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A closer examination of the relationship between children's weight status and the food and physical activity environment

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ABSTRACT

Objectives. Conflicting findings on associations between food and physical activity (PA) environments and children's weight status demand attention in order to inform effective interventions. We assess relationships between the food and PA environments in inner-city neighborhoods and children's weight status and address sources of conflicting results of prior research.

Methods. Weight status of children ages 3–18 was assessed using parent-measured heights and weights. Data were collected from 702 children living in four low-income cities in New Jersey between 2009 and 2010. Proximity of a child's residence to a variety of food and PA outlets was measured in multiple ways using geo-coded data. Multivariate analyses assessed the association between measures of proximity and weight status.

Results. Significant associations were observed between children's weight status and proximity to convenience stores in the 1/4 mile radius (OR = 1.9) and with presence of a large park in the 1/2 mile radius (OR = 0.41). No associations were observed for other types of food and PA outlets.

Conclusions. Specific aspects of the food and PA environments are predictors of overweight and obese status among children, but the relationships and their detection are dependent upon aspects of the geospatial landscape of each community.

Introduction

Large numbers of children and adolescents in the U.S., especially those from limited income households and from racial/ethnic minority groups, are overweight or obese. In 2009–2010, 31.8% of U.S. children and adolescents were overweight or obese, with rates above 39% among Hispanic and black populations (Ogden, 2012). Significant disparities have been documented in access to environments that support healthy behaviors, both related to food (Kipke et al., 2007; Larson et al., 2009; Morland and Filomena, 2007; Powell et al., 2007a, 2007b; Sturm, 2008; Zenk et al., 2006) and physical activity (PA) (Abercrombie et al., 2008; Crawford et al., 2008; Gordon-Larsen, 2006; van Lenthe et al., 2005), among populations that carry a disproportionate burden of obesity. Such findings have led to the implication of unhealthy environments in the etiology of the obesity epidemic (Kettel Khan et al., 2009; Larson et al., 2009; Morland and Evenson, 2009; Morland et al., 2006) and have resulted in a number of policy recommendations that aim to improve access to healthy foods and opportunities for PA (Institute of Medicine, 2012; Kettel Khan et al., 2009; Sturm and Cohen, 2009; White House Task Force on Childhood Obesity, 2010). Yet, research on the association between various aspects of the food and PA environments and children's weight status has produced inconsistent and often contradictory findings.

Different types of food outlets have been investigated for their associations with children's weight status. Increased availability of supermarkets in a student's school zip-code was associated with lower body mass index (BMI) and overweight among adolescents (Powell et al., 2007a, 2007b). Proximity of fast-food restaurants near middle and high schools was associated with a greater likelihood of the students being overweight (Davis and Carpenter, 2009), and proximity of fast-food restaurants to children's homes was associated with higher weight status (Mellor et al., 2011). Having a convenience store in the census block group of a child's residence, (Galvez et al., 2008) within close proximity to their homes (Laska et al., 2010; Leung et al., 2011), and near schools (Howard et al., 2011) was associated with unhealthy weight outcomes. Contradicting these findings are studies that showed lack of association between children's weight status and any type of food environment (An and Sturm, 2012; Lee, 2012) or lack of association with specific types of food outlets around children's schools and homes (Howard et al., 2011; Laska et al., 2010; Leung et al., 2011).

Studies of the associations between obesity and proximity to different elements of the PA environment have also yielded mixed

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results. Gordon-Larsen (2006) noted a positive association between number of PA facilities in a census block group and a reduced risk of an adolescent being overweight or obese. Similarly, Wolch et al. (2011) found that presence of a park near a child's home was negatively associated with the likelihood of their being overweight or obese. In contrast, others have found no associations between weight status and proximity to parks and PA facilities among children and adolescents (Burdette and Whitaker, 2004; Kligerman et al., 2007).

These conflicting findings may be attributed in part to different strategies for measuring proximity to environmental factors, a focus on varied age-groups of children, consideration of limited aspects of either the food or PA environment, and variation in the geographic characteristics of studied environments. Despite acknowledgment of the importance of simultaneous consideration of aspects of the food and PA environment (Black and Macinko, 2008; Papas et al., 2007; Sallis and Glanz, 2009), few such studies have been conducted. A lack of consideration of a more inclusive spectrum of potentially important elements of the environment precludes detection of independent effects and constrains our understanding of the implications for mounting effective interventions. Using data from four New Jersey cities on predominantly low-income, minority populations, the current study seeks to address these limitations by investigating the role of elements of the food and PA environments, considering a variety of potentially important measures of proximity, and assessing the association with the weight status of children in a broad spectrum of age groups.

Methods

Data sources

Survey data were collected in 2009–10 from a random-digit-dial sample of 1408 households having at least one child aged 3–18 years old in four New Jersey cities (Camden, New Brunswick, Newark, and Trenton). Survey items used in this analysis included household demographic characteristics and the geo-coded location of the respondent's home address. At the conclusion of the survey, respondents (parent in 94% cases, and referred to as such) were asked to weigh and measure themselves and all their children following instructions provided to them via mail along with a tape measure and reporting worksheet. Objective geo-coded data on location of food and PA outlets in the study cities as well as in a 1 mile buffer around the city boundary were collected using commercial and publicly available sources. Using methodology developed by Ohri-Vachaspati et al. (2011), food outlets in commercial data sources were categorized as supermarkets, small grocery stores and specialty stores, convenience stores, and limited service restaurants (referred to as fast-food restaurants). Data on private and public PA facilities and parks (larger than one acre) were assembled based on methodology proposed by Abercrombie et al. (2008) using data from county and city departments, web-based searches, Yellow Pages, and from commercial data sources. All food and PA outlets were geocoded for purposes of creating proximity measures. The distance from each respondent's home to the nearest facility was estimated using the distance tools in ArcGIS. Additional details about the survey and its administration, including collection of data on parent-measured heights and weights and sources for geospatial data, are included in Appendix.

Measures

Outcome variable

The outcome variable was weight status of children based on parent-measured heights and weights. Parent-measured heights and weights are highly correlated with professionally measured values (Carnell and Wardle, 2007) and considered more accurate than parent-reported estimates (Huybrechts et al., 2011). Potential self-selection bias associated with the sub-group from the sample providing measured heights and weights was assessed using procedures described in Appendix.

Children were classified as overweight or obese based on the age- and sex-specific percentile of the child's BMI calculated with parent-measured height and weight and the 2000 CDC Growth Charts (CDC-a). Children with BMI at or above the 85th percentile were considered overweight or obese. Children with any measured or calculated value identified as biologically implausible (CDC-b) were excluded from the analysis.

Exposure variables

Access to elements of the environment was measured by proximity of food and PA outlets to each individual child's residence. Proximity was measured in multiple ways, acknowledging that the same metric for capturing proximity may have different implications for access under varying geospatial conditions. First, distance to the nearest food and PA outlet from each child's home was measured in roadway network miles. Second, presence or absence of food and PA outlets was determined within each of three radii of the child's residence—1/4, 1/2, and 1 mile, with each child coded as 1 if a particular type of outlet was present within the specified radius and 0 if not. This measure captures the possibility that a threshold-distance is critical to access. Use of varied radii was intended to overcome problems associated with creation of arbitrary fixed boundaries around households which may have different meaning in varied geospatial contexts. Third, counts of food and PA outlets within the three radii captured the potential importance of density of particular facilities, acknowledging the prospect that density may affect price and choice of products.

Covariates

Covariates included child's age, gender, and race/ethnicity; mother's educational level; primary language spoken at home; nativity; household poverty status; and parent's self-measured BMI. Indicators of neighborhood socioeconomic conditions, calculated at the census block group level from pooled 2005 to 2009 American Community Survey data (Census Bureau) were also included. Each child was assigned the block group median income and the percentages within the block group that were non-Hispanic black, Hispanic, and Other.

Analysis

From the completed 1408 interviews, we confined our analysis to the subset of 702 children in 491 households whose parents provided measured heights and weights and who had complete data on the analytic variables. Sampling weights were developed specifically for children with parent-measured heights and weights so that survey estimates represent the population of 3–18 year olds in the four cities combined.

Our statistical analysis proceeded in two stages. In stage 1, we estimated a series of logistic regression models to assess the bivariate association between geospatial food and PA variables and child's weight status. In stage 2, we estimated multivariate regression models that included only those geospatial variables that were significant at $p < .10$ in the Stage 1 analysis. The multivariate models in Stage 2 also included covariates established by previous research as important predictors of child weight status. We estimated logit models to provide easily interpreted odds ratios and probit models, which have well established extensions that can account for the potential self-selection bias described above. Self-selection bias not accounted for by re-weighting of our sample was addressed in two ways. First, we compared parent-measured children to the other group of children according to observable individual and household-level variables. Second, we estimated probit models with a Heckman correction for self-selection (Heckman, 1976, 1979). In both analyses, we found that the main findings of our analysis were robust to potential self-selection (details in Appendix). All analyses were conducted using complex survey procedures in Stata Version 10 SE taking into account clustering at the household level.

Results

Thirty-eight percent of the children in our four study cities were overweight or obese (Table 1). The vast majority were Non-Hispanic black (47.8%) or Hispanic (40.1%) and 80.5% came from households with incomes at or below 200% of the federal poverty line. More than half had mothers with a high school education or less, and 72% had parents who were overweight or obese. Neighborhoods where children lived were mostly low income, and residents were largely Non-Hispanic black (49.5%) and Hispanic (35.4%).

Almost all children lived within one mile of a small grocery store and a large park and within 1/2 mile of a convenience store or fast-food restaurant; other exposure variables exhibited greater variation (Table 2). In the bivariate analyses (Table 2), presence of a convenience store within 1/2 mile, within 1/4 mile, numbers within