

## Smoking and Tobacco Retail Density Among Neighborhoods in Delaware

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### Introduction

Tobacco use exerts a large burden on the health of Delawareans and on the economy in Delaware. While cigarette smoking in Delaware has hit an all-time low of 17.8% in 2016, this is still higher than the national average of 15.5% in 2016.<sup>1,2</sup> The 2014 Surgeon General's Report estimated that 480,000 people die from cigarette smoke-related causes in the United States per year; in Delaware, an estimated 1,400 people die annually from cigarette smoke-related causes, including lung cancer.<sup>3,4</sup> Delaware, a relatively small state with a population of less than 1 million people, is burdened with a high rate of lung cancer.<sup>5</sup> In 2014, lung and bronchus cancers had the third highest incidence of all cancers in Delaware (58.3 cancer diagnoses per 100,000 people) and the highest death rate (42.2 deaths per 100,000 people) among all cancers in Delaware.<sup>6</sup> IMPACT Tobacco Prevention Coalition of Delaware estimates that the tobacco-related workplace productivity losses are \$391 million per year. Further, Delawareans spend \$532 million per year on tobacco-related direct medical services, of which \$95 million per year is on tobacco-related medical expenditures that are covered by Medicaid.<sup>1</sup>

State and local tobacco control efforts have increasingly focused on limiting access to tobacco products within communities. Tobacco retailer density is a measure of the number of retailers selling tobacco products per population in a given geographic area. Neighborhoods with high tobacco retail density have been associated with increased rates of cigarette smoking initiation among adults age 25-34 and for non-cigarette combustible product (such as little cigars)-initiation among adults 18-24.<sup>7</sup> Living in an area with higher tobacco retailer density has been associated with nicotine dependence among adults living with severe mental illness.<sup>8</sup> Additionally, living in areas with a higher density of tobacco retailers has been associated with higher odds of ever smoking among teens.<sup>9</sup> Retailer density might also impact those who wish to quit smoking, as studies show that individuals living in low-income areas who live further from a tobacco retail outlet were more likely to abstain from smoking than those living closer to a tobacco retailer.<sup>10</sup> Studies focused on the school environment have shown that with more tobacco retailers surrounding a school, there was higher prevalence of occasional and daily smoking among students, higher prevalence of ever smoking among students, and higher susceptibility for students to become smokers.<sup>11-13</sup>

Tobacco retailer density should be used to monitor the neighborhood-smoking environment due to the potential for retailers to sell to minors, foster smoking initiation in young people, deter quitting behavior, and creating a smoking-friendly environment within communities. Researchers have already used tobacco retailer density in Philadelphia and Illinois to assess the relationship between tobacco retailer density and proximity to schools.<sup>11,14</sup> However, no studies have explored tobacco retailer density in the state of Delaware.

The primary purpose of our study is to describe the geographic distribution of adult smoking prevalence and tobacco retailer density in Delaware in order to identify areas of burden and potential areas of focus for public health interventions. Additionally, we provide a more focused analysis of the geographic proximity of tobacco retail outlets to schools in the city of Wilmington.

## **Methods**

### **Data Sets**

We performed a descriptive study using publicly accessible datasets describing adult smoking prevalence from the CDC's Behavioral Risk Factor Surveillance System (BRFSS) and tobacco retailer locations from the Delaware Department of Finance, Division of Revenue in the state of Delaware. We used Policy Map to download BRFSS data by census tract, which was the smallest geographic unit available.<sup>15</sup> Census tracts are the census-derived geographic unit that corresponds to neighborhood.

### **Behavioral Risk Factor Surveillance System**

BRFSS is a nation-wide telephone survey conducted by the CDC that collects data about health risk behaviors.<sup>16</sup> We used this data to identify the estimated percent of adults reporting to smoke cigarettes in the most current data available to us in 2013. In Delaware, 5,052 people participated in the 2013 BRFSS.<sup>17</sup> Participants were considered current smokers if they responded, "every day" or "some days" to the question, "Do you now smoke cigarettes every day, some days, or not at all?" Estimates at the census tract level were derived using the BRFSS data, weighted by Census Metropolitan delineation files and the 2009-2013 American Community Survey 5-year estimates for the adult population and household income by age and race.<sup>15</sup>

### **Tobacco Retail Location**

Tobacco retailer location is collected as part of the list of Delaware Business Licenses by the Department of Finance, Division of Revenue.<sup>18</sup> According to state laws, a person or entity that is conducting business in the State of Delaware must have a Delaware business license from the Delaware Division of Revenue.<sup>19</sup> We determined that a tobacco retailer was labeled as either "tobacco products retailer" or "retailer-tobacco" and found 1353 tobacco retailers.

### **Geographic Analysis**

Maps throughout this study were created using ArcGIS® software by ESRI.<sup>20</sup> Additionally, all maps were displayed with the Delaware State Plane (NAD 1983 State Plane Delaware FIPS 0700 (Meters)) projected coordinate system.

## **Prevalence of smoking by census tract**

We linked the 2013 BRFSS/Policy Map data to 2017 TIGER/Line Shapefiles<sup>21</sup> in order to map current smoking rates by census tract in Delaware (CDC, 2018). We displayed the data using a choropleth map with graduated colors corresponding to the rates of smoking in census tracts. In addition, we mapped Delaware cities stratified by population size using graduated symbols.

## **Location of Tobacco Retailers**

Tobacco retailers were geocoded by address using the geocoder provided by FirstMap in ArcGIS to obtain the location of the retailers.<sup>22</sup> Of 1353 addresses, 1196 were automatically matched. Thirteen unmatched addresses were manually matched when the address had a match score of at least 75%, and was agreed upon by two individual investigators. This resulted in a final match rate of 89.4%.

## **Proximity of Schools and Tobacco Retailers in Wilmington**

We performed a proximity analysis to assess tobacco retailer distance from schools in the most populous city in Delaware: Wilmington. We used FirstMap Delaware to find both private and public school locations in Wilmington.<sup>23</sup> We used ArcGIS to identify the number of tobacco retailers contained within 500 and 1,000 feet of each school.

## **Density of tobacco retailers by census tract**

We identified tobacco retailer density per 1,000 people by census tract in Delaware. We aggregated the number of tobacco retailers by census tract and divided by the total the census tract population to get the density of tobacco retailers per 1,000 people by census tract. Data for the population per census tract was obtained from the 2016 American Community Survey from the U.S. Census Bureau.<sup>24</sup>

## **Statistical analysis**

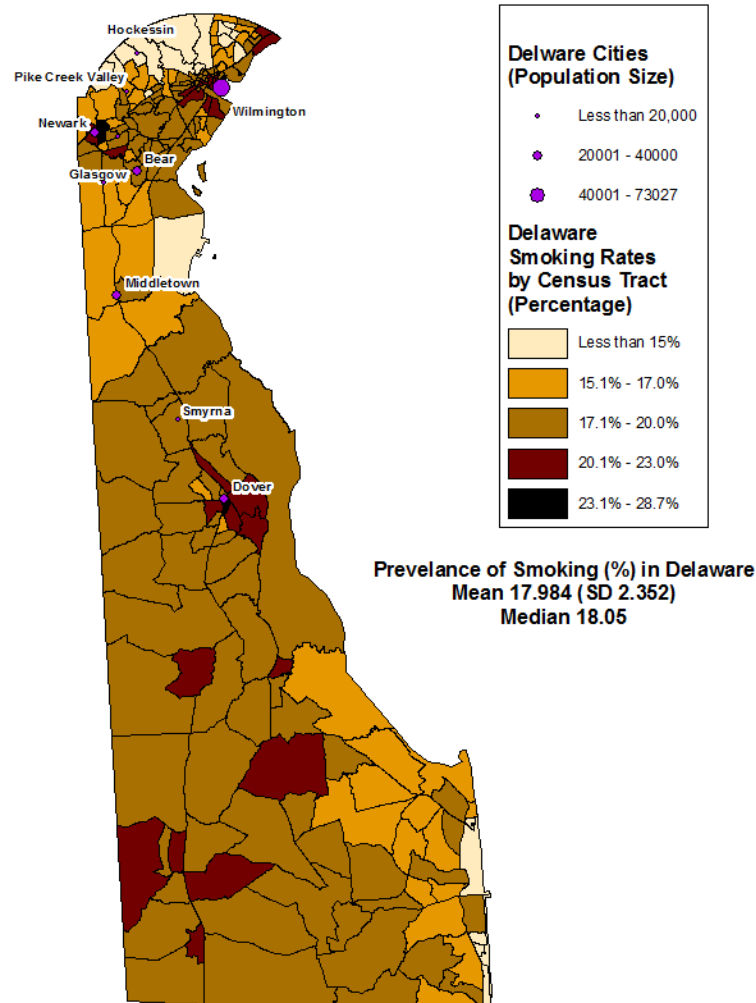
We conducted a simple linear regression to investigate the correlation of tobacco retailer density and the prevalence of adult smoking by census tract. We first conducted the analysis among all census tracts in Delaware, then limited the analysis only to urbanized areas as defined by the 2010 U.S. Census.<sup>25</sup> We conducted all statistical analyses using SPSS.<sup>26</sup>

## **Results**

### **Prevalence of smoking by census tract**

Upon visually inspecting the map of smoking prevalence in Delaware (see Figure 1), we observed census tracts with high smoking prevalence near Dover, Newark, and Wilmington that ranged from the highest smoking rates in Delaware (23.1-28.7%) to areas of lower, but still comparatively high smoking rates (20.1-23.0%). In addition, the census tracts with relatively low smoking rates were clustered in northern (northwest of Wilmington) and the southeastern coast of Delaware. In general, the census tracts with the highest smoking prevalence clustered around the largest cities, and those in suburban, rural, or coastal areas had lower smoking prevalence.

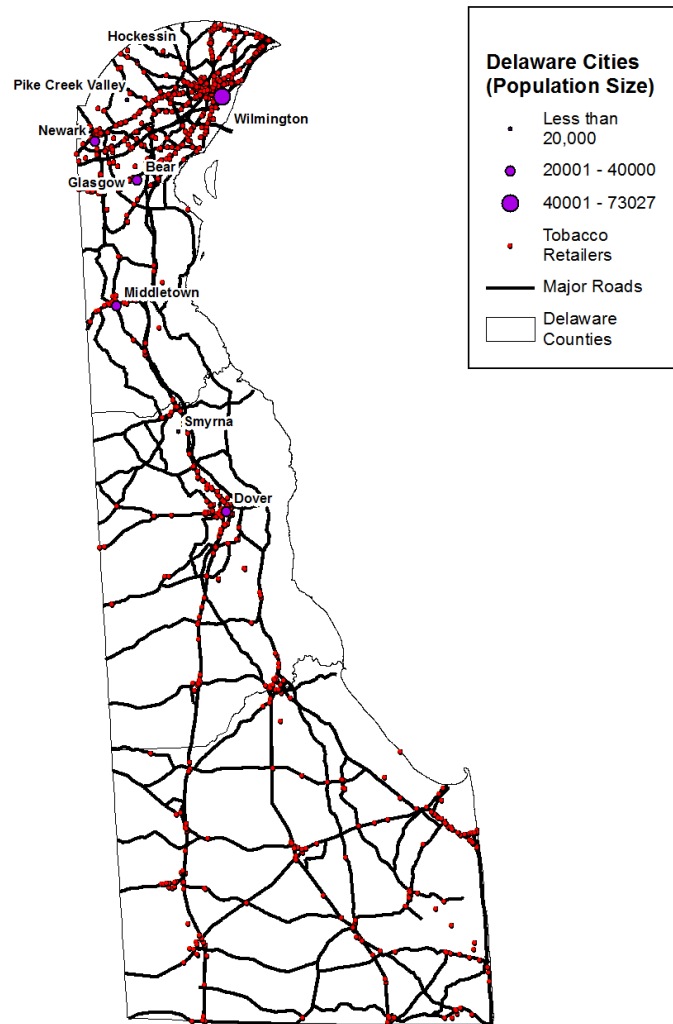
Figure 1. Prevalence of current smoking among adults by census tract in Delaware<sup>16,21</sup>



### Point data for tobacco retailers and school proximity analysis

A visual inspection of the tobacco retailer point data shows clusters of tobacco retailers in larger cities and around the major highways (see Figure 2). Few tobacco retailers have established themselves away from the main highways. One of the largest clusters of tobacco retailers is in Wilmington. For this reason, we took a closer look at Wilmington to examine the relationship between tobacco retailers and public and private schools.

Figure 2: Point data for tobacco retailers in Delaware.<sup>19,23</sup>



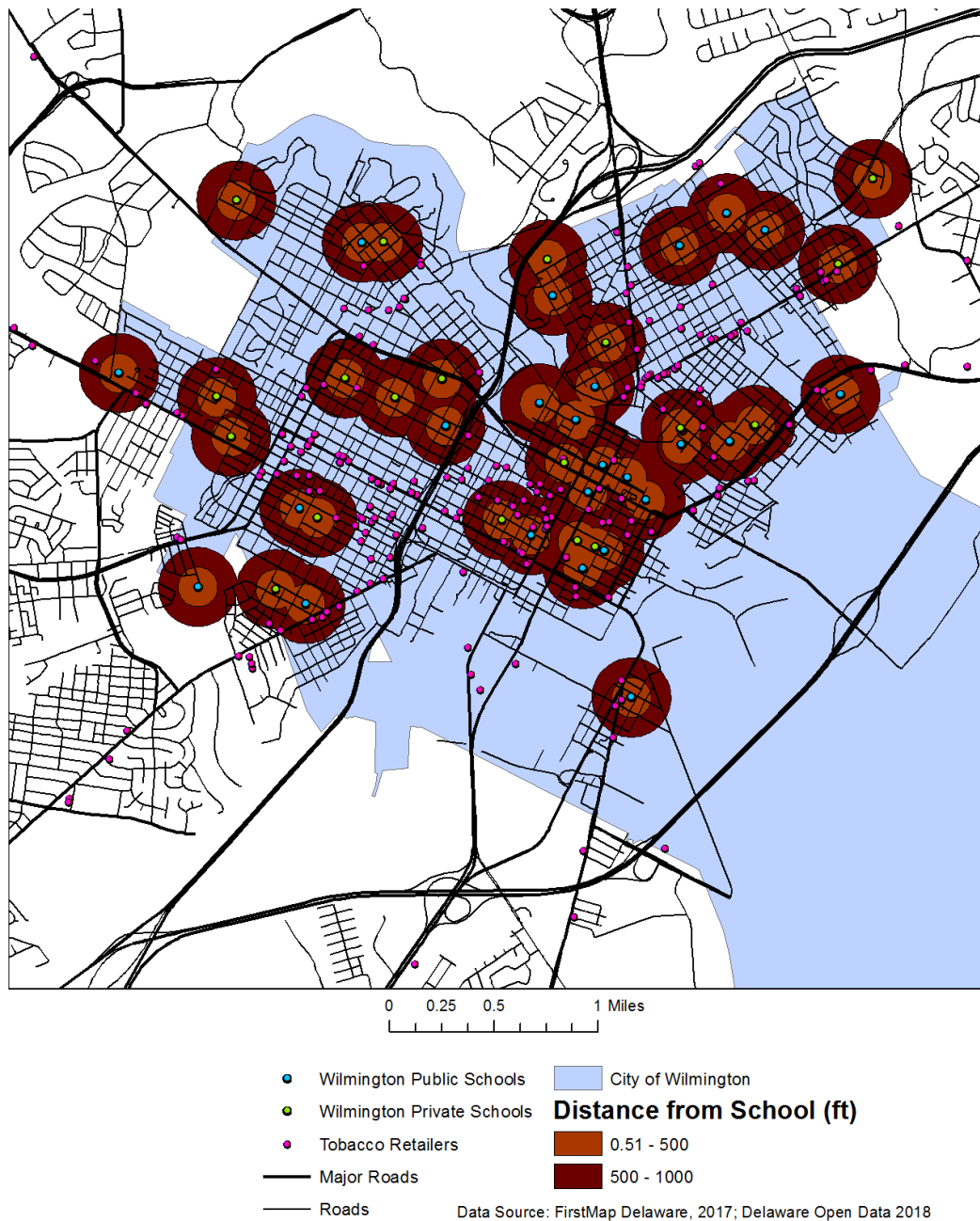
We mapped the locations of public and private schools and tobacco retailers to understand the number of public and private schools in Wilmington that are located within 500 and 1000 feet of a tobacco retailer and, vice versa, the number of tobacco retailers in close proximity to schools (see Figure 3). The results of this proximity analysis are summarized in Table 1. We found that there were 25 tobacco retailers within 500 feet of the schools and 86 retailers within 1000 feet. There were 16 Wilmington schools out of 48 (33.3%) with at least one tobacco retailer within 500 feet. Two schools had as many as four retailers within 500 feet. There were 37 schools (77.1%) with at least one retailer within 1000 feet. Amazingly, one school had eighteen tobacco retailers within 1000 feet. Of the 202 tobacco retailers in Wilmington, 11.4% were within 500

feet of a Wilmington school and 38.6% were within 1000 feet. In addition, there were an additional eight retailers outside of the Wilmington city limits that were within 1000 feet of a school and two within 500 feet.

Table 1. Count of Schools within N tobacco retailers

Count of schools with N tobacco retailers within 500 ft		Count of schools with N tobacco retailers within 1000 ft	
N	Schools	N	Schools
0	32	0	11
1	11	1	7
2	1	2	8
3	2	3	6
4	2	4	6
		5	3
		6	3
		9	1
		10	1
		13	1
		18	1
Total number of tobacco retailers (Percent of Wilmington tobacco retailers [%])		Total number of tobacco retailers (Percent of Wilmington tobacco retailers [%])	
25 (11.4)		86 (38.6)	

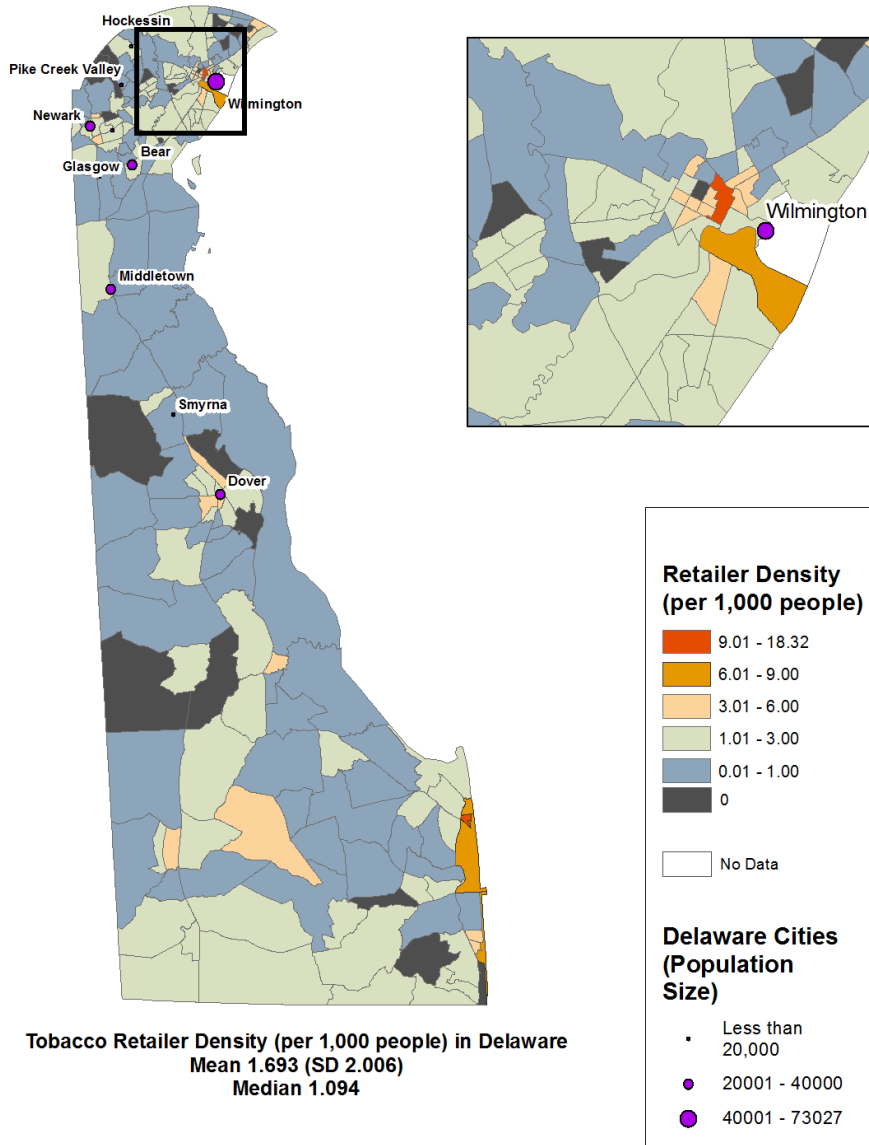
Figure 3: Proximity analysis for tobacco retailers and K-12 schools in Wilmington, DE.<sup>18,23</sup>



### Density of tobacco retailers by census tract

The map of tobacco retailer density reveals that much of the state has between zero and one tobacco retailers per 1000 people (see Figure 4). However, there are two areas with notable exceptions, the Wilmington area has several of the highest densities of retailers (including the highest at 18.32 retailers per 1000 people) as does the southeastern shoreline census tracts (including the second highest of 12.36 retailers per 1000 people). The Dover region has several census tracts in the 3.10-6.00 retailers per 1000 people-range but none as high as the southeastern shore or Wilmington.

Figure 4: Density of tobacco retailers by census tract.<sup>19,21</sup>



### Correlation between smoking prevalence and tobacco density in urban census tracts

Initially, we conducted a simple linear regression between tobacco retailer density and smoking prevalence in all census tracts in Delaware. Surprisingly, we did not find a significant correlation between our two variables ( $t_{212} = 1.86$   $p = .06$ ). Since we observed a higher smoking prevalence clustered around the larger cities in Delaware, such as in Dover and Wilmington, we decided to



limit our statistical analysis to urbanized census tracts. In the 117 urbanized census tracts in Delaware, the average smoking prevalence was 18.3% (Standard Deviation (SD): 2.49), and the average retailer density was 1.79 tobacco retailers per 1,000 people (SD: 2.04). This time, we found a significant correlation between smoking rates and tobacco retailer density ( $t_{115} = 3.69$ ,  $p < .001$ ). Pearson's correlation was 0.325, meaning that an increase of one tobacco retailer in an urbanized area in Delaware corresponded to an increase of smoking prevalence by 0.325%. We checked the assumptions of the linear regression and found the homogeneity of variances and normality of errors to be slightly questionable, which should be taken into account in our analysis.

## Discussion

In this study, we analyzed smoking prevalence, and tobacco retailer location and density in Delaware. Smoking prevalence and tobacco retailer density were observed by census tracts. Using tobacco retailer location, we also analyzed the proximity of tobacco retailers to schools in Wilmington.

Our analysis showed high density of tobacco retailers in Delaware cities. Wilmington had the census tracts with the highest tobacco retail density among all census tracts in Delaware. This was not surprising as urban areas, in general, have higher tobacco retail densities than less urbanized areas.<sup>27</sup>

Our proximity analysis showed that among the 48 total schools in Wilmington, 77.1% had at least one tobacco retailer within 1000 feet and 34.3% had at least one tobacco retailer within 500 feet. Seven schools had over five tobacco retailers within 1,000 feet. This resulted in an average of 0.56 retailers within 500 feet of a school and an average of 3.08 retailers within 1000 feet. The proximity of tobacco retailers to schools means that students are exposed to tobacco advertising and environments that portray smoking as a normal behavior. Studies have shown that as the number of tobacco retailers located in close proximity to schools increases, youth smoking increases.<sup>12,13</sup> Another study linked the density of tobacco retailers within one half-mile radius from a school to the prevalence of smoking among students.<sup>11</sup> Our study is the first that explores tobacco retail density in Delaware. This information can be used as an area of focus for local tobacco control efforts to limit the density of tobacco retail establishments, especially in dense urban areas such as Wilmington.

We looked at nearby Philadelphia, where more adult residents smoke cigarettes (19.5%) than in any other major U.S. city, because of the methods Philadelphia employs to investigate and curtail tobacco retailers.<sup>28</sup> Schools in Philadelphia had an average of 1.1 retailers within 500 feet and an average of 4.9 within 1000 feet compared to Wilmington's school averages of 0.56 and 3.08, respectively.<sup>14</sup> As a result of PDPH's research, Philadelphia instituted geo-based tobacco control policies in 2016 including limits on the number of new tobacco retailer permits by city planning district so that no planning district exceeded one retailer per 1000 daytime population, and prohibiting new retailers within 500 feet of a school. As Philadelphia planning districts divide the city into 18 districts made of many census tracts, the enacted retailer density limit in Philadelphia may not be directly comparable to the individual retailer density of census tracts used in our study. Furthermore, the PDPH used a commuter-adjusted daytime population rather than residential population (as our study does) to determine tobacco retail density. Despite this, tobacco control professionals in Delaware should consider implementing similar types of geo-based tobacco control policies based on retailer locations and density in order to reduce youth

and adult smoking initiation, exposure to tobacco advertising, and relapse among those who wish to quit smoking. We found several census tracts across Delaware, particularly in Wilmington, that exceed one tobacco retailer per 1,000. This is above the national median density for census tracts of 0.43 per 1000, and higher than the median rate for urban census tracts of 0.74 per 1000.<sup>27</sup> Reducing tobacco retailer density in Delaware has the potential to reduce smoking rates and have a lasting impact on health of Delaware residents. In the future, researchers should work to understand how retailer density directly relates to health outcomes in Delaware, and explore other ways of measuring the tobacco retail density within Delaware neighborhoods.

A visual comparison of the map of tobacco retailer density with the map of smoking prevalence shows that the Wilmington area has several census tracts that have a high density of tobacco retailers and a high smoking prevalence rate. However, this relationship is not found in the census tracts near Dover which have some of the highest rates of smoking but low rates of retailer density. Furthermore, census tracts along the southeast shoreline had some of the highest rates of retailer density but the lowest rates of smoking prevalence, possibly due to tobacco retailers catering to tourists that may not be accounted for in the smoking prevalence or census data. Upon statistical analysis, we found a significant relationship between smoking prevalence and tobacco retailer density in the urbanized census tracts of Delaware, which is consistent with the current literature. Still, it was interesting to note the relationship between tobacco retailer density and smoking prevalence (Pearson's coefficient = 0.325) in our simple linear regression. Although there are many other factors that contribute to smoking prevalence, such as demographics, tobacco product pricing, exposure to tobacco advertising, peer and family influence, and even second-hand smoke exposure,<sup>29</sup> tobacco product density may be a practical option for regulation of the neighborhood-tobacco environment.

### **Strengths & Limitations**

As there has been little prior research on the geographic distribution of smoking prevalence, tobacco retailer density, and proximity of tobacco retailers to schools in Delaware, our study is important as it identifies geographic areas that could benefit from public health interventions related to smoking. We found that generally, our results were consistent with the findings from the 2017 DHSS Cancer report for general trends in smoking rate demographics, but they did not report geographic trends such as areas of high and low smoking prevalence. In addition, there were no analyses including tobacco retailer location and proximity to schools.

Another notable feature of our study was our use of census tracts to display smoking prevalence and tobacco retailer density. Census tracts are a good unit of analysis for prioritizing neighborhood-based public health interventions because publicly accessible data is available for them through the U.S. census, and census tracts are small enough to highlight unique historical and cultural characteristics of neighborhoods. This is important when working on community-engaged research so that community members' voices and concerns can be effectively addressed.

While this study makes an important contribution to tobacco control efforts in Delaware, the study has limitations. Our unit of analysis was the census tract, which is the best geographic unit to describe neighborhoods within an area. However, our visual and statistical comparisons are limited by the ecological nature of these variables. Confounders such as age, sex, income, and other demographics may explain the variation we identified between variables or census tracts. While the tobacco retailer match rate was a respectable 89.4%, some tobacco retailers could not be geocoded because some individual retailers used P.O. boxes instead of physical addresses or

colloquial strip-mall names instead of street addresses. Additionally, while tobacco retail density by population is important, it may not account for fluctuating populations like at a tourist destination such as Rehoboth Beach which might explain the high tobacco retailer density compared to areas of similar demographics, but a more constant residential population.

### **Implications & Next Steps**

The main findings from our studies indicate that there is need for future studies analyzing geo-based relationships between tobacco retailer density and smoking status among adults, or initiation among kids, which would include controlling for important confounders such as age, gender, race, education level and income in Delaware.

While the map of retailer density shows that there is a wide range in tobacco retailer density by census tract, the five highest all have populations below 1,500 people. This means that the tobacco retailer density per 1,000 people could increase dramatically by opening a single store. Future research should investigate if there are contextual area-level characteristics that make these census tracts popular for locations of tobacco retailers. For instance, the census tract with the second highest tobacco retail density contains Rehoboth Beach, a popular tourist location. It is likely that the full public health burden of tobacco sales in Rehoboth Beach is not counted in health statistics based on a residential address, since tourists who smoke or develop lung cancer would not be a resident in that census tract. The outcomes of our study will be beneficial to both local and state agencies such as DHSS for future interventions. This includes current interventions pursued by the DHSS including interventions which target youth, cessation, special populations and the general population. Additionally, the DHHS has a program to fund local interventions called Mini-Grant, and our information present in this paper can point DHHS to where the need is highest.<sup>1</sup> These interventions should be tailored to the characteristics of the area and prioritized based on the tobacco-use and cancer-related burden particular to the area.

### **Conclusion**

This study identified the geographic distribution of and relationship between smoking prevalence and location of tobacco retailers for geographic areas in Delaware. We found that New Castle, Dover and Wilmington had a high prevalence of smoking while Wilmington and Rehoboth Beach had the highest tobacco retailer density. We also found that in Wilmington, over half of the private and public schools are within 1,000 feet from a tobacco retailer. This analysis is important to understanding the relationship between smoking and tobacco retailers. Additionally, this analysis will inform organizations who wish to decrease smoking rates in Delaware through public health interventions.

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