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Overweight and obesity: Can we reconcile evidence about supermarkets and fast food retailers for public health policy?

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Abstract

The aim of this study is to determine whether access to fast food outlets and supermarkets is associated with overweight and obesity in New York City neighborhoods. We use a Bayesian ecologic approach for spatial prediction and consistent with prior research, we find no association between fast food density and overweight or obesity. Consistent with prior research, we find that supermarket access has a salutary impact on overweight and obesity. Given the lack of empirical evidence linking fast food retailers with adverse health outcomes, policymakers should be encouraged to adopt policies that incentivize the establishment of supermarkets and the modification of existing food store markets and retailers to offer healthier choices. Reaching within neighborhoods and modifying the physical environment and public health prevention and

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intervention efforts based on the characteristics of those neighborhoods may play a key role in creating healthier communities.

Keywords

Overweight; Physical environment; Fast food; Supermarkets; Parks; Regulation, Health Policy

Introduction

The prevalence of overweight and obesity has grown dramatically over the past few decades in the United States and the European Region.[1,2] Race, ethnicity and socioeconomic status have been associated with excess weight[3–5] and numerous studies have suggested that these patterns are due in part to differential exposures to obesogenic aspects of neighborhoods that are associated with lower socioeconomic status.[6–8] A recent review of the literature suggests that increasing policy attention to the physicial environment is critical to reducing obesity and improving health outcomes,[9] yet research is inconclusive on the best approaches to achieving these goals. For national policy makers in both the United States and Europe, a number of strategies to promote access to healthier foods have been considered including zoning, revisiting agricultural trade policies, food production, distribution, taxation and even product design and advertising.[10,11,12,13]

Data and methodological approaches in research designs examining the impact of the physical environment on overweight and obesity vary considerably, making comparisons of findings and policy decisions difficult. Even the definition of neighborhood boundaries presents difficulties for data collection and analysis,[14,15] yet reaching within neighborhoods and adjusting public health prevention and intervention efforts based on neighborhood characteristics may play a key role. The aim of this study is to present an ecological analysis of the physical environment, specifically access to fast food retailers and supermarkets, on overweight and obesity at the neighborhood level for adults in New York City. We hypothesize that consistent with other findings, supermarket density will be negatively associated with overweight and obesity and access to fast foods will have little or no association. Our intent is to highlight the importance of this negative finding. Given the lack of empirical evidence justifying regulations against fast food retailers in the United States and the European Region,[1] policymakers should consider policies and strategies that not only encourage the establishment of supermarkets,[16] but should encourage food store owners and fast food retailers to promote affordable, healthier food choices within neighborhoods.

Background

A survey of U.S. studies suggests that the physical environment is generally examined using two categories of variables including access to healthy food choices and parks and amenities available for physical activity. Research findings linking these variables with obesity remain inconsistent. For example, a review of 13 studies on park proximity and physical activity by Kaczynski et al.[17] indicates significant positive associations yet in later work Kaczynksi and colleagues[18] find that when additional variables are introduced, proximity is no longer

significant; the type of facilities available within the parks account for the level of physical activity. In a review of 45 studies, Lovasi and colleagues[19] consider the impact of the built environment on obesity outcomes in low income, minority neighborhoods. Although their review supports the salutary health impact of supermarkets, findings regarding physical activity and safety are more mixed. Finally, in a review of 54 research studies, Larson et al.[20] suggest that access to supermarkets results in lower levels of obesity and poor, minority neighborhoods are less likely to have this access. Despite the higher density of fast food retailers in these same neighborhoods, research is still inconclusive regarding their impact on levels of obesity.

A closer look at several recent studies highlights both the growing consensus linking improved supermarket access to lower levels of obesity and the lack of consensus linking proximity and density of fast food establishments to neighborhood obesity prevalence. In a longitudinal, multilevel study of neighborhoods in the Framingham area of Massachusetts, Block and colleagues[21] report inconsistent findings between access to fast food outlets and BMI. Further, in a cross-sectional study of adults in eastern Massachusetts, Lopez[22] finds no association between fast food density and obesity risk, but “the presence of a supermarket was associated with decreased obesity risk after controlling for individual risk factors.” In a study of NYC neighborhoods, Rundle et al.[23] also report no significant association between unhealthy food outlets and BMI; conversely, they do find that a “higher local density of BMI-healthy food outlets was associated with a lower mean BMI,” findings consistent with those from Black and colleagues[24] and similar to studies of other U.S. cities.[25–30] Inagami and colleagues[30] find similar results for car owners in disadvantaged neighborhoods traveling to grocery stores located at further distances, concluding that lack of access to healthy food choices *within neighborhoods* accounted for higher BMIs. Finally, in a county-level study, Mehta and Chang[32] find that areas with a higher density of fast food relative to full-service restaurants are associated with higher weight-status and obesity risk.

Data and Methods

Community Health Survey

Health outcomes data for this study are derived from the New York City Community Health Survey (CHS).[32] The CHS is an annual list assisted random-digit dial telephone survey of non-institutionalized adults ages 18 and older conducted by New York City’s Department of Health and Mental Hygiene. The survey is designed to provide annual estimates of health behaviors and conditions. This study defines NYC neighborhoods by postal code (for additional details see Freeman, et al.).[33] Although individual postal codes do not necessarily correspond with New York City neighborhood boundaries, they are compact and numerous, and tend to correspond well with one or at most a few neighborhoods.

Study Participants

Our dataset combined five CHS surveys from 2002 to 2006 to yield a total of 48,486 responses. Respondent-reported postal codes were available for 48,014 individuals. The survey was then post-stratified to match control totals taken from the 2000 US Census Bureau postal code tabulation area file, resulting in 164 postal code areas.[33] Thus, we have

an opportunity to support or challenge the current thinking that ‘we are only as healthy as the zip code’ or postal code we live in.[34]

Variables

Health outcome data on overweight and obesity are measured using self-reported height and weight data from the CHS. People with a BMI≥25kg/m^2 are considered overweight and people with a BMI≥30kg/m^2 are considered obese (BMI; body mass index). It is well known that self-reported height and weight tends to underestimate obesity and overweight.[35] However, self-reported measures have been shown to yield similar levels of association with other health outcomes and physical measures.[36] We used existence of a regular provider to proxy for access to care.

To adjust for neighborhood distributions of demographic characteristics, we obtained adult population data from the United States Bureau of the Census, including data on gender, age, race/ethnicity, income, and education. Income is reported as income less than 200% of the federal poverty limit (FPL; as established by the U.S. Department of Health and Human Services) or greater than or equal to 200% FPL.

As suggested by our literature review, our indices that measure the physical environment include access to park space, fast food outlets and supermarkets and are calculated at the postal code level in order to match the geographic aggregation of the other neighborhood variables. We also include a measure of park safety. Data on NYC parks and crime rates are from the Department of Parks and Recreation and the New York City Police Department, respectively. Food data are from Dunn and Bradstreet following the work of Rundle and colleagues.[23] Data cover the same time period as the Community Health Survey.

Specifically, we define two food index variables: Total Fast Foods, which includes fast food restaurants and pizzerias, and Total Supermarkets, which includes supermarkets with at least $2 million U.S. dollars in annual sales or at least 18 employees and grocery stores with at least five employees. Our two park variables include Park Access and Park Crime Rate.

We calculate Total Supermarkets, Total Fast Foods and Park Access by first measuring the distance along a pedestrian-accessible road from each residential tax lot in NYC to a either the nearest entrance or address using the Network Analyst tool in ArcGIS9.3 software. For fast food retailers, the total number of fast food locations within a ¼ mile walk from the tax lot culminates in a density measure. In order to calculate population-weighted averages, we estimate the number of residents in each tax lot using the cadastral-based expert dasymetric system (CEDS) following Maantay and colleagues.[37,38] We aggregate the distance and density measures to postal codes by calculating population-weighted averages. Ultimately, this creates a population-weighted fast food variable that reflects the density of fast food outlets in a given postal code, and supermarket and park variables representing average population-weighted distance to the nearest feature of interest. Lastly, our Park Crime Rate reflects the rates of murder, rape, and robbery (1999–2001, inclusive) for the police precinct (n=76) that contains the park of interest.[39]

Statistical Analysis

We performed the analysis at the postal code level using WinBUGS software, version 1.43. We employed a Bayesian spatial autocorrelation approach for spatial prediction because neighborhood-level data are not independent (e.g. neighboring postal codes contribute correlated information so the effective sample size is smaller) and some neighborhoods suffer from a paucity of data. Bayesian analysis is being used more widely in clinical data analyses[40] and scholars have recognized its use in policy analysis[41,21] (we refer interested readers to a primer on bayesian statistics by O'Hagan and Luce[42]). Point and credible interval estimates come from the posterior distribution.[43]

The model we used is:

$$y_i = \text{logit}(p_{\text{overweight/obese},i}) = \alpha_0 + \sum \alpha_j \cdot \text{demographic}_{ij} + \sum \alpha_k \cdot \text{environment}_{ik} + \varepsilon_i,$$

where the ε_i among adjacent neighborhoods may be correlated, *i* ranges from 1 to 163 (number of postal codes with complete data), and *j* ranges over the seven different socio-demographic covariates used; *k* ranges over the four physical environment covariates used (park crime rate, park access, total fast foods, and total supermarkets). We model categorical independent variables; the outcome variable is a single number: logit (overweight or obese population/total population). If the error terms, ε_i were independent, and distributed normally with mean zero and unspecified variance, this would be an ordinary linear regression. But the ε_i are instead assumed to exhibit spatial autocorrelation. To account for spatial autocorrelation, we used the covariance structure specified in MacNab.[44] We report descriptive statistics and parameter estimates. Significant findings are defined for those variables with estimates whose 2-sided 95% credible interval excludes zero.

Results

The study sample consists of 164 postal codes. Table 1 reports the percentage of postal codes in which residents with the described attribute are the majority. More than half (55%) have residents who are overweight or obese. By race/ethnicity, these are non-Hispanic white (38%), non-Hispanic black (24%) and Hispanic (25%). A little over one-third (37%) of postal codes have a majority who live below 200% of the federal poverty level, majority (53%) female, and just under half have residents with some college or beyond (48%). The median percentage of postal codes in which residents have a regular health care provider is 78% but ranges from 58% to 99%. Crime rate as reported in the table is per 1,000 residents; the mean rate is 14.63. Although it is difficult to know what rate is 'safe,' it appears that, given the range in rates, some residents have access to parks that in a relative sense might appear considerably safer than others. There is an average distance of 0.24 miles (.39 km) to the nearest park entrance, however some tax lots are as near as 0.07 miles (383 feet; .11 km) and some as far as 3.0 miles (4.8km). As reported in Table 1, on average, there are nearly twice as many fast food establishments as supermarkets or groceries within a zip code. Based on the population-weighted distance to nearest location, nearly 7 out of 10 NYC residents have at least one fast food establishment within a quarter of a mile (.40km) of their residence, whereas only half have a supermarket or grocery that is easily accessible.

Regression results appear in Table 2. As expected, predictors of higher proportions of overweight or obese residents within postal codes include race, education, and poverty. Perhaps surprisingly, postal codes with a greater proportion of adult males are associated with higher levels of overweight, as are postal codes with a higher proportion of residents reporting having a regular health care provider. There is a marginal and non-significant effect on both overweight and obesity rates with regards to rates of violent crimes. Park Access and Total Fast Foods are also non-significant. The only physical environment variable that demonstrates significance consistently is Total Supermarkets. These data suggest that each additional accessible market is associated with a decrease in overweight rate by 0.086% and obesity by 0.106%. Thus, in an average postal code with 50,000 persons, this implies that increasing access by one supermarket within a ¼ mile of where residents live would result in approximately 43 fewer overweight people and 53 fewer obese people.

Discussion

We found a significant negative relationship between supermarket density and overweight and obesity and consistent with prior research, found no statistically significant association between fast food density and the proportion of residents who were overweight or obese. It may be that saturation of fast food providers and their ubiquitous nature assures that most neighborhood fast food environments are increasingly similar. However, this is not true for the penetration and proliferation of supermarkets and grocers. People in cities tend to food shop near their homes if such venues exist; as Inagami and colleagues[30] have demonstrated, even for those residents who share rides with those who own cars, these trips are infrequent and have no impact on reducing BMI. Thus, it is not surprising that the one physical environment ‘exposure’ variable that is highlighted in this study is local supermarket access.

This is an important finding to emphasize so that policymakers increase their focus on improving access to healthy food choices rather than emphasizing policies whose objectives are to prohibit fast food retailers from operating within neighborhoods. Policy prescriptives of ‘zoning out’ fast foods receive support in response to rising overweight and obesity among school-aged children. Interestingly, a recent study[45] finds no correlation between food retailers and children, which may suggest that policymakers could consider zoning options from the perspective of their parents.

Since grocery stores tend to be located in higher income and more densely populated areas,[46] local policymakers should consider policies to influence grocers to locate in lower income neighborhoods:[16] provide information to potential establishments regarding commercial locations near transportation or housing complexes, help retailers obtain WIC certifications (Women, Infants and Children) or SNAP (supplemental nutrition programs for lower income households), or provide data on potential demand for grocery products. Unmet demand and lost sales in poor neighborhoods may be systematically underestimated by grocers; one study estimates that nearly $9 billion dollars may be lost annually.[47]

But not all grocers are created equally. Performance zoning, for the *impact* of land use as opposed to restrictions placed on *how* the land is used, “provides greater flexibility by requiring that any development meet specified performance standards, rather than meeting

detailed requirements as to allowed uses and the characteristics of those uses…. and thus provide for greater economic efficiency."[48] Therefore policymakers could require food retailers, including fast food restaurants, to provide a number of healthy food choices on their menus.[49] Although not the obvious surrogate for healthier food choices, fast food providers, given their proliferation and impact on employment of minority and undereducated groups especially in cities like New York,[50] could become allies in improving the health of communities. There are also strategies available to policymakers that can support access to healthy food choices with innovative programs such as "Healthy Bodegas," farmers' markets, "Health Bucks," and "Green Carts," introduced by the NYC Department of Health and Mental Hygiene[51,52], that encourage the sale of fresh fruits, vegetables and low fat milk.

Questions remain about our results. Our findings suggest that postal codes with a greater proportion of adult males are associated with higher levels of overweight. However in low-income postal codes, those with a higher proportion of women are positively associated with overweight. A few higher income postal codes may unduly affect our results. Also, postal codes with a higher proportion of residents reporting regular providers are associated with higher levels of overweight. Research can elucidate roles for providers in reducing prevalence of overweight and obesity in their neighborhoods[53,54] and help determine differences in how overweight and obese residents use health care services. We also gathered data regarding insurance coverage from the CHS but this variable is highly correlated with provider and was dropped. Although the median percentage of postal codes in which residents have insurance is 86%, a relationship between insurance coverage and our outcome variables may exist at the *individual* level.

Limitations include: postal codes may include residents of diverse incomes, where census tracts may portray more economically homogeneous neighborhoods. Distinguishing postal codes where most residents' incomes are below 200% of the federal poverty limit may provide information for prioritizing resource allocation to reduce overweight and obesity. Issues of multicollinearity may limit the precision with which we can estimate the effects of single variables. Finally, future research with multi-level analyses of individual level responses and data aggregated at the postal code level, as done here, may provide further insights.

Conclusion

The New Public Health, as described by Halpin and colleagues[55], is a multi-faceted, international approach with policies aimed at individual, community and societal levels. Attention to the physical environment is part of a comprehensive public health agenda to 'stem the tide of the growing global burden of chronic disease' but assumes particular significance for limiting the impact of overweight and obesity on chronic disease. It is not easy to reconcile results of recent research. Our findings—supermarket access and fewer overweight and obese neighbors—may prove to be an integral part of the policy maker's repertoire to enhancing access to healthy food choices and improving population health. Further study can help to determine the impact of our policy recommendations for changing individual purchasing behavior and achieving public health objectives.[20,56]

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Table 1

Sociodemographic Characteristics by Postal Code (164 NYC Postal Codes)

Variable	Mean, SD	Median	Range
overweight	0.35, 0.057	0.35	0.20 – 0.56
obese	0.20, 0.07	0.20	0.05 – 0.37
Race			
non-Hispanic black	0.24, 0.27	0.09	0 – 0.92
Hispanic	0.25, 0.20	0.18	0.01 – 0.80
non-Hispanic white	0.38, 0.29	0.40	0 – 0.99
non-Hispanic other	0.14, 0.12	0.087	0 – 0.58
Gender			
Female	0.53, 0.025	0.53	0.38 – 0.59
Male	0.47, 0.03	0.47	0.41 – 0.62
Income			
< 200% FPL	0.37, 0.17	0.36	0.10 – 0.73
≥ 200% FPL	0.63, 0.17	0.64	0.27 – 0.90
Education			
% Low Education[a]	0.52, 0.16	0.55	0.104–0.796
% High Education[b]	0.48, 0.16	0.45	0.204–0.896
Regular Provider	0.78, 0.07	0.78	0.58 – 0.99
Park Crime Rate	14.63, 34.25	6.51	0.37–274.91
Park Access	1266.32, 1245.32	1096.26	383.02–15827.08
Total Fast Foods	2.51, 2.90	1.65	0.00–20.37
Total Supermarkets	1.18, 1.21	0.70	0.00–6.77

[a] Low Education includes less than or equal to high school diploma or GED

[b] High Education includes some college or beyond

Note: All variable results reported as *percentage of postal codes in which residents who have the described attribute are the majority* with the exception of Park Crime Rate (rate per 1,000 residents); Park Access (in feet: 5,280 feet = 1 mile = 1.6km); Total Fast Foods and Total Supermarkets (calculated number as described in methods).

Table 2

Logistic Regression Parameter Estimates

Variable	Overweight		Obese	
	β[a]	95% CrI	β	95% CrI
Race				
Black	1.23	(0.93, 1.54)[b]	1.26	(0,88, 1.65)[b]
Hispanic	1.45	(1.06, 1.84)[b]	1.05	(0.59, 1.51)[b]
White	0.71	(0.38, 1.06)[b]	0.61	(0.21, 1.02)[b]
Education				
≤High school/GED	2.36	(1.61, 3.13)[b]	2.30	(1.33, 3.23)[b]
Gender, Male	1.72	(0.27, 3.22)[b]	1.544	(−1.27, 3.88)
Primary Care Physician	1.37	(0.49, 2.42)[b]	0.67	(−0.32, 1.66)
Poverty				
<200%FPL	0.65	(0.26, 1.02)[b]	0.92	(0.46, 1.41)[b]
Park Crime Rate	0.00	(−0.00, 0.00)	0.00	(0.00, 0.00)
Park Access	0.17	(−0.00, 0.00)	−0.03	(−0.00, 0.00)
Total Fast Foods	0.02	(−0.01, 0.04)	0.01	(−0.02, 0.03)
Total Supermarkets	−0.09	(−0.12, −0.03)[b]	−0.11	(−0.17, −0.03)[b]

Abbreviation: CrI, credible interval

[a]The mean is analogous to the coefficient estimate, β, in a logistic regression analysis.

[b]Two-sided 95% credible interval does not contain 0.