailer license data within California were categorized and analyzed to examine the density over time and the associated sociodemographic factors at the county level. The study also used longitudinal data for population, race/ethnicity, age, gender and median household income variables rather than using baseline data. However, this study has some limitations. The retailer listing obtained does not include individuals (sole proprietors, husband and wife co-owners and domestic partners) who are registered with, or hold licenses or permits issued by, the California Department of Tax and Fee Administration since Civil Code section 1798.69(a) of the Information Practices Act prohibits the disclosure of the names and addresses of individuals. Hence, the study does not include the density of these tobacco retailers. The trends and characteristics of individually owned tobacco retail store density could not be examined. Also, the study does not include the stores which could not be matched and cross-referenced using Yelp. Each of the store from the listing was solely classified based on the listed category type on Yelp. Hence, if a store was on Yelp or listed under the wrong category, the classification could not be verified. In addition, this study was conducted at the county level and the results may not be generalizable to all the cities even within the same county since each city can have a distinct tobacco retail landscape. Also, since this is an ecological study, the interpretation of the findings does not apply to individuals. However, it is helpful in studying the factors affecting the tobacco retail landscape on a large scale which can be further investigate through observational studies.

## *Conclusion*

Examining the trends of tobacco retail density over time is crucial, given the morbidity and mortality burden associated with tobacco use. Exploring the sociodemographic factors that are associated with higher tobacco retail density exposes the disproportionate distribution of tobacco storefronts leading to disparities in tobacco use and thereby health disparities. Improving policies related to tobacco licensing and controlling retail density can help improve health equity. It is important to monitor the density of specialized tobacco and /or vape storefronts apart from overall tobacco retail density in order to reduce retail availability and variety of various new combustible, non-combustible and electronic nicotine devices which are increasingly used by youth and young adults. However, further research needs to be conducted at resolute levels (cities, zip codes) to compare specialized tobacco retail density and non-specific tobacco retail density in order to effectively strategize tobacco control policies which are tailored to reduce smoking prevalence and curtail perception of easy access to tobacco products.

## References

1. Tobacco Trends Brief | American Lung Association [Internet]. [cited 2020 Nov 10]. Available from: <https://www.lung.org/research/trends-in-lung-disease/tobacco-trends-brief/overall-tobacco-trends>
2. Fast Facts | Fact Sheets | Smoking & Tobacco Use | CDC [Internet]. [cited 2020 Nov 10]. Available from: [https://www.cdc.gov/tobacco/data\\_statistics/fact\\_sheets/fast\\_facts/index.htm#beginning](https://www.cdc.gov/tobacco/data_statistics/fact_sheets/fast_facts/index.htm#beginning)
3. Reitzel LR, Cromley EK, Li Y, Cao Y, Mater R Dela, Mazas CA, et al. The effect of tobacco outlet density and proximity on smoking cessation. *Am J Public Health*. 2011 Feb 1;101(2):315–20.
4. Farley SM, Maroko AR, Suglia SF, Thorpe LE. The Influence of Tobacco Retailer Density and Poverty on Tobacco Use in a Densely Populated Urban Environment. *Public Health Rep*. 2019 Mar 1;134(2):164–71.
5. Peterson NA, Lowe JB, Reid RJ. Tobacco outlet density, cigarette smoking prevalence, and demographics at the county level of analysis. *Subst Use Misuse*. 2005;40(11):1627–35.
6. Yu D, Peterson NA, Sheffer MA, Reid RJ, Schnieder JE. Tobacco outlet density and demographics: Analysing the relationships with a spatial regression approach. *Public Health*. 2010 Jul;124(7):412–6.
7. Ackerman A, Etow A, Bartel S, Ribisl KM. Reducing the density and number of tobacco retailers: Policy solutions and legal issues. Vol. 19, *Nicotine and Tobacco Research*. Oxford University Press; 2017. p. 133–40.
8. California Cigarette & Tobacco Products Licensees [Internet]. [cited 2020 Nov 10]. Available from: <https://www.cdtfa.ca.gov/taxes-and-fees/cigarette-licensees.htm>
9. Pattinson J, Lewis S, Bains M, Britton J, Langley T. Vape shops: Who uses them and what do they do? *BMC Public Health*. 2018 Apr 23;18(1):541.
10. Restaurants, Dentists, Bars, Beauty Salons, Doctors - Yelp [Internet]. [cited 2020 Nov 10]. Available from: <https://www.yelp.com/>
11. Welcome to Python.org [Internet]. [cited 2020 Nov 10]. Available from: <https://www.python.org/>
12. The complete Yelp business category list - Yelp [Internet]. [cited 2020 Nov 10]. Available from: [https://blog.yelp.com/2018/01/yelp\\_category\\_list](https://blog.yelp.com/2018/01/yelp_category_list)

13. Automatically Categorizing Yelp Businesses [Internet]. [cited 2020 Nov 10]. Available from: <https://engineeringblog.yelp.com/2015/09/automatically-categorizing-yelp-businesses.html>
14. (No Title) [Internet]. [cited 2020 Nov 10]. Available from: <https://data.census.gov/cedsci/table?q=United States&tid=PEPPPOP2019.PEPANNRES&hidePreview=false>
15. California Cigarette & Tobacco Products Licensing Act of 2003 – Retailer License [Internet]. [cited 2020 Nov 10]. Available from: <https://www.cdtfa.ca.gov/taxes-and-fees/spctretailers.htm>
16. Abdel Magid HS, Halpern-Felsher B, Ling PM, Bradshaw PT, Mujahid MS, Henriksen L. Tobacco Retail Density and Initiation of Alternative Tobacco Product Use Among Teens. *J Adolesc Heal.* 2020 Apr 1;66(4):423–30.
17. Henriksen L, Schleicher NC, Feighery EC, Fortmann SP. A longitudinal study of exposure to retail cigarette advertising and smoking initiation. *Pediatrics.* 2010 Aug;126(2):232–8.
18. Lee JGL, Sun DL, Schleicher NM, Ribisl KM, Luke DA, Henriksen L. Inequalities in tobacco outlet density by race, ethnicity and socioeconomic status, 2012, USA: Results from the ASPiRE Study. *J Epidemiol Community Health.* 2017 May 1;71(5):487–92.
19. Novak SP, Reardon SF, Raudenbush SW, Buka SL. Retail tobacco outlet density and youth cigarette smoking: A propensity-modeling approach. *Am J Public Health.* 2006 Apr;96(4):670–6.
20. Anesetti-Rotherme A, Herman P, Bennett M, English N, Cantrell J, Schillo B, et al. Sociodemographic disparities in the tobacco retail environment in Washington, DC: A spatial perspective. *Ethn Dis.* 2020 Sep 1;30(3):479–88.

### **Chapter 3: Discussion**

Tobacco retail landscape often demonstrates sociodemographic inequity which can influence more than just smoking prevalence. This study observed an inverse association between tobacco retail density (both specialized and non-specific) and proportion of youth and young adults. However, prior literature suggests that tobacco retail density influences smoking rates among youth and young adults.(1) Youth with frequent access to convenience stores that sell e-cigarettes and exposure to marketing advertisements were observed to have higher risk of e-cigarette initiation.(2) Studies have also observed that price promotions on tobacco products are associated with higher proportion of youth in the neighborhood.(3–5) Such price promotions in areas with lower median household income can induce a sense of easy accessibility and make tobacco use more appealing especially to youth. Retail licensing policies should aim at reducing the clustering of stores in such neighborhoods which will not only reduce the disparities in tobacco use but also reduce the exposure disparities through targeted marketing at these retail outlets. Prior study observed that implementing a ban on the sales of tobacco product within 1000 feet of schools in New York and Missouri would significantly reduce the tobacco use disparities by income and proportion of African American Population.(6) The inverse association between median household income and tobacco retail density has been established through various studies. Apart from confirming this finding, this study also observed a significant association between low income and retail density of specialized tobacco and/or vape stores. With changing tobacco retail landscape, it is important to note this association in order to regulate the number of licenses being issued to such specialized tobacco and/or vape stores.

Future research should aim at examining the longitudinal trends in clustering of specialized tobacco retail outlets at more resolute levels such as census tracts and also identify

distinct sociodemographic influencing the clustering. Also, studies should identify the impact of tobacco retailer licensing policies that can reduce evident tobacco use disparities that specifically impacts youth, racial/ethnic minorities and lower income individuals.

## References

1. Leatherdale ST, Strath JM. Tobacco retailer density surrounding schools and cigarette access behaviors among underage smoking students. *Ann Behav Med.* 2007;33(1):105–11.
2. D’Angelo H, Patel M, Rose SW. Convenience Store Access and E-cigarette Advertising Exposure Is Associated With Future E-cigarette Initiation Among Tobacco-Naïve Youth in the PATH Study (2013–2016). *J Adolesc Heal.* 2020;
3. Ribisl KM, D’Angelo H, Feld AL, Schleicher NC, Golden SD, Luke DA, et al. Disparities in tobacco marketing and product availability at the point of sale: Results of a national study. *Prev Med (Baltim).* 2017 Dec 1;105:381–8.
4. Waddell EN, Sacks R, Farley SM, Johns M. Point-of-Sale Tobacco Marketing to Youth in New York State. *J Adolesc Heal.* 2016 Sep 1;59(3):365–7.
5. Henriksen L, Schleicher NC, Dauphinee AL, Fortmann SP. Targeted advertising, promotion, and price for menthol cigarettes in California high school neighborhoods. *Nicotine Tob Res.* 2012;14(1):116–21.
6. Ribisl KM, Luke DA, Bohannon DL, Sorg AA, Moreland-Russell S. Reducing disparities in tobacco retailer density by banning tobacco product sales near schools. *Nicotine Tob Res.* 2017 Feb 1;19(2):239–44.