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The impact of neighborhood park access and quality on body mass index among adults in New York City☆

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ABSTRACT

Objective: To evaluate the association between adult individuals' body mass index (BMI) and characteristics of parks (size and cleanliness) in an urban environment taking into account the physical and social environments of the neighborhood.

Methods: Cross-sectional, hierarchical linear models were used to determine whether park effects were associated with BMI using self-reported height and weight data obtained from the Community Health Survey in New York City (2002–2006).

Results: Both the proportion of the residential zip code that was large park space and the proportion that was small park space had significant inverse associations with BMI after controlling for individual socio-demographic and zip code built environment characteristics (−0.20 BMI units across the inter-quartile range (IQR) for large parks, 95% CI −0.32, −0.08; −0.21 BMI units across the IQR for small parks, 95% CI −0.31, −0.10, respectively). Poorer scores on the park cleanliness index were associated with higher BMI, 0.18 BMI units across the IQR of the park cleanliness index (95% CI 0.05, 0.30).

Conclusions: This study demonstrated that proportion of neighborhoods that was large or small park space and park cleanliness were associated with lower BMI among NYC adults after adjusting for other neighborhood features such as homicides and walkability, characteristics that could influence park usage.

Introduction

As the prevalence of obesity has continued to rise nationally and in New York City (NYC), public health officials have engaged in multi-faceted prevention efforts aimed at reducing adult and childhood body mass index (BMI). In addition to developing programs designed to improve access to healthy foods, officials in NYC have promoted design and zoning initiatives intended to improve the use of space to encourage physical activity (New York City Department of Health and Mental Hygiene, 2010; New York City Government, 2010; White House Task Force on Childhood Obesity Report to the President, 2010); (New York City Department of Design and Construction, 2010).

Existing research examining the association of built environment characteristics such as park access, size, and quality with obesity has produced mixed results. Some studies found an inverse association between park size, access, and density and weight outcomes (Jaime et al., 2011; Rundle et al., 2012; Saelens et al., 2012; Wolch et al., 2011) while other studies reported no association (Potestio et al., 2009; Potwarka et al., 2008; Burdette and Whitaker, 2004; Prince et al., 2012; Norman et al., 2006). The lack of consistency in these findings may be attributed to cross-study heterogeneity in park size and characteristics and possibly differences in the neighborhood context surrounding parks. Park size may be an indicator for active versus passive engagement in physical activity, which in turn may affect obesity; whereas the condition and esthetics of the park could impact visitation (Bedimo-Rung et al., 2005). As opposed to active engagement which places an emphasis on moderate to vigorous physical activity, passive usage leads to more sedentary behaviors such as contemplation, picnicking or sunbathing (Bedimo-Rung et al., 2005). Characteristics of the surrounding

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neighborhood are also likely important. For example, while distance to parks may be an important indicator of availability, whether an individual actually travels that distance and visits the park may depend on neighborhood safety measures, land use mix, and walkability (Bedimo-Rung et al., 2005; Weiss et al., 2011). Previous research has shown that safety can be a factor on how residents perceive a local park, and whether proximity translates into use of the park and corresponding health benefits such as reduced obesity (Mobley et al., 2006; Weiss et al., 2011; Cutts et al., 2009; Leslie et al.; Scott and El, 1996). Furthermore, multiple studies have demonstrated associations between neighborhood walkability and physical activity and reduced risk of obesity (Sallis and Glanz, 2009; Rundle et al., 2007; Rundle et al., 2009; Frank et al., 2004). Neighborhood context may be particularly relevant in a dense urban environment such as NYC where many residents access parks by walking or public transportation.

The purpose of this study was to evaluate the association between individuals' body mass index (BMI) and characteristics of parks (size and cleanliness) in an urban environment taking into account the physical and social environment of the neighborhood such as walkability, poverty, and homicides. We hypothesized that both characteristics of the park and the neighborhood surrounding the park affect BMI.

Methods

The Community Health Survey (CHS) is a random-digit dial telephone survey of non-institutionalized adults aged 18 years and older conducted annually by the NYC Department of Health and Mental Hygiene (DOHMH) to monitor a range of health topics. Five consecutive years of survey data (2002–2006) were linked using Zip codes to geo-spatial data describing characteristics of the built environment. Sampling design and the weighting mechanism have been described elsewhere (New York City Department of Health and Mental Hygiene, 2009).

BMI, the outcome of interest in this study, was calculated using self-reported weight in pounds divided by self-reported height in inches squared, multiplied by a factor of 703 (to convert pound/in.^{2} to kg/m^2). To reduce measurement error in BMI due to self-reported height and weights, a two-step procedure to eliminate biologically implausible BMI values was employed. First, subjects with height and weight values outside of established ranges (male height: 51.3–80.5 in., male weight: 85.6–480.9 pounds; female height: 51.8–73.5 in., female weight: 74.1–570.9 pounds) were eliminated. Second, subjects with BMI values outside of a valid range (male: 14.9–65.0; female: 13.4–76.1) were removed (de Onis and Habicht, 1996; Physical Status: The Use and Interpretation of Anthropometry, 1995). From 2002 to 2006 a total of 48,482 subjects completed the CHS survey. After removing implausible BMI values and missing height and weight data, there were 44,282 subjects available for analysis.

The New York City Department of Parks and Recreation (NYCDP&R) provided data on park boundaries and park cleanliness. To account for park access of residents living in Zip code neighboring parks, all Zip code boundaries were buffered by 400 m. The proportion of buffered Zip code area defined as park space was used as a measure of Zip code level park access. This variable was further delineated into the proportion of buffered Zip code that was large park space (>6 acres) and the proportion that was small park space (≤6 acres); a definition determined by the NYCDP&R for administrative purposes.

The Park Inspection Program (PIP), conducted twice annually by NYCDP&R, provided park cleanliness measures. Specific details of this program have been reported elsewhere (Rundle et al., 2012). Briefly, for each park, zones were created and evaluated on four cleanliness measures (the presence of litter, glass, weeds, and graffiti) on an annual basis and then averaged across the years 2000–2006. The four neighborhood-level cleanliness metrics have a range of 0 for no inspection failures in any park zone within the Zip code to 1 indicating failure on all park zone inspections within the Zip code. A total park cleanliness score assessed the overall condition of park cleanliness and was calculated by averaging the combined four individual measures.

Further Zip code-level measures of the built environment were derived to assess the association between neighborhood safety and walkability and BMI. To calculate the average number of homicides per 10,000 persons for each Zip code, the total number of homicides from 2003 to 2006 were averaged and divided by the Census 2000 population estimate (New York Times, 2006). A neighborhood walkability index was calculated for each Zip code, incorporating several built environment measures including residential unit density, street intersection density, land use mix, retail floor space, and density of subway stations. The details of the construction of this variable have been described elsewhere (Neckerman et al., 2009).

Descriptive statistics were used to describe the demographic characteristics of the study population with stratification by the proportion of Zip-code land area that was large parks and the proportion that was small parks. The Chi-square test was used to evaluate categorical variables by park space above and below the median for each pair, large and small. The *T*-test was used to compare mean BMI for large and small park spaces above and below the median. Associations between Zip code-level park space, park quality, walkability and homicides were determined using Pearson correlation coefficients. A linear mixed effects model which included a random effect for Zip code to account for clustering of BMI within each Zip code was used to predict individual BMI, adjusting for individual-level variables including: sex, age, race/ethnicity, education, household income relative to the United States federal poverty line, nativity, marital status, self-reported health, employment, and the number of children under the age of 18 in the household. All individual-level data was obtained by interview from the CHS. The proportion of residents below the federal poverty line was also included as a neighborhood variable and identified from the United States Census 2000. Each neighborhood-level variable was re-scaled by subtracting the median and dividing by the interquartile range (IQR). This approach improved comparability across the measures so the beta coefficients reflect associations with a difference in the interquartile range of that variable. The model accounted for Zip code-level sampling weights. Analyses were performed using HLM version 6.08 (Scientific Software International, Skokie, IL) and Stata version 12 (Stata Corporation, College Station, TX).

Results

Demographic characteristics of the study population are presented in Table 1. Large park space as a percentage of Zip code land area ranged from 0% to 79% (median = 6.4%). Small park space as a percentage of Zip code land area ranged from 0% to 8% (median = 1.25%). After stratifying Zip codes by the median percentage of parks within a Zip code, there were no significant differences existed among demographic characteristics ($P > 0.05$) (Table 1). The spatial distribution of the percentage of large and small parks can be observed in Fig. 1.

Table 2 illustrates the correlations among Zip-code level built environment characteristics. There was no correlation between the percentage of the Zip area that was small park area and the percentage that was large park. Walkability had a significant inverse correlation with large parks ($\rho = -0.40$) and a positive correlation with small parks ($\rho = 0.28$). Homicides per 10,000 persons had a significant positive correlation with both the percentage of area that was small parks ($\rho = 0.29$) and with park cleanliness score ($\rho = 0.30$), indicating that poor cleanliness scores had a positive association with homicide.

The multi-level modeling results revealed that both the proportion of the residential zip code that was large park space and the proportion that was small park space had significant inverse associations with BMI after controlling for individual socio-demographic and zip code built environment characteristics (−0.20 BMI units across the inter-quartile range (IQR) for large parks (95% CI −0.32, −0.08); −0.21 BMI units across the IQR for small parks (95% CI −0.31, −0.10), respectively; Table 3). Poorer scores on the park cleanliness index were associated with higher BMI ($\beta = 0.18$, 95% CI 0.05, 0.30). Homicides per 10,000 persons had a significant positive association with BMI ($\beta = 0.33$, 95% CI 0.17, 0.49) and increasing walkability had a significant inverse association ($\beta = -0.40$, 95% CI −0.50, −0.30). When considering the count of large and small parks in each zip code instead of the proportion of land covered by large and small park space in each zip code, the direction, magnitude, and significance of the associations with BMI did not change (data not shown).

Discussion

This study demonstrated that greater neighborhood park access and greater park cleanliness were associated with lower BMI among NYC