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Research Article

Walking Distance to Tobacco Outlets in Vulnerable Areas Baltimore City: An Issue of Health Equity

Abstract

Introduction: Health equity concerns related to tobacco use are significant in Baltimore City. We use spatial analytic techniques to understand the density of tobacco outlets by areas of socioeconomic vulnerability, and their location within walking distance of residences compared with vehicle ownership.

Methods: Population demographic indicators were obtained from the 2010 Census and associated with increasing numbers of tobacco outlets using a linear regression model. The distance from the centroid of each census block to the nearest licensed tobacco retailer was calculated using a spatial joining techniques.

Results: In Baltimore City, there are 3.18 tobacco retailers per 1,000 residents ages 16 and over. Indicators of vulnerability associated with increased numbers of tobacco retailers include lower median household income ($p=0.006$), lower employment ($p=0.045$), increased poverty ($p=0.009$), and increased density of Class A liquor outlets ($p<0.001$). The proportion of households per census tract that don't have access to a vehicle is significantly associated with increased number of tobacco retailers ($p=0.003$); 85% of census tracts have an average distance of $\frac{1}{4}$ mile or less to the nearest tobacco vendor.

Conclusions: Tobacco retailers in Baltimore are located in areas of highest neighborhood deprivation. Importantly, our analysis shows a powerful correlation between those areas lacking vehicle ownership with the highest number of tobacco vendors; those individuals that rely on walking or public transportation are the ones with tobacco retailers within a $\frac{1}{4}$ mile walking distance. One policy option is linking zoning restricting tobacco retailers from vulnerable neighborhoods in order to promote health and health equity.

Introduction

The dangers of cigarette smoking are well established; over 480,000 deaths occur annually in the United States due to cigarette smoke, making tobacco use the leading preventable cause of death [1,2]. According to the Centers for Disease Control and Prevention, an estimated 18.1% of adults currently smoke in the United States [3]. The prevalence is even higher in Baltimore City; in 2013, an estimated 22.7% of residents self-reported being a "current smoker", defined as smoking at present and having smoked at least 100 cigarettes in their lifetime [4]. Despite this significant health burden, cigarette sales have been subject to relatively few restrictions [5].

Several studies have documented an association between the density of tobacco retailers and tobacco use [6-9]. In addition, studies have shown that tobacco outlet density tends to be highest in lower socioeconomic neighborhoods or areas, resulting in a significant issue of health equity [8,10-12].

Health disparities and equity concerns related to tobacco use are significant in Baltimore City; data shows that smoking prevalence is higher in black, non-Hispanic individuals, individuals with less than a high school graduation, and those with annual incomes under \$15,000 per year [13,14]. In areas that have limited public transportation as well as low personal vehicle ownership, individuals will access services that are within walking distance. Studies of tobacco outlets have shown the importance of proximity to residences or other vulnerable areas. For example, Halonen and colleagues showed that in Finland, living less than $\frac{1}{2}$ km from a tobacco store reduced the likelihood of smoking cessation among moderate/heavy smokers [15]. In the US, $\frac{1}{4}$ mile is most frequently used as an acceptable walking distance [16].

To date there have been no studies assessing the availability of tobacco retail outlets by areas of vulnerability in Baltimore City. Our focus is on walkability, and thus we use epidemiologic and spatial analytic techniques to understand the density of

tobacco outlets located within walking distance of residences and how that compares with indicators of vulnerability.

Methods

Epidemiologic analysis

The following indicators were obtained from the 2010 Census at the census tract level and explored for their association with increasing numbers of tobacco outlets per census tract: percent of population identified as African American, percent of population under 18 years of age, median household income, percent over 16 years of age that were employed, percent of population over 16 years of age with an annual income below the poverty level, percent of population that immigrated from abroad within the past year, percent of owner-occupied housing units, number of Class A liquor outlets per 1,000 residents, number of vacant buildings per 10,000 households, and percent of households with no vehicles. The association was quantified using a linear regression model in Stata 13.0 (Stata Corporation, College Stations, TX, USA), and significance of the association was measured by the p value.

Spatial analysis

All data were analyzed using ArcGIS 10.1 (Esri, Redlands, CA, USA). A list of Baltimore City retailers for 2014 was provided by the Office of the Comptroller of Maryland; the list was supplemented with 81 additional tobacco retailers, such as convenience stores, liquor stores, and gas stations, within 1/2 mile of the City's boundary. These addresses were geocoded, and the distance from the centroid of each of Baltimore's census blocks to the nearest tobacco retailer was calculated using a spatial join of the tobacco retailer layer to the census block centroid layer. In order to mitigate the difference between Euclidean and Manhattan distances, census blocks, the smallest geographic unit in which population data were available ($\mu\text{area} = 188,712.7 \text{ ft}^2$, or 0.00677 mi^2), were used in calculations. To mitigate effects of census blocks skewed towards increased size due to industry, parkland, waterways or roadways, an average distance, weighted for population, was calculated for each census tract using the following formula:

$$\text{Weighted Average Distance} = \frac{\sum(\text{dist}_{\text{block}} \times \text{pop}_{\text{block}})}{\sum \text{pop}_{\text{block}}}$$

$\text{dist}_{\text{block}}$ = Distance from centroid of census block to nearest tobacco retailer

$\text{pop}_{\text{block}}$ = 2010 U.S. Census population of census block

Results

In Baltimore City, there are 3.18 tobacco retailers per 1,000 residents ages 16 and over. Tobacco retailers are concentrated on the major roads/corridors leading in and out of the city, and within the areas of lowest at-birth life expectancy and highest rates of a wide range of poor health outcomes. When looking at the association between number of tobacco retailers within a census tract and sociodemographic measures, indicators of vulnerability associated with increased tobacco retailers include lower median household income ($p=0.006$), lower employment ($p=0.045$), increased poverty ($p=0.009$), lower

home ownership ($p<0.001$), and increased density of Class A liquor outlets ($p<0.001$).

Importantly, the proportion of households with lack of vehicle ownership is significantly associated with increased number of tobacco retailers at a census tract level in Baltimore City ($p=0.003$). 85% of census tracts have an average distance of 1/4 mile or less to the nearest tobacco vendor. Figure 1 shows the correlation between the average distances to the closest tobacco retailer with the areas of the city with the lowest vehicle ownership.

Discussion

The density of tobacco retailers in Baltimore City is extremely high at over 3 per 1,000 residents ages 16 and over. While some large metropolitan areas such as Philadelphia have similarly high densities, Rodriguez and colleagues showed that the national median for urban census tracts was 0.74 per 1,000 total population [17,18]. As has been shown in several cities, tobacco retailers are more likely to be located in areas of highest neighborhood deprivation, representing a significant problem of health equity.

Importantly, our analysis shows a powerful correlation between those areas with a majority of households without access to a vehicle and those with the highest number of tobacco vendors; those individuals that rely on walking or

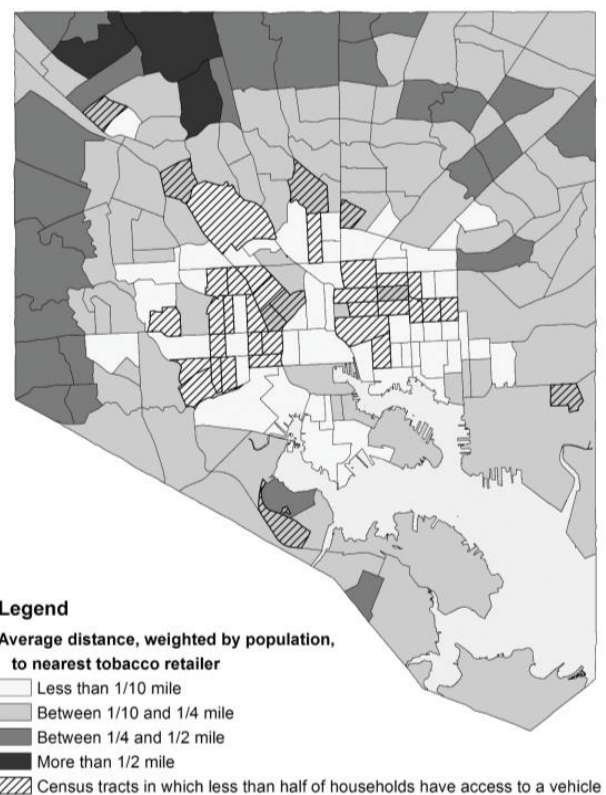


Figure 1: Average distance, weighted by 2010 U.S. Census population, to the nearest tobacco retailer, with census tracts in which less than 50% of households had access to a vehicle highlighted, according to the 2009-2013 American Community Survey

public transportation are the ones who will find tobacco retailers within a quarter-mile walking distance. Interestingly, premature mortality (deaths prior to the age of 75 and thus considered preventable) is also correlated with lack of vehicle ownership in Baltimore City; the mean premature mortality rate is statistically significantly higher in census tracts in which less than half of households have access to a vehicle compared with the city overall (65.4 vs 86.4 per 10,000 residents; $p < 0.01$).

The only supply-side strategy recommended by the Community Guide to prevent initiation of tobacco use among youth and young adults, promote quitting among adults and youth, and identify and eliminate tobacco-related disparities among population groups is increasing the unit price for tobacco products [19]. This analysis suggests that restrictions on the density and number of tobacco retail outlets should also be considered in order to reduce tobacco use through reduced access.

The issue of zoning as a tool to promote health equity is an important one in Baltimore City as in many urban centers [20]. We have illustrated that it is not enough for public health practitioners to encourage individuals to “get out and walk” as a means of physical activity; linking zoning restricting tobacco retailers from vulnerable neighborhoods is critical for the promotion of public health and health equity.

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