Zoning for Health: The Obesity Epidemic and Opportunities for Local Policy Intervention\textsuperscript{1,2}

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Abstract

Several states and local communities have started to experiment with policy initiatives that affect the built-up environment in an attempt to decrease the prevalence of obesity. The focus of these policy measures has generally been to eliminate geographical disparities in access to food. Recent policy proposals include the use of zoning laws to create a healthier food environment by providing incentives for chain grocers to open stores in disadvantaged, underserved areas and providing incentives for existing food retailers to offer healthier products. The economic feasibility of implementing these types of interventions depends on the policymaker’s ability to identify communities most at need. We use computer simulations, based on introducing new chain grocers in targeted areas, to map the effects on BMI of this modification in the food environment. In this study, we show that targeting economically disadvantaged communities with high prevalence of obesity-related diseases can provide an effective means of identifying areas where policy implementation will be most beneficial for improvements in health outcomes such as BMI. \(J. \text{Nutr.} \) 140: 1181–1184, 2010.

Introduction

Insights from the obesity literature suggest that the increase in prevalence of obesity in the United States is largely attributable to an environment that promotes overconsumption of unhealthy foods (1–4). Although much of the work in this area has focused on the consumption of fast food, there is an increasing body of evidence that suggests that limited geographical access to healthy food is also contributing to the obesity epidemic. Work by Wrigley et al. (5) suggested that limited access to food retailers, in particular chain grocers, has played an influential role on dietary quality. Other studies have suggested that the availability of chain grocers is associated with fruit and vegetable intake and that limited access to chain grocers may be positively correlated with BMI (3,6,7).

National chain grocers are more likely to offer the widest range of foods, often at the lowest prices (8). These chain grocers, however, may not be equally distributed across neighborhoods. It has been argued that chain grocers have left inner city areas in favor of fringe and suburban locations, effectively creating “food deserts” (9). Similarly, new chain grocers have been observed to preferentially locate in higher-socioeconomic-status neighborhoods (10). As a result, disadvantaged residential neighborhoods are left with limited geographical access to food retailers, specifically those retailers that carry healthy and affordable foods (11).

The result of studies that examine the spatial distribution of food retailer establishments is mixed. In a national study conducted at the zip-code level, Powell et al. (12) find that low-income, urban, minority neighborhoods are less likely to have access to chain grocers. These results are supported by other studies conducted by Morland et al. (13) in Mississippi, North Carolina, Maryland, and Minnesota. Zenk et al. (12–14), in a study of neighborhoods in Detroit, found that access to chain grocers was associated with minority status but not with income. Other studies conducted in the United Kingdom have not found differences in the association between supermarket location and the racial and socioeconomic composition of neighborhoods (15).

More specific research on the types of food carried by retailers finds that there are disparities in healthy foods in neighborhoods defined on the basis of race and socioeconomic characteristics (16–18). The literature on the relationship between diet quality and availability of healthy foods in stores also shows rather mixed results. Studies conducted in the United Kingdom by Cummins et al. (19) find no impact on fruit and vegetable consumption when chain grocers are introduced into a new community, whereas Wrigley et al. (20) find a modest but positive impact on diet quality. Studies in the United States have, however, found positive associations between proximity to grocery stores and diet quality (21–23).

There is a large body of literature that associates obesity and/or obesity-related health outcomes, such as diabetes and cardiovascular disease, with neighborhood factors (24–28). One neighborhood factor that has generated increasing attention in the literature is the potential role that accessibility to...
healthy foods has on diet quality and ultimately on BMI. Evidence suggests that there is an association between accessibility to healthy foods and better diet (7,29), lower BMI, and obesity (3,6,30). In sum, these pieces of evidence suggest that access to healthy foods may be one of the mechanisms through which neighborhood factors affect health, particularly if access is dependent on the socioeconomic or racial composition of neighborhoods. Access to healthy food is an easily identifiable characteristic of the built environment, and it therefore constitutes a potentially useful and effective avenue through which public policy can affect population health.

A number of states and local communities have started to experiment with different types of policy initiatives, all of which are aimed at eliminating the geographical disparities in access to food. Recent policy proposals include the use of zoning laws to create a healthier food environment (31). Zoning laws effectively restrict land use by limiting the prevalence of fast food restaurants and promoting the development of healthier alternatives. Alternative policy proposals that have been implemented include monetary incentives to existing food stores to stock healthy food items and the financial support and subsidization of farmers’ markets and other venues to facilitate access to fresh fruits and vegetables. The success of these types of interventions depends on the policymaker’s ability to identify communities most at need for a particular policy intervention. As we will show in the subsequent policy simulation, targeting communities with high prevalence of obesity-related diseases may provide an effective means of identifying areas where policy implementation will be most cost effective.

Subjects and Methods

Simulations. The simulations conducted were based on a spatial econometric model estimated by Chen et al. (32) using survey and administrative data from Marion County, IN. Using the data from this study, we simulated the effect of a local public policy that is aimed at modifying the built environment by increasing access to healthy foods. In practical terms, we introduced new chain grocers in previously underserved neighborhoods and subsequently mapped the effects of changing the food environment on the BMI of all individuals included in the survey. Our policy simulation models were programmed in R (version 2.8.1) [Hornik (2009), "The R FAQ", http://CRAN.R-project.org/doc/FAQ/R-FAQ.html, ISBN 3-900051-08-9], and we used ArcGIS to manipulate the spatially referenced data and to map the spatial distribution of the policy impact on BMI for all individuals in the survey. The decision to use a spatial econometric model as the basis for our simulations was based on the fact that we were using spatially referenced data. When the spatial properties of these data were explored in earlier studies, there was evidence of clustering of high-BMI individuals and also evidence of spatial autocorrelation in the data (32). Other studies have similarly found evidence of spatial clustering of obese individuals, both at high and low levels of spatial aggregation (14,33,34). Spatial clustering can be caused by 2 factors: individuals with similar characteristics (such as race and income) tend to live close to each other, and the shared characteristics of the neighborhood where they live potentially affect people in a similar way. In the context of our simulation, differences in accessibility to large-chain grocery stores may therefore have induced dietary variation across space. In turn, this dietary variation may have led to differences in BMI across space. The use of a spatial econometric modeling technique is pivotal because if spatial autocorrelation is present in the data, ordinary least-squares estimates may be biased and/or inefficient (35).

The association between BMI and access to chain grocers may be different for people who live in poor versus wealthier communities. Factors such as inadequate public transportation systems, unsafe streets, or the effect of social factors within a person’s community are some of the reasons why this variable may differ between poor and wealthier communities. The spatial econometric model that we simulate allows this type of flexibility by interacting access to chain grocers with the type of community that a person lives in. For each survey respondent in our sample, the community is defined by the characteristics of the people immediately surrounding him or her. Specifically, if >20% of an individual’s immediate neighbors are poor (defined as being at or below 200% of the federal poverty level), then he or she is classified as living within a poor community or among low-income peers. By this definition, ~42.9% of the sample was classified as living in a poor community.

The underlying spatial econometric model estimates the effect of access to chain grocers on BMI, controlling for race, sex, income, age, and education and allows the effect to be different for people living in poor or rich communities. The model finds that for people who live in poor communities, access to chain grocers is negatively associated with BMI. Access is not significantly associated with BMI for people who live in richer communities (32).

Data. The econometric results were used in a local policy simulation that utilizes data from 2 other sources. The first source was the Marion County Health Department Obesity Needs Assessment Survey conducted in Marion County, IN in 2005. Along with information on weight, shopping and eating habits, as well as use of trails and recreation areas, this unique data source contains geographic identifiers for each individual in the sample (at the level of the nearest cross street to an individual’s home). The second data source was administrative data from the Marion County Health Department’s health safety inspection records, which contained information on chain grocers within Marion County. An extensive discussion of the data can be found in Chen et al. (36). The sample consists of 3,550 individuals, and the mean BMI of the respondents is 27.7. The sample is 30.3% nonwhite, 58.1% female, with a mean age of 47 y. In terms of income, ~20.7% of the sample was categorized as having incomes <200% of the federal poverty level. In terms of health behaviors, ~25.9% of the sample smoked. The mean number of chain grocers within 1 mile (1.61 km) of a person’s residence was 1.

Targeting neighborhoods. To conduct policy simulations we first select policy implementation areas on the basis of neighborhood characteristics. Neighborhoods are defined on the basis of 1-km by 1-km areal units (37). These areal units provide small-area estimates of the mean income and education level of a neighborhood. The small area-estimates came from the Socioeconomic Data and Applications (SEDAC) project, which provides small-area estimates of income and education derived from Census data. The spatial unit of observation in the SEDAC data for Marion County, IN is 20 arc seconds, which is approximately a 1-km by 1-km grid cell.

We decided to use small-area estimates to identify the neighborhoods to target because there is an obvious advantage to moving away from using large areal units such as counties or census tracts. These areas are largely administrative in nature, and the sociodemographic characteristics of these administrative units may not accurately reflect the actual sociodemographic composition of the neighborhoods within the census tract or county. In our simulation we target neighborhoods where 40% or more of the population are below 200% of the federal poverty level and 40% or more have at most a high school diploma.

We then use geographic information service (GIS) techniques to spatially link the data from the Obesity Needs Survey to these small 1-km by 1-km areas. The prevalence of cardiovascular disease and diabetes for each grid cell is then estimated using the Obesity Needs Survey data. An area is a candidate for health zoning if the 1-km square area has a population with relatively low income, low education, and a high prevalence of cardiovascular disease and diabetes. High prevalence is defined as being 2 standard deviations above the mean prevalence for the study sample.

Results

Based on this targeting criterion, we identify 5 neighborhoods in our study area where we should implement a policy to modify the food environment. The exact geographical placement of the
5 chain grocers is shown on the map of Marion county (see Fig. 1). The polygon-shaped areas are Thiessen polygons and actually represent the 3,550 people in our study. Using Thiessen polygons instead of points to represent individuals in a map is useful in this context because we can more easily identify who is a neighbor of whom (much like squares on a checkerboard), and we can perceptively visualize the simulated spatial spillover effects that occur when we introduce a policy change.

Once we have placed the chain grocer on the map, we then use GIS techniques to count the number of chain grocers within 1 mile (1.61 km) of a person’s residence. There are ~302 people who are directly affected by the opening of the 5 new grocery stores in Marion County; that is, for these people the number of grocers in their local food environment (measured using a 1-mile [1.61-km] buffer) changes. Of these, 295 people live in poor communities.

The spatial policy simulations provide estimates of the total effect of improving access to chain grocers on BMI for every individual in our survey. As the map in Figure 1 shows, the people who are proximate to the new chain grocer are affected the most. As explained earlier, the spatial econometric model that we use allows our neighbors’ behavior to influence our behavior (and vice versa) through spillover effects. These spillover effects are clearly seen by the spatially dispersed pattern of the marginal effects. As we radiate outward from the location of the new chain grocery, we see that the effect on BMI exhibits a smooth spatial distance-decay pattern.

When we calculate the average marginal effect for the people who live in poor communities, a simulated increase in access to grocery stores is associated with a significant decrease in BMI of 0.43 (P < 0.05). The significance of these effects demonstrates that even after a policy maker selects policy targets using neighborhood characteristics, there is still substantial variation in the individualized policy response based on the person’s own characteristics as well as his or her community characteristics.

Discussion

There have been numerous calls by public health administrators to modify the built environment to reduce obesity and improve public health. Most local communities have limited financial resources to engage in these types of activities. From a practical standpoint, it would be cost prohibitive to change the environment for everyone within a particular community. Zoning for health or selecting locations to intervene on the basis of prevalence of certain diseases is one way to achieve this objective cost effectively.

As this simulation shows, the key policy implementation issue is how to go about identifying target areas. In this article we suggest targeting areas based on sociodemographic characteristics and the prevalence of certain types of health conditions, such as cardiovascular disease and obesity. The richness of our data source allowed us to identify geographical areas where a policy intervention should take place. Many county public health departments may not have small-area estimates of their population’s health. Their ability to pursue such strategies would then depend on the county’s ability to obtain small-area statistics on their population’s health. This may limit the usefulness of this proposed targeting strategy from a policy perspective.

Throughout our discussion we have framed the simulation in terms of adding a chain grocer to a neighborhood. This example was based on earlier evidence that chain grocers are more likely to carry healthy foods at lower prices than other retailers (8). However, the simulations would have given the same result if the policy instrument had been a tax subsidy, a lump sum payment, or any other type of financial incentive provided to retailers to induce them to sell healthier foods at reasonable prices.

A broad spectrum of research is needed to fully understand the ways in which the food retailer environment affects dietary intake and health. First, more attention should be paid to the statistical models used to estimate the associations between access to food retailers and diet quality and health. The data used for these studies are usually spatially referenced, so the underlying spatial properties of the data should be explored and then accounted for in the statistical estimation (14). Second, there should be more research on the impact of real interventions in the food retailer environment on dietary intake and health (19). These studies should provide estimates of policy interventions at differing geographic scales. The benefits of this strategy are shown in the map of our simulations, indicating that people living closest to the targeted intervention site will benefit the most, with the effects radiating outward as individuals are located further away. This type of information will strengthen the evidence base for the relationship between access to healthy foods and diet and health. Finally, these studies should outline how policy interventions can be implemented on a larger scale by identifying how best to engage city planners and other community leaders to assist in the reengineering of the food landscape.

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**Literature Cited**


