The Inequitable Distribution of Tobacco Outlet Density: The Role of Income in Two Black Mid-Atlantic Geopolitical Areas

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Abstract

Introduction—Studies have shown that communities with higher concentrations of low-income racial and ethnic minorities correlate with a greater presence of tobacco outlets. Community-level income has consistently been among the strongest predictors of tobacco outlet density. This study analyzes two Maryland geopolitical areas with similar racial concentrations yet differing income levels in an attempt to disentangle the race-income relationship with tobacco outlet density.

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Study Design—In this cross-sectional examination of tobacco outlet and census tract-level sociodemographic data, Baltimore City, Maryland and Prince George's County, Maryland were geocoded to determine tobacco outlet density.

Methods—Tobacco outlet density was defined as the mean number of tobacco outlets per 1,000 persons per census tract. Comparisons of tobacco outlet density and sociodemographic variables were analyzed via two-sample t-tests, and the direct effect of sociodemographic variables on tobacco outlet density for each area was analyzed via spatial lag regressions.

Results—Prince George's County, the area with the higher income level ($77,190 vs. $43,571), has a significantly lower tobacco outlet density than Baltimore City ($p < .001$). Prince George's County has a 67.5% Black population and an average of 3.94 tobacco outlets per 1,000 persons per tract. By contrast, Baltimore City has a 65.3% Black population and an average of 7.95 tobacco outlets per 1,000 persons per tract. Spatial lag regression model results indicate an inverse relationship between income and tobacco outlet density in Baltimore City and Prince George's County ($\beta = -0.03$, $p < 0.01$ $\beta -0.01$, $p = 0.02$, respectively), and a significant interaction term indicating a greater magnitude in the relationship between income and tobacco outlet density in Baltimore City ($\beta = -0.05$, $p < 0.01$).

Conclusion—Results suggest that higher socioeconomic status, even in primarily underrepresented racial and ethnic geopolitical areas, is linked to lower tobacco outlet density.

Keywords

Tobacco outlets; Census Tracts; Race; Income; Communities; Geopolitical Areas

Introduction

The study of the physical availability and concentration of retailers who sell tobacco products in any defined inhabited area, better known as tobacco outlet density, is a relatively new concept in drug epidemiology. Despite the infancy of the concept, many of its methodologies, including geospatial analyses, are well established due to their derivation from several decades of research on alcohol outlet density. [1, 2] However to the contrary, the relationships investigated in this emerging field are under constant change and development. Literature review reveals early studies focused on the association between tobacco outlet density and smoking prevalence, particularly youth smoking.[3, 4] Also among the early studies were investigations of the association between tobacco outlet density and population demographics, specifically underrepresented racial and ethnic groups such as Blacks and Hispanic/Latinos.[5, 6, 7] Despite the early work, relatively few current studies involving tobacco outlet density examine the relationship with population demographics. The prevailing notion resulting from the early tobacco outlet density-demographics studies strongly suggest that inhabited areas with higher concentrations of underrepresented racial and ethnic groups correlate with higher tobacco outlet density, and recent work has expanded this relationship to include underrepresented non-racial groups.[8, 9, 10]

Prior tobacco outlet density studies focused on the role of socioeconomic status along with race, concluding that lower income was related with higher density.[5, 6, 7, 8, 10] However, it was not until a study by Fakunle and colleagues that socioeconomic status and race were

controlled in the same analytical model.[11] The results of the study, which included multivariable regression analyses of tobacco outlet density by Black population percentage, Hispanic/Latino population percentage, and median household income in two New Jersey counties, showed that median household income had a moderate, negative correlation with tobacco outlet density. Furthermore, it suggested that median household income had the strongest relationship with tobacco outlet density even when controlling for race. The study proposed that the positive association between tobacco outlet density and the concentration of underrepresented racial and ethnic groups may not be as substantial if an area is stratified by median household income. Additionally, tobacco retailers may target areas where there is little-to-no economic power to counter their presence, which typically are also areas highly populated by underrepresented racial and ethnic groups. The public health implications of tobacco, including the high number of preventable health issues and deaths caused by its use are well known, as well as the exacerbation of negative health outcomes among individuals of lower socioeconomic status regardless of race or ethnicity.[12] However, severely lacking are studies that investigate the potential environmental forces that may drive tobacco consumption among lower-income individuals. Further investigation was imperative due to the potential of altering the trajectory for research of tobacco outlet density and population demographics, as well as providing evidence in support of initiating policy aimed at reducing tobacco availability (e.g., restricting tobacco retail licensing, reforming outlet zoning ordinances, etc.) in communities sensitive to price, physical access, and health.

This study continued investigation of the relationship between tobacco outlet density and median household income by analyzing two Maryland geopolitical areas: Baltimore City and Prince George's County. Selection of the areas was based on background research of their racial and socioeconomic compositions. The result was a natural "isolation" of race and ethnicity allowing for a focused analysis of tobacco outlet density among two distinct areas with differing median household incomes, but similar racial compositions. The areas had statistically similar racial compositions (comparing Whites versus Blacks), but distinct economic distributions (e.g., high and low median household income). The hypothesis was that the geopolitical area with the relatively higher median household income, holding race constant via the community selection process, would have relatively lower tobacco outlet density.

Methods

Population data for residential census tracts were obtained in 2014 from the 2010 Decennial Census. Demographic data were obtained from the 2007-2011 American Community Survey. Tobacco outlet data from 2013 were obtained from the Maryland Judiciary Business License database. All retailers are required to obtain a permit to sell tobacco and the state maintains that database of licensed retailers. After obtainment, the data were geocoded in 2014 via ArcMap and a spatial join tool was used to determine the number of tobacco outlets per residential census tract. A residential census tract was defined as a tract that was inhabited by at least 600 individuals. One tract was deleted based on this threshold.

Study Areas

Two geopolitical areas in Maryland – Baltimore City and Prince George's County – were chosen for this study (see Table 1). Baltimore City is the fourth most populous geopolitical area in Maryland and the largest independent city in the United States.[13] It is located in the central area of the state and has a total population of 620,961, 200 residential census tracts, a large Black population (65.25%), and a median household income of $43,571. By contrast Prince George's County, the second most populous geopolitical area in Maryland, is located in the southwestern area of the state and has a total population of 863,420, with 218 residential census tracts, a large Black population (67.49%), and a median household income of $77,190. These areas provide the basis for an income comparison across similar racial and ethnic communities.

Statistical Analysis

The unit of measurement for tobacco outlet density in this study was the number of licensed tobacco outlets per 1,000 persons within each residential census tract. It is aligned with the measurement of alcohol outlet density in a number of past studies and tobacco outlet density in more recent studies.[14, 15, 16, 17] Additionally, a population-based measure provides an immediate indication of tobacco availability among residents in highly concentrated urban areas as opposed to less concentrated rural areas. Two-sample t-tests were conducted to determine if significant differences existed between the study areas of comparison in regards to race, median household income, as well as tobacco outlet density.

Areas of high tobacco outlet density tend to be clustered together, and adjacent census tracts tend to be more similar than census tracts that are not adjacent. Moran's I was used to assess the spatial autocorrelation of the outcome variable, tobacco outlet density. The Moran's I was 0.259 for Baltimore City (p <0.001) and 0.093 for Prince George's County (p = 0.008). The clustering of tobacco outlets violates the regression assumption of independence, therefore spatial lag models were used to assess the relationship between race, income, and tobacco outlet density. Spatial lag models were conducted for both Baltimore City and Prince George's County; these models estimate and adjust for spatial dependence in the regression model.[18] A second model included the census tracts in both counties and added an interaction between county and median household income. Spatial lag modeling was conducted using the R software.

Results

Income and Tobacco Outlet Density

There were significant differences in socioeconomic status between the two jurisdictions. Specifically, Baltimore City had a significantly lower median household income and significantly higher percentage of incomes below poverty level than Prince George's County (see Table 1). When comparing differences in tobacco outlet density by community-level income there were significant differences between the two jurisdictions (Baltimore City vs. Prince George's County = 7.03, $p < .001$), in that the more affluent area, Prince George's County, had a statistically significantly lower density of tobacco outlets ($M = 3.94$, $SD = 3.80$, range = 0-20) than the poorer area ($M = 7.95$, $SD = 7.43$, range = 0-74).

Spatial Lag Regression Models: Race, Median Household Income, and Tobacco Outlet Density

Spatial lag models were used to assess the relationship between race, median household income, and tobacco outlet density for both areas (see Tables 2 and 3). In Baltimore City there was an inverse relationship between median household income and tobacco outlet density in both the unadjusted and adjusted models ($\beta = $ -0.02, $p < 0.01$ $\beta = $ -0.03, $p < 0.01$, respectively), such that higher median household income was associated with lower tobacco outlet density. However, there was a direct relationship between percent Black and tobacco outlet density in the unadjusted model and an inverse relationship in the adjusted model ($\beta = $ 0.001, $p < 0.01$ $\beta = $ -0.02, $p = 0.02$, respectively). Similar to Baltimore City, there was an inverse relationship between median household income and tobacco outlet density for Prince George's County in both the unadjusted and adjusted models ($\beta = $ -0.01 $p < 0.01$ for both models). Also similar to Baltimore City, there was a positive relationship between percent Black and tobacco outlet density in the unadjusted model, but unlike in Baltimore City the relationship remained direct in the adjusted model ($\beta = $ 0.001, $p < 0.01$ β 0.002, $p = 0.63$, respectively). There were no other significant associations for these areas.

Race or Income: Spatial Lag Regression Models with Interaction Terms

The spatial lag models described above were extended to include an interaction term between county and income (see Table 4). The model for Baltimore City (Black and lower income) and Prince George's County (Black and middle income) had a significant interaction term ($\beta = $ -0.05, $p < 0.01$), indicating that the magnitude of the relationship between income and tobacco outlet density was stronger for Baltimore City.

Discussion

Currently, convenience stores (e.g., gas stations and small grocery stores) account for the largest sales of tobacco and have more tobacco advertising than other retail outlets.[19] Tobacco outlets are more likely to exist in low-income, underrepresented racial and ethnic communities where rental costs are low and the lower costs of tobacco products attract low-income individuals, resulting in community norms that support smoking.[20] A number of studies concluded that areas with higher concentrations of Blacks and lower median household income have greater tobacco outlet density, [5, 6, 7, 21, 22] and higher smoking prevalence as evidenced by the number of cigarettes smoked per day. [23, 24, 25, 26] Unlike most studies, Mayers and colleagues did not find the same relationships and found instead two factors – population density and percent commercial – to be highly relevant factors when it comes to tobacco outlet density. This current study sought to compare tobacco outlet density in two distinct geopolitical areas of Maryland – Baltimore City and Prince George's County. Each area has a similar racial composition, but the median household income of its residents varies. The goal was to elucidate the relationship between median household income and tobacco outlet density among similarly racially composed geopolitical areas. What is most intriguing about these results is the confluence between race and median household income. Namely, the results from the analyses were consistent with our hypothesis that the geopolitical area with a higher median household income level (i.e., Prince George's County), despite having a similar racial concentration as Baltimore City,

would have lower tobacco outlet density. However, in Baltimore City, there was an inverse relationship between median household income as well as percent Black and tobacco outlet density. That is, higher median household income and higher percentage of Black residents was associated with lower tobacco outlet density. This is consistent with results from other published studies examining the relationship between alcohol outlet density, race, and SES.[18, 27]

In the simplest of terms, the reversal in direction of the relationship between percent Black and tobacco outlet density in Baltimore shows how much income matters. Delving further, such a reversal may be a reflection of the city's racial composition, complicated by its strong intertwining with socioeconomic status. Historically, Baltimore has been a working class (low-to-middle income) area and has been predominantly Black for several decades. Many mechanisms have perpetuated institutional racism in Baltimore such as segregation and redlining, and the result is that a majority of Blacks have typically been among the lowest in income. The residual effects continue today to the point where "Black" and "low-income" or "impoverished" in Baltimore are almost interchangeable. The spatial lag model suggests that the unadjusted positive relationship between percent Black and tobacco outlet density in Baltimore is affected by the relative lack of economic influence among Black citizens, hence the switch to a negative relationship when adjusted for income and other factors.

These findings must be viewed within the following limitations. Notably, we were unable to determine a causal relationship between community-level income and tobacco outlet density from these data. Despite this limitation, the data did provide a unique opportunity to examine two proximally close geographic regions and the race-income relationship to tobacco outlet density, which provides further support for the link between socioeconomic status and tobacco outlet density.

Future directions for research include investigating how income inequality affects tobacco outlet density as well as the close proximity of tobacco outlets to one's home, which represents a cue to smoking and easy access to tobacco products (e.g., cigarettes, cigarillos, loose tobacco, cigarette rolling machines, filters, and rolling papers).[28] Additionally, the influence of other commercial businesses must be considered in future studies of tobacco outlet density. Finally, the increased number of stores that market other potentially detrimental substances – such as alcohol and fast food – must be addressed to further understand the link between fast food and alcohol consumption, and tobacco use as environmental contributors to the health consequences of those residing in low-income and underrepresented racial and ethnic communities.

The broader field of inquiry examining the social determinants of health has begun to address macro-level interventions to address income inequality but more research is needed to address inequities in tobacco availability. The role of neighborhood structure in the etiology of tobacco outlet density disparities remains unstudied. One hypothesis is that there is a greater variety of tobacco retailer entities (e.g., corner stores and larger retail establishments) in poorer neighborhoods compared to more affluent neighborhoods. As a field, we have inadequately addressed what might drive this outside of the composition of who lives in the neighborhood. Redlining, disproportionate policing, and other investment

restrictions (i.e., various forms of institutional racism) may help drive these disparities.[29] Additionally it is important to address the role of political influence on outlet availability, or the lack thereof, as it is associated with neighborhood economic vitality.[30] Long-term future studies should include the investigation of city planning efforts and neighborhood revitalization, as well as the utilization of sociology literature to investigate other methodologies for capturing neighborhood differences beyond its residents.

Zoning and other land use regulations have been successful in limiting the density of tobacco outlets, especially in low-income and minority communities.[31] Our preliminary results suggest that policy relevant solutions addressing income inequality may also improve the tobacco outlet landscape and sequelae of individual and community risk. Possible policy implications include firm restrictions/limits on the number of tobacco licenses issued to proprietors of tobacco outlets in low-income and underrepresented racial and ethnic communities.[32]

Acknowledgments

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Highlights

- Baltimore City and Prince George's County, Maryland are geospatially analyzed

- T-test shows no significant difference in Black population percentage

- T-test shows significantly higher income in Prince George's County

- T-test shows significantly lower tobacco outlet density in Prince George's County

- Spatial lag model shows negative link between income and tobacco outlet density

Table 1

T-tests Comparing Demographics and Tobacco Outlet Density of Baltimore City and Prince George's County, Maryland

Characteristic	Baltimore City	Prince George's County	t-statistic[1]	df
Population Per Residential Census Tract (SD)	3,118.81 (1,347.87)	3,969.92 (1,465.75)	**-6.15**	415
Black Population Percentage (SD)	65.25% (34.62%)	67.49% (24.79%)	-0.76 ($p = 0.45$)	415
Median Household Income (SD)	$43,571 ($23,286)	$77,190 ($27,061)	**-13.52**	414
Percentage of Incomes below Poverty Level (SD)	19.57 (14.47)	6.28 (5.80)	**12.50**	414
White Population Percentage (SD)	31.82 (32.36)	22.82 (18.96)	**3.50**	415
Tobacco Outlet Density (SD)	7.95 (7.43)	3.94 (3.80)	**7.03**	415

[1]boldface indicates statistical significance of p<0.001.

Table 2

Spatial Lag Regression Model Coefficients for Select Demographic Variables in Baltimore City – 2007-2011

	Unadjusted		Adjusted	
N (Census Tracts) = 198	β	p^2	β	P
Median Household Income	**-0.022**	**0.004**[**]	**-0.033**	**0.001**[**]
% Black	**0.001**	**0.001**[*]	**-0.019**	**0.018**[*]
% Hispanic	0.024	0.355	0.007	0.788
% with less than HS Diploma	0.079	0.069	0.077	0.104

[2]boldface indicates statistical significance

[*]p<0.05;

[**]p<0.01.

Table 3

Spatial Lag Regression Model Coefficients for Select Demographic Variables in Prince George's County – 2007-2011

N (Census Tracts) = 218	Unadjusted		Adjusted	
	β	P[3]	β	P
Median Household Income	**-0.009**	**0.001**[**]	**-0.009**	**0.001**[**]
% Black	**0.001**	**0.001**[**]	0.002	0.625
% Hispanic	0.004	0.929	0.000	0.959
% with less than HS Diploma	0.040	0.069	0.010	0.695

[3] boldface indicates statistical significance

[*] p<0.05;

[**] p<0.01.

Table 4

Spatial Lag Regression Model Coefficients for Select Demographic Variables with Interaction Coefficients – 2007-2011

	Baltimore City & Prince George's County	
N (Census Tracts) = 416	β	p[4]
Median Household Income	**-0.053**	**0.001**[**]
% Black	**-0.012**	**0.009**[**]
% Hispanic	-0.009	0.286
% with less than HS Diploma	0.050	0.104
County	-1.714	0.001[**]

[4]boldface indicates statistical significance

[*]$p<0.05$

[**]$p<0.01$.