

Tobacco Retail Outlet Density in King County: Implications for
Health Equity and Youth Access to Tobacco

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Abstract

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Preventing youth access to tobacco, and decreasing the likelihood of youth smoking experimentation, remains an essential component in the fight against tobacco. Disparities exist in the amount of tobacco advertising that lower-income and minority youth are exposed to. Youth who are in areas of higher tobacco outlet density and are more heavily exposed to advertising are more likely to try cigarettes. This thesis explores the potential relationship between King County census tract demographics, tobacco outlet density and retail violation rates. An association could indicate inequity in youth access to tobacco between communities. A moderate, but statistically significant, negative correlation was found between tobacco retail outlet density and median household income. Correlations for demographics by race/ethnicity (African-American and Hispanic) were weaker but still statistically significant. No correlation was found between retail violation rate and the demographic variables. These findings indicate that youth in census tracts with lower household incomes and a greater proportion of minorities are exposed to higher densities of tobacco retail outlets. Further research can determine if smoking rates are higher for youth in these King County census tracts, and can indicate if zoning to limit outlet density or location could work towards preventing youth tobacco initiation.

“There is inconsistency in public health messaging that combines warnings about the danger of smoking with tolerance of a retail environment that practically spews cigarettes out of every crevice.”
(Cohen & Anglin, 2009, p.1)

Introduction

Smoking during adolescence is associated with a number of short-term and long-term health problems, such as being at a higher risk for tobacco addiction as an adult, reduced lung function, compromised lung growth, and severe wheezing, especially in more susceptible populations (U.S. Department of Health and Human Services, 2012). The Center for Disease Control and Prevention now also indicates that nicotine in tobacco products could have harmful effects on brain development (Centers for Disease Control, 2016b). In 2015, 11.4% of U.S. 12th grade students, 6.3% of 10th grade students and 3.6% of 8th grade students reported smoking cigarettes in the past 30 days (National Institute on Drug Abuse, 2015). While these smoking rates are much lower than when rates peaked in the late 1990s, preventing adolescent smoking should still be considered a public health priority. Each day over 2,500 youth under the age of 18 try smoking for the first time, and over 500 youth who have already tried cigarettes become daily smokers (Bach, 2015). Preventing youth access to tobacco—and thus decreasing the likelihood of smoking experimentation—remains an essential component in the fight against tobacco.

The first step towards limiting youth access to tobacco at the national level came in 1992, when the Substance Abuse and Mental Health Services Administration (SAMHSA) passed the Synar amendment requiring all states to have a law prohibiting the sale of tobacco products to anyone under the age of 18 (U.S. Food and Drug Administration [FDA], 2015). The 2009 Family Smoking Prevention and Tobacco Control Act (FSPTCA) expanded this by establishing a federal law limiting the purchase of tobacco products to individuals who are at least 18 years of age (FDA, n.d.). Both the FSPTCA and the Synar amendment require checks to be conducted at

tobacco retail outlets to assess compliance with youth access laws; rates of illegal sales to minors during Synar checks are reported as retail violation rates (FDA, 2015).

Despite these laws and the annual monitoring of youth access through retail compliance checks, underage youth still report being able to purchase tobacco products from the licensed outlets in their communities (Levinson & Patnaik, 2013). Canadian researchers Cohen and Anglin have called the current model for selling tobacco products “an anachronism in need of reform,” noting the contradiction between the prominent public health message that smoking is extremely harmful and the ubiquity of tobacco products in the retail environment (2009, p.1). Existing studies have indicated that tobacco retail outlets are even more ubiquitous—measured as outlet density in a given population—in communities with low-socioeconomic status and higher proportions of African-Americans, Hispanics and other minority groups (Hyland et al., 2003; Laws, Whitman, Bowser & Krech, 2002; Schneider, Reid, Peterson, Lowe & Hughey, 2005; Shortt et al., 2015).

Disparities in tobacco outlet density or retail violation rates have never been formally investigated in King County, Washington, although the County committed to addressing health disparities when it launched the Equity and Social Justice (ESJ) Initiative in 2008. In 2015 the Office of ESJ released a report of baseline indicators of equity in the County; this report’s only tobacco indicator is adult use (Beatty & Foster, 2015). The State of Washington recently released a report on tobacco-related disparities across the state that included an analysis of tobacco outlet density based on community characteristics as a way of measuring tobacco related disparities between communities (Washington State Department of Health [WSDOH], 2014b). Those at the state-level clearly believe that tobacco outlet density is an important measure of health equity.

The research presented here is an attempt to establish a baseline assessment of tobacco retail outlet densities and retail violation rates—and potential disparities therein—within King County. It explores the potential relationship between King County census tract demographics, tobacco outlet density and retail violation rates, which could indicate inequity in youth access to tobacco between communities. More specifically, it asks: 1) if census tract demographics (median household income, level of education, and proportions of the population that are non-white, African-American, Hispanic/Latino and under age 18) are correlated with the density of tobacco outlets in the tract; 2) if these tract-level characteristics are associated with density of tobacco outlets located in school neighborhoods; and 3) if these characteristics are related to the rate of vendor compliance with laws prohibiting the sale of tobacco to minors.

Background and Literature Review

Rates of smoking—and of tobacco-related health problems—differ for specific populations, with low-socioeconomic-status (SES), minority and other marginalized populations experiencing a higher burden of tobacco use and disease (Fagan, Moolchan, Lawrence, Fernander & Ponder, 2007). In King County, this holds true for both adults and youth. Adults in lower income brackets and those who identify as African-American or American Indian/Alaska Native report higher rates of smoking than the average rates for the County (Public Health – Seattle & King County, 2014a). Youth who identify as American Indian/Alaska Native and Native Hawaiian/Pacific Islander also smoke at rates that are one and a half to two times greater than their peers (Public Health – Seattle & King County, 2014b).

In addition to the disparities in use and health outcomes, studies have shown that low-SES and minority communities experience a higher density of advertising (Barbeau, Wolin, Naumova & Balbach, 2005; Laws et al., 2002; Pucci, Joseph & Siegel, 1998). Additionally,

these communities experience targeted tobacco advertising; for example, mentholated cigarette brands such as Kool and Newport are marketed much more heavily in neighborhoods that are predominantly African-American than in predominantly White neighborhoods (Laws et al., 2002; Pucci et al., 1998). This is a clear issue of health equity considering that youth exposure to tobacco advertising has been found to be associated with higher odds of tobacco initiation (Henriksen, Schleicher, Feighery, & Fortmann, 2010; Johns, Sacks, Rane & Kansagra, 2013).

Youth Tobacco Access: Tobacco Outlet Density and Proximity

Density of tobacco retail outlets in a community is another possible way to quantify disparities in youth exposure to tobacco products and marketing. Tobacco outlet density has been shown to increase youth exposure to point-of-purchase advertisements present at retail locations (Henriksen et al., 2010; Loomis et al., 2012). Higher tobacco retail outlet density has also been found to be associated with more positive perceptions of smoking among non-smoking youth and norms about tobacco use (Adams, Jason, Pokorny & Hunt, 2013; Henriksen et al., 2008; Loomis et al., 2012). An extensive body of literature has explored the relationship between tobacco retail outlet density and demographics, and nearly all studies have found that higher outlet density occurs in communities that are lower-income and have higher proportions of minority populations, especially African-American and Latinos (Barbeau et al., 2005; Hyland et al., 2003; Laws et al., 2002).

There is a considerable body of literature that looks at the association of tobacco retail outlet density (at city, census-tract, and school-neighborhood levels), with outcomes such as youth smoking prevalence and susceptibility to future smoking. One city-level study conducted in California found that adolescent lifetime smoking (having ever tried a cigarette, even just a puff) was greater in cities with higher retail outlet density, measured as the number of outlets per

10,000 people (Lipperman-Kreda et al., 2015). A number of studies have looked at tobacco outlet density within school “neighborhoods” (which has been defined by different researchers as buffered areas of differing size around a school). Henriksen, et al. (2008) found that prevalence of current youth smoking (having smoked at least one time during the past 30 days) was greater at high schools with highest retail density (>5 outlets in a 0.5-mile buffer around the school) compared to schools without any outlets within this “neighborhood” buffer. Adams et al (2013) also assessed tobacco retail outlet density within a 0.5-mile radius around each school, and found that density of retailers was significantly related to the prevalence of lifetime smoking, but not current smoking, among youth. Another study found that increasing density of retailers within a 1-mile radius around each school was associated with a higher likelihood of youth experimental smoking (OR=1.11), but only for high-school-age youth in urban areas (McCarthy et al., 2009).

Finally, while the vast majority of studies have focused on outlet density, two studies also investigated measures of tobacco retail outlet proximity to school. Henriksen et al. measured proximity two ways—presence of a tobacco outlet within 1,000 feet of a high school and the distance to the nearest tobacco outlet from the school—but found that neither proximity measure was associated with youth smoking prevalence (2008). Similarly, McCarthy et al. found no relationship between the average proximity of outlets within a 1-mile radius of a school and youth smoking behaviors (2009). These findings indicate that rates of youth smoking experimentation are influenced by tobacco outlet densities around schools, but not measures of tobacco outlet proximity to schools.

Youth Tobacco Access: Retail Violation Rates

Minimum age sales restrictions for tobacco products constitute the main policy approach to limiting youth access across the United States. As described above, the Synar retail violation

rate is the official measure of vendor compliance reported by states, and is calculated annually from the federally-mandated unannounced Synar inspections that each state must conduct at a random but representative sample of tobacco outlets (FDA, n.d.). The standard protocol for these inspections generally involves having a non-smoking, high-school-aged youth (who is not allowed to use makeup or clothing to appear older) attempt to purchase cigarettes from a vendor; youth cannot lie about their age or refuse to present identification showing their age (DiFranza, Savageau & Bouchard, 2001). Each successful purchase is considered a sales violation, and this is how a state—or county—tobacco retail compliance rate is calculated.

Several researchers have tried to determine if retail violations—and therefore youth tobacco access—vary based on area demographic characteristics. One study investigated the presence of retail violations by neighborhood (census block group) demographics to determine if retail violations were more prevalent in lower-income and more diverse neighborhoods. They found that across Florida neighborhoods, the presence of tobacco retail violations was associated with lower per capita income and a larger Hispanic population (Asumda & Jordan, 2009). A more recent study explored the relationship between tobacco outlet retail violations, outlet proximity to schools and block group demographics. Kirchner et al looked at illegal sales to minors at tobacco outlets located within a 1,600m radius of high schools in the D.C. area (2015) and found that compliance violations were more likely as proximity to a high school increased (OR=1.36), but only within block groups where more than 56% of the population was African-American (a proxy in this study for low-SES). However, the inverse was true for higher-SES block groups, such that increased proximity to a high school was associated with a lower probability of illegal sales to minors (Kirchner et al., 2015). These findings demonstrate a

disparity in tobacco retail access for youth, indicating a higher burden of retail violations in communities with low-SES and a higher concentration of minorities.

In the realm of tobacco prevention and control, there has been much debate about the validity of using retail violation rates as a true measure of youth tobacco access. Standard measures of vendor compliance with sales restrictions for tobacco do not necessarily reflect youths'—especially those who are established smokers—ability to purchase tobacco products (Levinson & Patnaik, 2013). Due to the constraints placed on the youth test-shopper as part of the standard protocol, compliance checks may be “too artificial to reflect accurately the experience of underage smokers,” who know which stores to frequent, may lie about their age, or use other behaviors to increase the likelihood of being sold tobacco (DiFranza et al., 2001, p.227). As such, even when compliance with youth access laws is strong, underage smokers still report being able to purchase their own tobacco products. For example, in 2008, Colorado reported a retail violation rate of 11%, but a statewide survey found that 60.6% of high schoolers under age 18 said their most recent tobacco purchase attempt had been successful (Levinson & Patnaik, 2013). One important reason for this discrepancy is that retail violation rates are a measure of the proportion of retail outlets that violate the law and not a measure of the success of youth's individual purchase attempts, so the retail violation rate does not directly estimate actual rates of tobacco sales to minors. Kirchner and colleagues explain that a measure of “actual underage sales would need to account for highly variable sales volume levels between retailers, as well as self-selection effects, as youths seek out outlets known to sell to minors” (2015, p.57). Vendor compliance rates are a potential measure of youth access to tobacco products, but only if compliance checks can better reflect youths' actual purchase attempts.

Based on the findings of two systematic reviews, a majority of the existing literature indicates that improved vendor compliance has little to no significant correlation with reductions in prevalence of youth smoking (Fichtenberg & Glantz, 2002; Stead & Lancaster, 2005 [2008 update]). In addition to established smokers' knowledge of which retail outlets to frequent, increased compliance may not necessarily correlate with lower rates of youth smoking because underage smokers—especially younger and experimental smokers—report getting cigarettes from other social sources, such as friends, family members, or even stealing (DiFranza & Coleman, 2001). For example, the 2012 Washington State Health Youth Survey (HYS) revealed that while only 15% of 8th grader and 12% of 10th grader “current smokers” report that their primary means of obtaining cigarettes was purchasing their own from a store, 38% of 12th grade current users primarily purchase their own cigarettes (WSDOH, 2014a). Younger smokers may have to rely more on social sources than their older peers, which could indicate that increased compliance with youth access laws has been effective in reducing the ability of younger and unexperienced smokers to purchase tobacco products. As such, there are those in the tobacco control community who continue to emphasize the importance of retail compliance in limiting youth access to tobacco (Jason, Pokorny & Schoeny, 2003; Tutt, Bauer & DiFranza, 2009). Additionally, restricting minors' access to tobacco products through age-based sales laws, along with monitoring and enforcement of these laws, and community mobilization, is included in the Community Guide as an effective part of a comprehensive tobacco control program (Guide to Community Preventive Services, 2015).

Local Youth Tobacco Access

Measures of tobacco outlet density have never been calculated for King County, although reports of retail compliance for the county and state are made available each year. Washington

State's 2015 Synar retailer violation rate was over 17%, which is the highest it has been since 1997, when the state first started monitoring vendor compliance (WSDOH, 2016). While the King County rate of Synar non-compliance for 2015 was drastically lower than the state (8.1%) it also represents an increase—albeit slight—from the past two years (7.3% in 2014 and 6.8% in 2013) (WSDOH, 2016). It is worth noting here that King County conducts far more tobacco compliance checks than other counties in the state, as well as conducting enforcement and vendor education with a much greater proportion of all tobacco outlets in the county; this most likely contributes to the much lower violation rate than the state.

Despite yearly variation in the difference between the state and county Synar rates, the smoking rate for youth does not differ substantially between King County and the State as a whole (Washington State Healthy Youth Survey, n.d.). Additionally, while rates of non-compliance in King County have decreased over the past 5 years, from just under 13% in 2011 and 2012, to around 7% in 2013-2015 (as mentioned above), rates of current tobacco use reported by youth barely decreased (for 8th and 12th graders) or stayed the same (for 6th and 10th graders) between the 2012 and 2014 Healthy Youth Survey years (Washington State Healthy Youth Survey, n.d.). This indicates that, at least for King County as a whole, there may not be a direct (or at least immediate) link between vendor compliance rates and youth smoking. Yet it is also possible that retail violation rates and youth smoking rates vary across diverse areas of the county, resulting in youth from certain marginalized communities experiencing greater access to tobacco products than their more privileged peers. As such, and even in light of the lack of consensus regarding the utility of retail violation rates in estimating youth access to tobacco, it remains important to assess this measure using a more precise geographical unit of analysis.

Considering the county's relatively strong compliance rates—but continued presence of smoking—it may also be necessary to consider alternative ways to limit youth access to tobacco that do not rely solely on age restrictions or compliance checks. Limitations on tobacco retail outlet density could play an important role in changing the youth tobacco access landscape while simultaneously working towards elimination of disparities in access. In order to do so, however, the current tobacco retail density must be established.

Methods

This descriptive study relied on existing demographic data and tobacco outlet location data for King County, Washington. Data was included for all census tracts in the county and therefore no sampling methods were used.

Data Collection

A list of all tobacco retail outlets (N=1,905) in King County, Washington was obtained from the Washington State Department of Health which maintains a record of all outlets by county. The tobacco retail list was from 2015, which was the most current record available. This list included the business names, addresses and a unique business identifier (UBI) for all tobacco retail outlets. With the assistance of a member of the King County Tobacco Prevention Program, 29 duplicate outlets were removed from the list, resulting in a new list of 1,876 outlets. Records from all King County compliance checks conducted in 2015 (N=1,180) were obtained from the county's Tobacco Prevention Program. This record included federal Synar checks (N=184) and all additional checks conducted as part of annual King County Tobacco Prevention Program surveillance (N=996). The additional checks included 28 retail outlets that were defined as

“vapor” stores, of which only two were included (using the same business name) on the list of retail outlets obtained from the Department of Health¹.

Demographic data was obtained from the American Community Survey (ACS) 5-Year Estimates (2010-2014) for all census tracts in King County (U.S. Census Bureau, 2015a-c). The demographic indicators included median household income, race/ethnicity, age, and educational attainment.

Two files with spatial location data were obtained from the King County GIS (geographic information system) Data Portal. The School Sites in King County shapefile contains geographic locations of every school building in the county as of 2015, including details about school district and type. The second file obtained was the 2010 Census Tracts for King County shapefile, containing King County census tract boundaries but excluding major bodies of water.

Spatial Location Data

Tobacco outlet locations were geocoded using a google script editor which uses physical addresses to determine latitude and longitude based on Google’s geo-locator. The majority of tobacco outlets were successfully geocoded this way, but 21 (1.1%) required manual geocoding due to address errors in the original file. This included 20 tobacco outlets located inside Sea-Tac Airport for which the street and zip code were incorrectly listed. These were manually corrected and then geocoded. The full set of geocoded tobacco outlets was mapped with ArcGIS software version 10.3.1 (ESRI, Redlands, CA), and converted to a shapefile.

The 2010 Census Tracts shapefile containing the census tract boundaries (N=397) was added as the base layer of the map. The 2014 ACS demographic data was joined to this shapefile

¹ In 2015, stand-alone vapor stores were not required to obtain a license to operate in King County, and therefore did not appear on the Department of Health list of retail outlets.

based on census tract ID, resulting in a final layer containing the demographic information for all census tracts.

Tobacco retail outlet location points were layered on to the base map. Initial spatial analysis showed that 11 outlets were actually located outside of the King County boundaries. Using the “Select by Location” tool in ArcGIS, an updated shapefile of tobacco retail outlets that were located within the King County boundary (N=1,865) was created and used for the rest of the analysis.

The School Sites in King County shapefile was added to the map. The “Select by Attribute” tool in ArcGIS was used to refine the shapefile to include only active elementary, middle, high and K-12 schools (excluding colleges/universities, administrative and vacant buildings). This refined layer was used for analysis.

Compliance check outlet locations were geocoded using the same methods described for the full set of retail outlets.

Spatial Analysis

Two measures of tobacco outlet density were created: one at the census-tract level and one at the school-neighborhood level. Census tract outlet density was defined as the number of tobacco outlets in a census tract per 1,000 people (Rodriguez, Carlos, Adachi-Mejia, Berke & Sargent, 2013; WSDOH, 2014b). First, the Spatial Join tool for points to polygons in ArcGIS was used. This joined a count of the number of tobacco outlets (points) in each tract (polygon) to the attribute information for the census tracts. Then, using the 2014 ACS 5-Year Estimates of census tract population, the number of outlets per 1,000 individuals was calculated. This provided a density measure that accounted for census tract population size.

To determine school-based outlet density, the buffering tool in ArcGIS was used. Circular buffers were created around each school using a radius of 0.5 miles (805 m). This distance has been described by other researchers as a reasonable walking distance to and from school (Adams et al. 2013; Henriksen et al. 2008). Selecting by location in ArcGIS, a new shapefile was created containing only the tobacco outlets that were within the 0.5mi buffer around each school. A spatial join was conducted, as described above, this time joining a count of the tobacco outlets located near schools (N=1,302) to each census tract. Density calculations were again performed to account for population size within each census tract. This yielded a measure of the number of outlets located within school neighborhoods per 1,000 individuals for each census tract.

Geocoded compliance check locations were mapped with ArcGIS and the Spatial Join tool was used to match each outlet to the census tract it fell within from the 2010 demographics base layer. Ten outlets were not matched with census tract layer, seven of which were outlets located outside of the King County boundary. A census tract label was determined for each of the remaining compliance check locations (N=1,170). Selecting by attribute, a selection was created of compliance checks which had resulted in a sales violation (N=103). These outlets were again joined with the 2010 Census Tract boundary layer, and each a count of sales violations was generated for each tract. Retail violation rates were calculated for each census tract based on the number of recorded sales violations out of the total number of checks conducted over the 2015 surveillance year.

Data Analysis

The main outcome variables used for analysis were the two measures of tobacco outlet density calculated for each census tract (outlets per 1,000 people and outlets within 0.5 miles of a

school per 1,000 people) and the 2015 retail violation rate for each census tract. Independent variables used for data analysis were median household income; percent of the population with a high school degree or higher; percentages of the population that identify as White, African-American, and Hispanic/Latino; and percent of the population that was under the age of 18.

Descriptive statistics were calculated for the census tracts for all dependent and independent variables using Stata 13.0 (StataCorp, 2013). Pearson's test for correlation was conducted to assess the relationship between independent and dependent variables. Census tract was used as the level of analysis.

Results

Table 1 presents descriptive statistics of all variables for the census tracts and King County. Analysis found that 70% of tobacco retail outlets in King County are located within 0.5 miles of a school. Mean tobacco outlet densities for census tracts—both overall and near schools—were similar to the densities for King County as a whole. Median household income was, on average, higher for the census tracts than for the county as a whole. Census tracts contained an average of 4.7 tobacco retail outlets, but varied substantially. There were 54 census tracts (13.6%) that were found to contain no tobacco retail outlets, while 10 census tracts (2.5%) contained 20 or more. On average, there were 3.3 tobacco retail outlets located within 0.5 miles of a school for the census tracts, but only 291 tracts (73.3%) contained this kind of outlet. The retail violation rate for King County (8.8%) was slightly lower than the mean retail violation rate across the 300 census tracts in which checks took place (8.9%).

Table 1. Descriptive Statistics for King County Census Tract Demographics and Tobacco Retail Outlets

King County Census Tracts (N=397)	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	King County Total
Median Household Income	78,606.2	30,825.4	5,938	188,077	73,035
Population Size	5060.4	1585.7	1,079	12,105	2,008,997
High School Graduate or Higher (% Adults 25+)	91.9	7.5	60	100	92.1
White (%)	74.1	16.4	9.3	98.9	73.7
African American (%)	6.2	7.4	0	41.4	7.9
Hispanic or Latino (%)	9.0	7.7	0	45.6	9.2
Population Under 18 Years Old (%)	20.8	6.8	0.4	41.9	21.1
Tobacco Retail Outlets	4.7	5.2	0	43	1,865
Tobacco Outlets per 1,000 people	1.0	1.4	0	14.8	0.9
Tobacco Retail Outlets within School Area	3.3	4.0	0	23	1,302
Tobacco Outlets within School Area per 1,000 people	0.7	0.9	0	7.4	0.6
Retail Violation Rate [†]	8.9	18.5	0	100	8.8

Note: *M* = Mean; *SD* = Standard Deviation. [†] Retail violation rate was calculated only for the census tracts where checks took place (N=300).

Median household income was found to have a moderate, but statistically significant, negative correlation with tobacco retail outlet density at the census-tract level ($r = 0.39$, $p < 0.001$), and a similar relationship with tobacco retail outlet density at the school level ($r = 0.41$, $p < 0.001$). Associations between other census tract characteristics and retail outlet densities were weaker but still significant, ranging from 0.14 to 0.35 (Table 2). An significant inverse relationship was found between outlet density and the percentage of the population under 18. No correlation was found to exist between retail violation rate and the demographic variables.

Table 2. Correlations between Census Tract Demographics, Outlet Density and Retail Violation Rate

Variables	1	2	3	4	5	6	7	8	9
1. Median Household Income	--								
2. High School Graduate or Higher (%)	0.62*	--							
3. White (%)	0.43*	0.68*	--						
4. African American (%)	-0.50*	-0.64*	-0.76*	--					
5. Hispanic or Latino (%)	-0.51*	-0.67*	-0.34*	0.28*	--				
6. Population Under 18 Years Old (%)	0.32*	-0.20*	-0.12*	0.09	0.23*	--			
7. Tobacco Outlets per 1,000 people	-0.39*	-0.26*	-0.17*	0.21*	0.15*	-0.33*	--		
8. Outlets in School Area per 1,000 people	-0.41*	-0.23*	-0.14*	0.22*	0.15*	-0.35*	0.80*	--	
9. Retail Violation Rate	-0.09	-0.02	0.02	0.00	0.1	-0.08	0.11	0.05	--

Discussion

This study is the first to examine the relationship between King County census tract demographics and exposure to tobacco products by measuring tobacco retail outlet density and retail violation rates. Although correlations between census tract characteristics and tobacco outlet densities were found to be only moderate in strength, all density relationships were statistically significant. Median household income was found to have the strongest association with tobacco outlet density for both the census tract and school areas.

These findings are consistent with published studies that found higher densities of tobacco retail outlets in lower-income areas (Hyland et al., 2003; Laws et al., 2002; Shortt et al., 2015). However, while a number of the existing studies found race and ethnicity to have a similarly strong association with tobacco outlet density, the present study found associations based on percent African-American and percent Hispanic/Latino population that were somewhat weaker than for median household income (Schneider et al., 2005; Yu, Peterson, Sheffer, Reid & Schneider, 2010).

This study was unique (to the author's knowledge) in considering the percent of the population under age 18—and therefore legally unable to purchase tobacco products—in relation to census tract outlet density and retail violation rate. Counter to what was expected, this measure of the prevalence of minors was inversely related to tobacco outlet density, indicating that there are fewer tobacco retail outlets in census tracts where there are more kids.

Finally, it was interesting to find no significant associations between the retail violation rate and any of the census tract demographic variables. Although the usefulness of this rate as a measure of youth tobacco exposure has been debated, the lack of any association with

these variables seems to indicate that lower-income communities and communities of color in King County do not experience a disproportionate burden of retail violation rates.

Study Limitations

One limitation of this study was that the compliance checks conducted by the Tobacco Prevention Program beyond the federally-mandated Synar checks were not a random or representative sample of tobacco retail outlets in the county. Instead, due to limited resources, the Program uses a convenience sample to reach as many tobacco outlets as possible over the course of the year. This means that not all outlets receive a compliance check, and therefore not all outlets have the potential to be non-compliant. Considering that 43 census tracts with at least one retail outlet did not receive any compliance checks in 2015, it is possible that a true association between retail violation rate and census tract demographics could have been obscured. In the future, statistical analyses could be used to indicate the representativeness of the sample of census tracts included in compliance checks.

Implications of Findings

This study's findings have implications for health equity promotion in King County and for future work in tobacco prevention and control. Given the established link between tobacco retail outlet density and initiation of smoking in youth, King County youth in lower-income census tracts appear to be at a higher risk for smoking experimentation than their peers in higher-income tracts. Additionally, youth in areas of higher outlet density may be more likely to perceive tobacco as easily accessible by youth (Henriksen, Flora, Feighrey & Fortmann, 2002; Lipperman-Kreda et al., 2015). Furthermore, normative beliefs among youth regarding the acceptability of tobacco use in their community—or by their peers—may be influenced to be more amenable to tobacco use (Adams et al., 2013; Shortt et al., 2015). Prevention science

emphasizes the importance of clear community norms about substance use as a protective factor for preventing problem behaviors such as tobacco use (Hawkins, Catalano & Arthur, 2002). A lack of clear norms about the unacceptability of tobacco use, due to the high density of tobacco outlets in a community, is certainly worthy of being addressed as part of a comprehensive tobacco prevention and control effort.

Several researchers have pointed to the role that zoning policies could potentially play in limiting retail outlet density, and thus youth exposure to tobacco (Adams et al., 2013; Cohen & Anglin, 2009; Lipperman-Kreda et al., 2015). Another asserts that adopting policies that restrict the number, type and location of tobacco outlets could “hasten the endgame” (Henriksen, 2015, p.e1). One reason that zoning ordinances are not more widely used seems to be the lack of clear causation between higher outlet density and higher rates of tobacco use (Schneider et al., 2005). For King County, establishing a clear link between higher outlet density and higher rates of youth tobacco use could work to build a case for considering zoning approaches to limit outlet density and promote health equity for all census tracts. Future research could build on the findings of this study by using survey data to determine smoking rates for schools or census tracts, and assessing the relationship between outlet density and tobacco use for King County youth. In the coming years, research can also play an important role in monitoring youth access to e-cigarette and vaping products as these new outlets may increase overall tobacco outlet densities in King County, and may impact rates of retail violation, now that vapor retail outlets must also comply with minimum age sales laws.

Citations:

- Adams, M.L., Jason, L.A., Pokorny, S., Hunt, Y. (2013). Exploration of the link between tobacco retailers in school neighborhoods and student smoking. *Journal of School Health*, 83(2), 112–118.
- Asumda, F., & Jordan, L. (2009). Minority youth access to tobacco: a neighborhood analysis of underage tobacco sales. *Health & place*, 15(1), 140-147.
- Bach, L. (2015, December). The path to tobacco addiction starts at very young ages. Campaign for Tobacco Free Kids.
- Barbeau, E.M., Wolin, K.Y., Naumova, E.N., & Balbach, E. (2005). Tobacco advertising in communities: associations with race and class. *Preventive Medicine*, 40(1), 16-22.
- Beatty, A. & Foster, D. (2015). The determinants of equity: Identifying indicators to establish a baseline of equity in King County. King County Office of Performance, Strategy and Budget: Seattle, WA.
- Centers for Disease Control and Prevention (CDC). (2016a). Youth & tobacco use. Retrieved from http://www.cdc.gov/tobacco/data_statistics/fact_sheets/youth_data/tobacco_use/
- Centers for Disease Control and Prevention (CDC). (2016b). E-Cigarette ads and youth. Retrieved from: <http://www.cdc.gov/vitalsigns/ecigarette-ads/>
- Cohen, J.E., & Anglin, L. (2009). Outlet density: a new frontier for tobacco control. *Addiction*, 104(1), 2-3.
- DiFranza, J.R., & Coleman, M. (2001). Sources of tobacco for youths in communities with strong enforcement of youth access laws. *Tobacco Control*, 10(4), 323-328.
- DiFranza, J.R., Savageau, J.A., & Bouchard, J. (2001). Is the standard compliance check protocol a valid measure of the accessibility of tobacco to underage smokers? *Tobacco Control*, 10, 227–232.
- ESRI. (2015). *ArcGIS*. Version 10.3.1. Redlands, CA: Environmental Systems Research Institute.
- Fagan, P., Moolchan, E.T., Lawrence, D., Fernander, A., & Ponder, P.K. (2007). Identifying health disparities across the tobacco continuum. *Addiction*, 102(s2), 5-29.
- Fichtenberg, C. M., & Glantz, S. A. (2002). Youth access interventions do not affect youth smoking. *Pediatrics*, 109(6), 1088-1092.
- Guide to Community Preventive Services. (2015) Community mobilization with additional interventions to restrict minors' access to tobacco products. www.thecommunityguide.org/tobacco/communityinterventions.html.
- Hawkins, J. D., Catalano, R. F., & Arthur, M. W. (2002). Promoting science-based prevention in communities. *Addictive behaviors*, 27(6), 951-976.
- Henriksen, L. (2015). The retail environment for tobacco: a barometer of progress towards the endgame. *Tobacco control*, 24(e1), e1-e2.
- Henriksen, L., Flora, J. A., Feighery, E., & Fortmann, S. P. (2002). Effects on youth of exposure to retail tobacco advertising. *Journal of Applied Social Psychology*, 32(9), 1771-1789.
- Henriksen, L., Feighery, E.C., Schleicher, N.C., Cowling, D.W., Kline, R.S., & Fortmann, S.P. (2008). Is adolescent smoking related to the density and proximity of tobacco retail outlets and retail cigarette advertising near schools? *Preventative Medicine*, 47(2), 210-214.

- Henriksen, L., Schleicher, N. C., Feighery, E. C., & Fortmann, S. P. (2010). A longitudinal study of exposure to retail cigarette advertising and smoking initiation. *Pediatrics*, 126(2), 232-238.
- Hyland, A., Travers, M. J., Cummings, K. M., Bauer, J., Alford, T., & Wieczorek, W. F. (2003). Tobacco outlet density and demographics in Erie County, New York. *American Journal of Public Health*, 93(7), 1075-1076.
- Jason, L. A., Pokorny, S. B., & Schoeny, M. E. (2003). It is premature to abandon youth access to tobacco programs. *Pediatrics*, 111(4), 920-921.
- Johns, M., Sacks, R., Rane, M., & Kansagra, S. M. (2013). Exposure to tobacco retail outlets and smoking initiation among New York City adolescents. *Journal of Urban Health*, 90(6), 1091-1101.
- Kirchner, T.R., Cillanti, A.C., Cantrell, J., Anesetti-Rothermel, A., Ganz, O., Conway, K.P. ... Abrams, D.B.. (2015). Tobacco retail outlet advertising practices and proximity to schools, parks and public housing affect Synar underage sales violations in Washington, DC. *Tobacco Control*, 24(e1), e52-e58.
- Laws, M.B., Whitman, J., Bowser, D.M., & Krech, L. (2002). Tobacco availability and point of sale marketing in demographically contrasting districts of Massachusetts. *Tobacco Control*, 11(suppl 2), ii71-ii73.
- Levinson, A.H., & Patnaik, J.L. (2013). A practical way to estimate retail tobacco sales violation rates more accurately. *Nicotine & Tobacco Research*, 15(11), 1952-1955.
- Lipperman-Kreda, S., Grube, J. W., Friend, K. B., & Mair, C. (2015). Tobacco outlet density, retailer cigarette sales without ID checks and enforcement of underage tobacco laws: associations with youths' cigarette smoking and beliefs. *Addiction*, 11(3), 525-532.
- Loomis, B. R., Kim, A. E., Busey, A. H., Farrelly, M. C., Willett, J. G., & Juster, H. R. (2012). The density of tobacco retailers and its association with attitudes toward smoking, exposure to point-of-sale tobacco advertising, cigarette purchasing, and smoking among New York youth. *Preventive medicine*, 55(5), 468-474.
- McCarthy, W.J., Mistry, R., Lu, Y., Patel, M., Zheng, H. & Dietsch, B.. (2009). Density of tobacco retailers near schools: effects on tobacco use among students. *American Journal of Public Health* 99(11), 2006–2013.
- National Institute on Drug Abuse. (2015, December). Monitoring the Future 2015 survey results. Retrieved from: <https://www.drugabuse.gov/related-topics/trends-statistics/infographics/monitoring-future-2015-survey-results>
- Pucci, L.G., Joseph, H.M., & Siegel, M. (1998). Outdoor tobacco advertising in six Boston neighborhoods: evaluating youth exposure. *American Journal of Preventative Medicine*, 15(2), 155-159.
- Public Health – Seattle & King County, APDE. (2014a, December). King County Community Health Indicators: Any tobacco use (school age), King County, 2012. Retrieved from <http://www.kingcounty.gov/healthservices/health/data/indicators.aspx>
- Public Health – Seattle & King County, APDE. (2014b, December). King County Community Health Indicators: Cigarette smoking (adults), King County, 2009-2-13 average. Retrieved from: <http://www.kingcounty.gov/healthservices/health/data/indicators.aspx>
- Rodriguez, D., Carlos, H. A., Adachi-Mejia, A. M., Berke, E. M., & Sargent, J. D. (2013). Predictors of tobacco outlet density nationwide: a geographic analysis. *Tobacco Control*, 22(5), 349–355.

- Schneider, J. E., Reid, R. J., Peterson, N. A., Lowe, J. B., & Hughey, J. (2005). Tobacco outlet density and demographics at the tract level of analysis in Iowa: implications for environmentally based prevention initiatives. *Prevention Science*, 6(4), 319-325.
- Shortt, N. K., Tisch, C., Pearce, J., Mitchell, R., Richardson, E. A., Hill, S., & Collin, J. (2015). A cross-sectional analysis of the relationship between tobacco and alcohol outlet density and neighbourhood deprivation. *BMC public health*, 15(1), 1.
- StataCorp. (2013). *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP.
- Stead, L. & Lancaster, T.. (2005). Interventions for preventing tobacco sales to minors. *Cochrane Database of Systematic Reviews*, 1.
- Tutt, D., Bauer, L., & DiFranza, J. (2009). Restricting the retail supply of tobacco to minors. *Journal of public health policy*, 30(1), 68-82.
- U.S. Census Bureau (2015a). ACS demographic and housing estimates. 2010-2014 American Community Survey 5-year estimates. Retrieved from:
http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_5YR_DP05
- U.S. Census Bureau (2015b). Educational attainment. 2010-2014 American Community Survey 5-year estimates. Retrieved from:
http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_5YR_S1501
- U.S. Census Bureau (2015c). Median household income in the past 12 months, 2010-2014 American Community Survey 5-year estimates. Retrieved from:
http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_5YR_B19013
- U.S. Department of Health and Human Services. (2012). Preventing tobacco use among youth and young adults: A report of the Surgeon General. Retrieved from:
<http://www.surgeongeneral.gov/library/reports/preventing-youth-tobacco-use/>
- U.S. Food and Drug Administration. (2015). A Strategic Partnership: The Food and Drug Administration's (FDA) tobacco retail compliance inspection contracts and the Substance Abuse and Mental Health Services Administration's (SAMHSA) Synar Program. Retrieved from:
<http://www.fda.gov/TobaccoProducts/GuidanceComplianceRegulatoryInformation/Retail/ucm284341.htm>
- U.S. Food and Drug Administration. (n.d.). Compliance and enforcement report: 2009 – 2013. Retrieved from
<http://www.fda.gov/TobaccoProducts/GuidanceComplianceRegulatoryInformation/ucm396171.htm>
- Washington State Healthy Youth Survey (n.d.). Healthy Youth Survey fact sheet: Tobacco use for King County, 2012 & 2014. Retrieved from: <http://www.askhys.net/FactSheets>
- Washington State Department of Health. (2016, Feb 17). Illegal tobacco sales to minors at highest level since 1997: More than 17 percent of tobacco retailers sold to minors in 2015. [Press release]. Retrieved from
<http://www.doh.wa.gov/Newsroom/2016NewsReleases/16014SynarReportNewsRelease>
- Washington State Department of Health. (2014a, January). Washington Healthy Youth Survey 2012 Analytic Report. DOH publication no.160-193. Retrieved from:
<http://www.doh.wa.gov/DataandStatisticalReports/DataSystems/HealthyYouthSurvey>

Washington State Department of Health. (2014b, October). Tobacco-related disparities in Washington State: Tobacco is a Health Equity Problem. DOH publication no. 340-240. Retrieved from:

<http://www.doh.wa.gov/DataandStatisticalReports/HealthBehaviors/Tobacco/PreventionandHealthEquity>

Yu, D., Peterson, N. A., Sheffer, M. A., Reid, R. J., & Schnieder, J. E. (2010). Tobacco outlet density and demographics: Analysing the relationships with a spatial regression approach. *Public health*, 124(7), 412-416.