Measuring food deserts in New York City's low-income neighborhoods

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A B S T R A C T
There has been growing interest in the environmental factors that contribute to poor health outcomes, particularly in areas where health disparities are pronounced. The locations of food deserts, or unhealthy food environments, correspond to areas with the highest proportions of African-American/Black residents, a population suffering from higher rates of many chronic conditions, including obesity and diabetes in our study area. This study seeks to enhance our understanding of the role of the neighborhood environment on residents’ health, by examining neighborhood food availability and access in low-income and wealthier neighborhoods of New York City. We documented the neighborhood food environment and areas we call “food deserts” by creating methodological innovations. We calculated the lowest scores within East and Central Harlem and North and Central Brooklyn—areas with the highest proportions of Black residents and the lowest median household incomes. By contrast, the most favorable food desert scores were on the Upper East Side, a predominantly white, middle and upper-income area.

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1. Introduction

More than half of adult New Yorkers are either overweight or obese, and obesity levels are rising rapidly (Van Wye et al., 2008). Being at an unhealthy weight increases a person’s risk of developing many conditions, including diabetes, high blood pressure, high cholesterol, some types of cancer, and heart disease (Pi-Sunyer, 2002). In New York City, as in other urban settings, there are higher rates of obesity in low-income minority neighborhoods than in more affluent and predominantly white neighborhoods. The prevalence of obesity in one of New York City’s wealthiest neighborhoods, known as the Upper East Side, was 9% in 2006, while prevalence ranged from 21% to 30% among adults living in East and Central Harlem and North and Central Brooklyn; some of New York City’s lowest income neighborhoods. Similarly, disparities exist in diabetes prevalence rates; 5% of adults living in the Upper East Side neighborhood report a diabetes diagnosis, compared with 10–15% of adults living in East and Central Harlem and North and Central Brooklyn (New York City Department of Health and Mental Hygiene, 2008).

Policymakers have begun to examine the built environment, specifically access to healthy and unhealthy foods, to understand how neighborhood food availability may be contributing to race/ethnic and economic disparities in overweight, obesity and diabetes (USDA, 2009). The term “food desert” has been widely used to describe areas where low-income residents of color do not have access to healthy and affordable food and fast food restaurants dominate the landscape (Beaulac et al., 2009; Mari Gallagher Research and Consulting Group, 2006). Research has demonstrated that access to healthy foods in urban areas is limited by factors such as poverty and race (e.g., see USDA, 2009; Moore and Diez Roux, 2006; Galvez et al., 2007; Franco et al., 2008).

While research suggests food deserts exist and are more prevalent in disadvantaged areas, there is a lack of consistency in how food deserts are defined and identified (Beaulac et al., 2009; USDA, 2009; Walker et al., 2010). Several researchers have found a lack of supermarkets in lower-income, predominantly African-American areas (Moore et al., 2008; Zenk et al., 2005; Walker et al., 2010) and an overabundance of fast food restaurants (Kwate et al., 2009; Block et al., 2004). However, the findings on racial/ethnic and income disparities in access to fast food restaurants are more mixed (Morland et al., 2002b; Wang et al., 2007; Zenk and Powell, 2008). Convenience stores are often viewed as providing an abundance of unhealthy food (Lucan et al., 2010), yet their ubiquity in dense urban environments and position as a foundation of urban “foodways” (Cannuscio et al., 2010) warrant further examination to confirm they are by and large unhealthy. Researchers who have directly assessed disparities in specific food items available in grocery stores, small and large, have found mixed results (Beaulac et al., 2009).
Most research examining food deserts focuses on identifying a lack of healthy food available in disadvantaged neighborhoods by way of supermarkets, fruit and vegetable markets, or specific items available within existing markets and studies rarely combine an analysis of both healthy and unhealthy food access opportunities (Beaulac et al., 2009; Walker et al., 2010). Very few researchers combine healthy and unhealthy sources into one indicator to make statements about disparities in the balance of healthy and unhealthy foods available (Beaulac et al., 2009; Mari Gallagher Research and Consulting Group, 2006; Walker et al., 2010) and we are not aware of any studies that combine surveys of multiple establishment types with in-store direct item measurement to create such a healthy/unhealthy food desert indicator.

In this study we describe the food environments in low-income neighborhoods in New York City where obesity rates are high and compare these with high-income areas with much lower prevalence of obesity. We use Geographic Information Systems (GIS) to count food resources within a street network buffer around Census block groups to quantify accessibility to multiple food outlet types. In New York City, as in other urban areas, supermarkets, small convenience stores, also known as bodegas, and fast food restaurants are primary sources of food (Horowitz et al., 2004; Graham et al., 2006) and are therefore the three establishment types upon which we focus. We also use results from an in-store survey of specific food items to construct a food desert index that takes into account both healthful and unhealthful food outlets and small markets carrying healthy foods. We then examine differences in our food desert index by race/ethnic and economic composition.

2. Methodology

2.1. Data collection

Researchers conducted a block-by-block assessment of every establishment selling food and beverages in North and Central Brooklyn (also referred to as Brooklyn) and East and Central Harlem (also referred to as Harlem). Survey areas were chosen because they are low-income and largely Black and Hispanic neighborhoods (Demographic Profile, NYC Department of City Planning, 2001a, 2001b) and have high levels of premature morbidity and mortality. A portion of the Upper East Side was selected as a comparison area because of its contrasting affluence and adjacency to Harlem. Surveyors, who included student intern employees and volunteers, participated in a 3-hour training provided by senior researchers who had developed the survey and researchers from the survey team in Brooklyn, before the Harlem survey was launched. The survey team conducted several pilot field visits to the same establishments to insure surveyors coded items uniformly. Surveyors also traveled in pairs and consulted with each other to catalog survey items (see below). At each store surveyed (see Gordon et al. (2007) for the preliminary analysis) researchers obtained permission to conduct the assessment. In each establishment assessed, researchers determined the type of establishment, the availability, placement, and price of representative healthy and unhealthy foods as well as the presence and type of storefront advertisements (food, nonalcoholic beverage, alcohol, or cigarette ads).

The Brooklyn assessment was conducted from August 2004 to October 2004 and the Harlem and Upper East Side assessments were conducted from June to December in 2005. The Harlem survey was very similar to the Brooklyn survey; however, some minor revisions and additions were made based on the Brooklyn survey experience. Both surveys included a range of representative healthy and unhealthy items.

Using data drawn from the 2000 U.S. Census summary file 3, we categorized Census block groups in terms of their racial/ethnic and economic composition. For this, we calculated the proportion of black or African-American residents, the proportion of Hispanic or Latino residents, and proportion of white residents. To describe economic composition, we used the median household income (see Table 1).

| Table 1 |
| Block group, demographic and food access characteristics by neighborhood. |

<table>
<thead>
<tr>
<th>Area (km²)</th>
<th>Population</th>
<th>Population/ km²</th>
<th>Proportion Black</th>
<th>Proportion Latino</th>
<th>Proportion White</th>
<th>Median household income ($)</th>
<th>Average number of supermarkets</th>
<th>Proportion healthiest bodegas</th>
<th>Proportion fast food restaurants</th>
</tr>
</thead>
<tbody>
<tr>
<td>All block groups (n=448)</td>
<td>Mean (SD)</td>
<td>0.05 (0.02)</td>
<td>1280 (963)</td>
<td>27,665</td>
<td>0.55 (0.34)</td>
<td>0.33 (0.29)</td>
<td>0.20 (0.25)</td>
<td>29,365</td>
<td>(23,988)</td>
</tr>
<tr>
<td>33rd%</td>
<td>0.04</td>
<td>865</td>
<td>19,265</td>
<td>0.33</td>
<td>0.11</td>
<td>0.05</td>
<td>18,760</td>
<td>0</td>
<td>0.07</td>
</tr>
<tr>
<td>66th%</td>
<td>0.05</td>
<td>1274</td>
<td>28,992</td>
<td>0.79</td>
<td>0.44</td>
<td>0.21</td>
<td>28,405</td>
<td>1</td>
<td>0.25</td>
</tr>
<tr>
<td>Max</td>
<td>0.20</td>
<td>7386</td>
<td>115,794</td>
<td>1</td>
<td>1</td>
<td>0.98</td>
<td>200,001</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Upper East Side block groups (n=39)</td>
<td>Mean (SD)</td>
<td>0.04 (0.02)</td>
<td>2377 (1397)</td>
<td>52,976</td>
<td>0.02 (0.03)</td>
<td>0.06 (0.05)</td>
<td>0.89 (0.07)</td>
<td>90,472</td>
<td>(35,806)</td>
</tr>
<tr>
<td>33rd%</td>
<td>0.04</td>
<td>1402</td>
<td>43,127</td>
<td>0.01</td>
<td>0.03</td>
<td>0.08</td>
<td>70,360</td>
<td>1</td>
<td>0.26</td>
</tr>
<tr>
<td>66th%</td>
<td>0.05</td>
<td>2576</td>
<td>61,059</td>
<td>0.02</td>
<td>0.06</td>
<td>0.92</td>
<td>95,552</td>
<td>2</td>
<td>0.34</td>
</tr>
<tr>
<td>Max</td>
<td>0.12</td>
<td>5891</td>
<td>97,123</td>
<td>0.15</td>
<td>0.24</td>
<td>0.98</td>
<td>200,001</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>East and Central Harlem block groups (n=156)</td>
<td>Mean (SD)</td>
<td>0.05 (0.03)</td>
<td>1433 (1129)</td>
<td>31,439</td>
<td>0.61 (0.28)</td>
<td>0.34 (0.26)</td>
<td>0.15 (0.15)</td>
<td>22,005</td>
<td>(11,614)</td>
</tr>
<tr>
<td>33rd%</td>
<td>0.04</td>
<td>850</td>
<td>23,263</td>
<td>0.45</td>
<td>0.16</td>
<td>0.06</td>
<td>15,597</td>
<td>0</td>
<td>0.10</td>
</tr>
<tr>
<td>66th%</td>
<td>0.05</td>
<td>1576</td>
<td>37,964</td>
<td>0.80</td>
<td>0.48</td>
<td>0.19</td>
<td>25,130</td>
<td>1</td>
<td>0.23</td>
</tr>
<tr>
<td>Max</td>
<td>0.20</td>
<td>7386</td>
<td>115,794</td>
<td>1</td>
<td>0.92</td>
<td>0.72</td>
<td>99,308</td>
<td>4</td>
<td>0.67</td>
</tr>
<tr>
<td>North and Central Brooklyn block groups (n=253)</td>
<td>Mean (SD)</td>
<td>0.05 (0.02)</td>
<td>1016 (542)</td>
<td>21,437</td>
<td>0.59 (0.33)</td>
<td>0.37 (0.32)</td>
<td>0.12 (0.13)</td>
<td>24,484</td>
<td>(10,443)</td>
</tr>
<tr>
<td>33rd%</td>
<td>0.04</td>
<td>827</td>
<td>17,318</td>
<td>0.42</td>
<td>0.11</td>
<td>0.03</td>
<td>19,133</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>66th%</td>
<td>0.05</td>
<td>1112</td>
<td>24,298</td>
<td>0.84</td>
<td>0.50</td>
<td>0.13</td>
<td>26,512</td>
<td>1</td>
<td>0.22</td>
</tr>
<tr>
<td>Max</td>
<td>0.14</td>
<td>5077</td>
<td>70,438</td>
<td>1</td>
<td>1</td>
<td>0.60</td>
<td>95,167</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

* Figures were calculated based on establishments that are within a quarter mile of block group center points.

Tertile ranks are provided because these cut points are the basis for high, medium, and low accessibility designations for the food environment measures.
2.2. Food desert index

Our food desert index is a measure of the healthy and unhealthy food options available to residents of the surveyed areas. It consists of three components: access to supermarkets, bodegas carrying healthy foods (defined according to a “representative healthy food scale” described below), and fast food restaurants. Access is defined in reference to block groups, whereby supermarkets, bodegas with healthy food, and fast food restaurants were counted for each block group when they fell within a quarter mile of the block group.

Block groups, which consist of approximately 3 city blocks in our study area were chosen as a proxy for residence. Block groups are the smallest Census areas for which income data are available, so while it would have been more accurate to measure access from blocks, which are roughly the size of one city block, we were constrained by data availability at this geographic scale (see Table 1 for characteristics of block groups). The quarter mile distance was chosen because literature suggests people are willing to walk for approximately 5 min to reach neighborhood retail and services. It takes roughly 5 min to walk a quarter mile or 400 m (Atash, 1994; Pushkarev and Zupan, 1975). To quantify access to our three food outlet types, using a GIS, we measured a quarter mile distance along the street network in all possible directions from the population-weighted center point of each Census block group. The block group center point was weighted by the Census block population therein to more accurately approximate where people actually live within the block group and to minimize the error introduced by using block groups to approximate residences. This yielded a quarter mile “walking path” buffer around each block group. Using the block group center point allowed us to use the street network to measure distance and to simulate walking behavior that must follow streets and sidewalks.

Two of the food desert index components, supermarkets and fast food restaurants, were categorized as part of the survey. Supermarkets were indicated by surveyor assessment of the establishment as a “large variety store” or a “large chain variety store.” Fast food restaurants are national or local chain establishments with no table service.

To create a definition of healthy bodegas we developed a “representative healthy food” scale, which we used to define “healthy bodegas.” Ten items were chosen from the in-store survey to be included in this scale. These included apples, oranges, bananas, skim and low-fat milk, water, tomatoes, carrots, leafy greens, and 100% juice. These items were chosen because they represent, at a minimum, fresh fruits and vegetables that are part of a healthy diet, low-fat milk because it is recommended for people over 2 years of age, and water and 100% juice for their nutritional value and in contrast to common alternative beverages that contain little nutritional value. Each store received a rating of “1” for each item it offered, with a total possible score of 10. This maximum score was reclassified to indicate “least healthy” stores (total score = 1–3), “moderately healthy” stores (4–6) and the “most healthy” stores (7–10).

We assigned each block group a number corresponding to the supermarkets, bodegas, and restaurants that fell within the quarter mile buffer, considered “accessible” to the block group. We calculated the average number of supermarkets within the buffer. We then used the “representative healthy food” scores and number of fast food restaurants to calculate, respectively, the proportion of bodegas that were “most healthy” and the proportion of all restaurants identified as fast food within the buffer (see Table 1 for food access characteristics of block groups).

Each of the three food desert index components was ranked according to the level of accessibility of healthy or unhealthy food it represented (low, medium, or high). A “1” represented low access to healthy food and a “3” represented higher access to healthy food. Each block group buffer was assigned a score of 1, 2, or 3 for each of the three components accessible to it—average number of supermarkets, proportion of “most healthy” bodegas, and proportion of restaurants identified as fast food (see Table 2).

A block group had zero supermarkets or “most healthy” bodegas within a quarter mile it was assigned a score of 1 and if a block group had zero fast food restaurants it was assigned a score of 3. The final food desert index score was calculated by summing for each block group buffer the three component rankings. Each block group received a score ranging from 3 to 9. Three was the lowest possible score (all three components within the block group buffer were ranked “1”), representing few opportunities to access healthy food and many opportunities to obtain fast food. Nine was the highest possible score (all three components within the block group buffer were ranked “3”), representing many opportunities to access healthy food and fewer opportunities to obtain fast food.

2.3. Analysis

We calculated descriptive statistics for demographic and food access variables and examined the relationship between the block

<table>
<thead>
<tr>
<th>Establishment type</th>
<th>Accessibility measure</th>
<th>Accessibility rank</th>
<th>Rank based on</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supermarkets</strong></td>
<td>Total number of supermarkets within a quarter mile walking distance of the block group center point</td>
<td>1 (low)</td>
<td>Zero supermarkets within a quarter mile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (medium)</td>
<td>One supermarket within a quarter mile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 (high)</td>
<td>More than one supermarket within a quarter mile</td>
</tr>
<tr>
<td>&quot;Healthy&quot; bodegas</td>
<td>Proportion of &quot;healthy&quot; bodegas of all bodegas within a quarter mile walking distance of the block group center point</td>
<td>1 (low)</td>
<td>First tertile: &quot;Healthy&quot; bodegas comprise up to 7% of all bodegas within a quarter mile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (medium)</td>
<td>Second tertile: &quot;Healthy&quot; bodegas comprise between 8% and 25% of all bodegas within a quarter mile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 (high)</td>
<td>Third tertile: &quot;Healthy&quot; bodegas comprise greater than 25% of all bodegas within a quarter mile</td>
</tr>
<tr>
<td>Fast food restaurants</td>
<td>The proportion of fast food restaurants of all restaurants within a quarter mile walking distance of the block group center point</td>
<td>1 (low)</td>
<td>Third tertile: fast food restaurants comprise greater than 14% of all restaurants within a quarter mile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (medium)</td>
<td>Second tertile: fast food restaurants comprise up to 14% of all restaurants within a quarter mile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 (high)</td>
<td>First tertile: there are no fast food restaurants within a quarter mile</td>
</tr>
</tbody>
</table>
group demographic variables (race/ethnicity and median household income), food desert index components (average number of supermarkets, proportion of “most healthy” bodegas, proportion of restaurants identified as fast food), and the total “food desert index” score. We calculated Pearson’s product-moment correlations to assess the significance of the bivariate relationship between each of the block group demographic variables and the food environment indicators.

3. Results

The analysis of the relationship between demographic variables to food desert index components and to a total food desert index score is shown in Table 3. In comparing predominantly black/African-American block groups to block groups in which the proportion of black residents is relatively low, black block groups had a significantly lower proportion of bodegas characterized as “most healthy”, had fewer supermarkets, and had a lower food desert index score. Conversely, in comparing block groups with the highest proportion of Latinos to those with a low percentage of Latinos, predominantly Latino block groups had a significantly higher proportion of “most healthy” bodegas and a higher food desert index score. Block groups with a higher proportion of white residents, when compared to those with fewer whites, had a significantly higher proportion of “most healthy” bodegas, more supermarkets, and higher food desert index scores. Finally, block groups with the highest median household income had a significantly higher proportion of “most healthy” bodegas, more supermarkets, and higher food desert index scores compared with the lowest income block groups. While areas with a higher percentage of blacks/African Americans and Latino residents had a slightly higher percentage of fast food restaurants than areas with the lowest percentage of blacks/African Americans and the lowest percentage of Latino residents, areas with a higher percentage of white residents and residents with higher incomes had a slightly lower percentage of fast food restaurants than areas with the lowest percentage of white residents. However, this association was not significant in bivariate comparisons.

4. Discussion

This paper contributes two novel ways to measure food availability: the “representative healthy food” score and the “food desert index.” In New York City’s “food deserts,” opportunities to purchase healthy foods are limited. These deserts are characterized by few supermarkets, many bodegas – few of which are deemed “healthy” – and an abundance of fast food restaurants. Within East and Central Harlem and North and Central Brooklyn, the locations of these food deserts correspond to areas with the highest proportions of Black residents and the lowest median household income. In contrast, neighborhoods with the highest proportion of Latino residents have greater access to healthy foods, as reflected in their higher food desert index scores (consistent with Galvez et al., 2007); however, this is mostly driven by a greater proportion of “healthy” bodegas. Although the effects of acculturation on diet are mixed, it appears that less acculturated individuals, recent immigrants who comprise these study neighborhoods, consume less fast food, snacks, sugar and sugar-sweetened beverages and added fats and they consume more rice, beans and fruit (see review by Ayala et al., 2008) and generally, Latino residents living in neighborhoods with higher proportions of immigrants report better access to healthy food (Ospyuk et al., 2009). Even higher food desert index scores were calculated for block groups on the Upper East Side, a predominantly white, middle and upper-income area where residents have more healthy food options and fewer opportunities to purchase high-caloric, high-fat foods from fast food restaurants.

That access to healthy food varies by neighborhood and within neighborhoods echoes the work of other researchers (Moore and Diez Roux, 2006; Morland et al., 2002a; Block et al., 2004; Hendrickson et al., 2006; Pearson et al., 2005). Our insignificant findings related to disparities in access to fast food restaurants are also consistent with other literature (Block et al., 2004; Kwate et al., 2009; Morland et al., 2002b; Wang et al., 2007; Zenk and Powell, 2008).

Several study limitations should be noted. First, although the Brooklyn research team trained the Harlem team in the assessment protocol, the data collection was conducted by two different teams (in Harlem and in Brooklyn) during different time periods, leaving open the possibility of some divergence from standardization. Second, although researchers have used a quarter mile buffer as a reasonable indicator of food access, this buffer is a somewhat arbitrary parameter. Some will travel farther for food, and for others, a quarter mile is a hardship. The use of block groups as our proxy for residence, rather than blocks, means that for larger block groups with more dispersed population we are potentially misclassifying accessibility for some residents. Also, these comparisons are primarily within poor neighborhoods because our higher income, mostly white comparison neighborhood was proportionately much smaller in size and population than both East and Central Harlem and North and Central Brooklyn. If a larger comparison area had been available, we might have had additional power to detect disparities in access to healthy and unhealthy foods between lower-income, mostly black/African-American neighborhoods and wealthier neighborhoods with greater proportions of white residents. In addition, race and income characteristics were not analyzed simultaneously, but the authors believe the analysis provides an important glimpse into the environments of different neighborhoods nonetheless. Finally, given that we had created and were piloting these surveys, reliability and validity properties of the scales were not assessed.

Increasingly, researchers are exploring the environmental forces contributing to an “obesogenic” environment, especially in poor and minority neighborhoods with disproportionate numbers of residents suffering from obesity, diabetes, and the impact...
of those chronic conditions. These neighborhoods, like the food deserts identified in our research, are distinguished by readily available, relatively cheap, high-fat, calorie-rich food (Yancey, 2004). Our study, along with others with similar results, indicate the need for systemic change to confront the obesity epidemic and its related consequences, calling for government and business, as well as individuals and families, to take responsibility for reversing this trend (Lang and Rayner, 2007). Researchers and policymakers have begun to call for a more comprehensive and socio-ecological approach to understanding food access and food systems (Kaufman and Karpati, 2007): they urge consideration of socioeconomic class divisions and gender roles to transportation systems and car ownership (Coveney and O’Dwyer, 2009; Inagami et al., 2009), as well as urban planning and agricultural policy (Furey et al., 2001; Caraher et al., 1998; Whitehead, 1998). For urban municipalities considering policy and environmental strategies to improve the food environment, future research is needed to address the impact of these strategies on the health of residents of low-income communities.

References