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Green and lean: Is neighborhood park and playground availability associated with youth obesity? Variations by gender, socioeconomic status, and race/ethnicity

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ABSTRACT

Parks and park features are important for promoting physical activity and healthy weight, especially for low-income and racial/ethnic minority youth who have disproportionately high obesity rates. This study 1) examined associations between neighborhood park and playground availability and youth obesity, and 2) assessed whether these associations were moderated by youth race/ethnicity and socioeconomic status (SES). In 2013, objectively measured height and weight were collected for all 3rd–5th grade youth (n = 13.469) in a southeastern US county to determine body mass index (BMI) percentiles. Enumeration and audits of the county's parks (n = 103) were concurrently conducted. Neighborhood park and playground availability were calculated as the number of each facility within or intersecting each youth's Census block group. Multilevel linear regression models were utilized to examine study objectives. For boys, no main effects were detected; however, SES moderated associations such that higher park availability was associated with lower BMI percentile for low-SES youth but higher BMI percentile for high-SES youth. For girls, the number of parks and playgrounds were significantly associated with lower BMI ($b = -2.2$, $b = -1.1$, $p < 0.05$, respectively) and race/ethnicity and SES moderated associations between playground availability and BMI percentile. Higher playground availability was associated with lower BMI percentile for White and high-SES girls but higher BMI percentile for African American and low-SES girls. Considerable variation was detected in associations between park and playground availability and youth obesity by SES and race/ethnicity, highlighting the importance of studying the intersection of these characteristics when exploring associations between built environment features and obesity.

1. Introduction

In the United States, youth obesity has been recognized as a major public health problem of the 21st century due to its severe physical, social, and emotional health consequences during childhood and into adolescence and adulthood (Ogden et al., 2014; Dietz, 1998; Reilly et al., 2003). Youth from racial/ethnic minority and/or low socioeconomic backgrounds, as well as those who reside in the southeastern US, have disproportionately high rates of obesity (Ogden et al., 2014). National-level prevention initiatives, like Healthy People 2020, have focused on reducing overall youth obesity levels with a particular emphasis on eliminating racial/ethnic and socioeconomic disparities (United States Department of Health and Human Services, 2000, 2012). To reach those goals, researchers and practitioners have recognized and begun to address the complex and multifactorial nature of obesity by applying social ecological frameworks that attribute chronic health problems to a variety of individual, interpersonal, community, and policy-level factors (Sallis et al., 2006; Swinburn et al., 1999; Casey et al., 2014).

With the shift to a multifaceted approach to addressing obesity, researchers have increasingly focused on community-level influences on public health (Sallis et al., 2006). Within ecological frameworks, built, or man-made, environmental features have been recognized as critical components of community health by either facilitating or hindering

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health-promoting behaviors such as physical activity (PA) and healthy eating (Jackson et al., 2013; Berrigan and McKinno, 2008; Papas et al., 2007). In particular for youth, parks have been highlighted as a critical element of the built environment that can promote active living (Cohen et al., 2007; Kaczynski and Henderson, 2007; Potwarka et al., 2008; Bedimo-Rung et al., 2005). Parks are often widespread across communities and possess diverse facilities and amenities that provide low to no-cost outlets for youth to be physically active. Indeed, considerable research has shown that access to greater number of parks is related to higher levels of PA in youth (Roemmich et al., 2006; Epstein et al., 2006; Ries et al., 2009; Timperio et al., 2008), though some studies have shown that the strength and direction of these associations vary by gender (Moore et al., 2014) and race/ethnicity (Babey et al., 2008). Despite established patterns between park availability and higher levels of PA among youth, the relationship between park availability and youth weight status has been less consistent with some authors reporting no associations (Potwarka et al., 2008; Burdette and Whitaker, 2004; Kligerman et al., 2007; Oreskovic et al., 2009). Conversely, other research, including multiple nationally-representative studies, has found that greater park availability is related to lower weight status in youth (Alexander et al., 2013; Gordon-Larsen et al., 2006; Gilliland et al., 2012; Hsieh et al., 2015; Veugelers et al., 2008). Likewise, three longitudinal studies revealed slower weight gain for youth that had improved access to green spaces like parks (Bell et al., 2008; Sanders et al., 2015; Wolch et al., 2011).

Despite these encouraging results, several gaps in the literature still merit attention. First, few studies have considered specific park features, like playgrounds, in relation to youth obesity (Potwarka et al., 2008), although research utilizing direct observation and participant surveys has shown that particular park attributes are important for park visitation and park-based PA for various age groups (Floyd et al., 2011; Reed and Hooker, 2012; Besenyi et al., 2013; Babey et al., 2008). For younger children, playgrounds are a common park facility that attracts visitors and offers active play opportunities (Floyd et al., 2011; Besenyi et al., 2013; Veitch et al., 2006; Black et al., 2015; Colabianchi et al., 2011). Indeed, research has demonstrated that playgrounds are often one of the most used park features (Floyd et al., 2011) and areas where children are observed in moderate-to-vigorous PA compared to other park activity areas (Besenyi et al., 2013). However, little research has examined associations between playgrounds and youth obesity, which may be imperative evidence in advocating for parks and playgrounds as priority neighborhood features that can promote and sustain children's health.

Second, researchers have posited that inequities in the availability of neighborhood built environment resources, like parks and playgrounds, may contribute to observed disparities in obesity prevalence among low-income and minority youth (Gordon-Larsen et al., 2006; Schulz and Northridge, 2004). However, few studies have tested these hypotheses and examined how relationships between park/playground availability and youth obesity vary by race/ethnicity or socioeconomic status (SES). Among research that has explored this nuanced connection, findings have been mixed (Alexander et al., 2013; Casey et al., 2014; Duncan et al., 2012). For example, Alexander et al., 2013 found that in a national sample of youth, African American children that had parks available had a significantly lower risk of obesity compared to African American children that had no parks, but there was no association for non-Hispanic White children, regardless of the number of parks (Alexander et al., 2013). Another study in France showed that there was a significant increase in risk of overweight/obesity with lesser access to urban PA facilities, but only for lower socioeconomic youth (Casey et al., 2012). Finally, several studies have documented the importance of examining gender differences when considering how park availability impacts PA and obesity (Moore et al., 2014; Wolch et al., 2011; Besenyi et al., 2013; Babey et al., 2015; Wilhelm Stanis et al., 2014). Multiple longitudinal assessments have shown stronger health effects for proximal availability to green spaces and parks for boys compared to girls, (Sanders et al., 2015; Wolch et al., 2011) which is concerning given the sharp decline in PA patterns and increase in overweight/obesity as girls age (Troiano et al., 2008).

Variations in the association between weight status and availability of parks by race/ethnicity, socioeconomic status, or gender are important to ascertain to better understand how the health of particular demographic and socioeconomic groups may vary based on community built environment features. Therefore, the purposes of this study were 1) to examine associations between neighborhood park and playground availability and youth obesity, and 2) to assess whether these associations were moderated by youth race/ethnicity and SES.

2. Methods

2.1. Study setting

This study occurred in a large county in the southeastern United States, with a 2013 total population of 474,266, of which 77.1% was Non-Hispanic White, 18.5% was African American, and 8.5% was Hispanic or Latino (United States Census Bureau, 2012). In 2013, the median household income of the county was $48,886 and approximately 15.0% of residents lived below the federal poverty line (United States Census Bureau, 2012).

2.2. Measures and data collection

2.2.1. Youth obesity and demographic characteristics

Trained physical education teachers from 51 elementary schools collected and recorded the height and weight for all children in 3rd–5th grade ($n = 14.232$) enrolled in the county school district as a part of regular district protocol. These data were collected in 2013, concurrent with the timing of the park environmental audits (described below). Height, weight, date of birth, and date of testing were used to calculate body mass index (BMI) percentiles using standardized protocols for youth from the Centers for Disease Control and Prevention (Center for Disease Control, 2014). BMI percentile was the dependent variable in the present analyses.

Demographic information and residential address, reported by the parent/guardian and compiled at the school district level, were also obtained for each youth in the sample. Three demographic predictors were categorized for all youth: gender, SES measured by school lunch status, and race/ethnicity. Gender and SES were dichotomized as male or female and free/reduced or full pay, respectively. Race/ethnicity was classified as African American, Hispanic, White, or Other. Using a geographic information system (GIS; ArcGIS 10.2.2), 94.6% of the youth's home addresses were successfully geocoded at the point address level, which was used as the final sample ($n = 13.469$).

2.2.2. Neighborhood characteristics

Demographic and socioeconomic characteristics were gathered from the US Census Bureau's 2008–2012 American Community Survey for all census block groups ($n = 255$) in the study area. Block groups are the next to smallest geographical unit recognized by the Census Bureau (United States Census Bureau, 2010). They are small, generally permanent subdivisions within a county that usually contain from 600 to 3000 people and are fairly homogenous in terms of population characteristics, economic status, and living conditions (United States Census Bureau, 2010). The variables collected and used for this study for all block groups included median household income, total percentage of racial and ethnic minority residents (i.e., all persons other than those identifying as non-Hispanic White), total population, and block group area.

2.2.3. Park and playground availability

Parks were enumerated using GIS shapefiles and park lists provided by the main municipalities within the study area. Parks not deemed useable and publicly accessible after an in-person audit were excluded from the shapefiles (n = 9). Using GIS, we determined the number of parks within and intersecting each participant's block group, similar to other studies examining how neighborhood environments are related to youth obesity (Frank et al., 2012; Saelens et al., 2012).

To examine playground availability, audits of all open and accessible parks in the study county (n = 103) were conducted in 2013 using the Community Park Audit Tool, which previously demonstrated strong inter-rater reliability (almost all items with percent agreement >70%; Kaczynski et al., 2012). For this study, we determined the number of total park playgrounds within or intersecting each census block group using GIS and included playground availability as the second main independent variable (Frank et al., 2012; Saelens et al., 2012).

2.3. Statistical analyses

Two-level linear models were used to answer the study research questions with separate models for each gender. Hierarchal, or multilevel, linear models accounted for the potential nested effects of children within neighborhoods (Diez-Roux, 2000). In null models, the block groups accounted for 4.2% and 3.8% of the variation in BMI percentile in boys and girls, respectively, suggesting some variance in the dependent variable across level-2 units and justifying the use of multilevel modeling analyses (Bell et al., 2014). For this study, the level-1 predictor variables included all youth demographic characteristics (i.e., SES, age, race/ethnicity), while the level-2 predictor variables were block group characteristics (i.e., park and playground availability, size, population, percent of residents that are racial/ethnicity minority, and median household income). To aid in the interpretation of the estimates provided by the statistical models, three census-derived block group variables were re-scaled to represent differences in BMI percentiles per larger differences in these three predictor variables. Block group population units were scaled to per 1000 persons, median household income was scaled to per $10,000, and percent minority was scaled to per 10%.

Initially, descriptive statistics were calculated for the outcome variable and all level-1 and level-2 covariates, including the distribution of youth across block groups (Table 1). Using PROC MIXED in SAS v9.4 with maximum likelihood estimation and Satterthwaite degrees of freedom, we estimated a series of six statistical models, five of which are presented in Tables 2 and 3. First, an unconditional model with no predictors was estimated to assess between-neighborhood variation, or intra-class correlation, in BMI percentile (not shown; Bell et al., 2014). Then, all three individual-level youth characteristics (i.e., level-1) and all census-derived block group characteristics (i.e., level-2) were added as fixed effects (Model 1). Model 1 accounts for all the compositional differences across block groups in order to examine the unique contribution of our main independent variables, number of parks and playgrounds. Model 2 represents the main effect model for number of parks followed by two corresponding interaction models (i.e., number of parks*SES and number of parks*race/ethnicity variables; Models 3a and 3b). Then, we estimated the main effect model for number of playgrounds (Model 4) followed by the two corresponding interaction models (i.e., number of playgrounds*SES and number of playgrounds*race/ethnicity; Models 5a and 5b).

In addition to examining significance of statistical tests, we examined model fit throughout the model-building process by examining the changes in -2 log-likelihood and applying the chi-square likelihood ratio test to examine statistical significance for model fit (Bell et al., 2014). We compared Model 2 and Model 4 to Model 1 to assess model fit for the main effects of park and playground availability. Then, we compared Models 3a and 3b to Model 2 and Models 5a and 5b to Model 4 to assess model fit for the interaction models. Interpretations of results were based on significant statistical tests ($p < 0.05$) and model fit statistics. Finally, we tested for the presence and influence of influential outliers for the final models. Four level-2 units had high values on multiple indicators of influence (i.e., Cook's D, PRESS statistics, and studentized residuals). Removing these observations and re-running the analysis did not impact the study conclusions, so all data were included in the final models (Bell et al., 2010).

Table 1
Sample characteristics.

	Mean or %	SD	Range
Youth characteristics (n = 13.469)			
Body mass index percentile	64.0	29.78	(0.0, 99.8)
Age (years)	9.7	0.99	(7, 13)
Gender			
Male	50.8%		
Female	49.2%		
Student lunch status			
Full priced	54.7%		
Free or reduced price	45.3%		
Race/ethnicity			
White	62.3%		
African American	18.9%		
Hispanic	11.5%		
Other	7.4%		
Neighborhood characteristics (n = 255)			
Number of youth per block group	52.8	41.26	(2.0, 249.0)
Percent racial/ethnic minority	31.5%	23.32	(0.0, 98.6)
Median household income ($)	48,866.0	23,835.7	(9705, 147,679)
Block group population	1776.2	864.77	(297, 4566)
Block group area (sq. miles)	3.1	6.89	(0.18, 68.48)
Number of parks	0.47	0.82	(0.0, 5.0)
Number of playgrounds	0.49	1.09	(0.0, 7.0)

3. Results

3.1. Sample characteristics

All youth and block group sample characteristics are presented in Table 1. Youth in the study included 6846 males and 6623 females who were distributed across 255 block groups (density: 2–249, average: 53). Approximately 62% of youth were white, 45% received free/reduced lunch, and the average BMI was in the 64th percentile (SD = 29.8). In addition, there were about 0.5 parks and 0.5 playgrounds per block group, with slightly more variance for playgrounds (Table 1). Across all models, youth race/ethnicity and socioeconomic status were significantly related to youth BMI for boys and girls such that African American, Hispanic, and low SES youth had higher BMI percentiles (Tables 2 and 3). In addition, median household income for the block group was inversely related to youth BMI percentile throughout all models (Tables 2 and 3).

3.2. Park availability

The best fitting model and subsequent interpretations for males and females and park availability is Model 3b in Tables 2 and 3. The number of parks in the youth's block group was significantly associated with lower BMI percentile for females ($b = -2.2$, $p < 0.05$; Table 3), but not males ($b = 1.5$, $p = 0.08$; Table 2). Youth SES moderated the association between park availability and BMI for both males ($b = -1.96$, $p < 0.05$) and females ($b = 2.3$, $p < 0.05$), though in different directions. For males, higher neighborhood park availability was associated with lower BMI percentile for low SES males but higher BMI percentile for high SES males (Fig. 1). For females, higher neighborhood park availability was associated with lower BMI percentile for high SES females but not low SES females (Fig. 2).

3.3. Playground availability

Overall, there were no significant associations or interactions for playground availability and youth obesity among males (Table 2). For females, both Models 5a and 5b had significantly better fit than Model

Table 2
Estimates from two-level linear modeling predicting male youth weight status in 2013, n = 6846.

		Park availability			Playground availability		
	Model 1 *b* (SE)	Model 2 *b* (SE)	Model 3a *b* (SE)	Model 3b *b* (SE)	Model 4 *b* (SE)	Model 5a *b* (SE)	Model 5b *b* (SE)
Fixed effects							
Intercept	59.4 (0.8)*	59.3 (0.8)*	59.4 (0.9)*	58.9 (0.8)*	59.5 (0.8)*	59.5 (0.8)*	59.2 (0.9)*
Individual characteristics							
Youth SES (referent = high SES)	6.0 (0.9)*	6.1 (0.9)*	6.1 (0.9)*	7.0 (1.0)*	6.0 (0.9)*	6.0 (0.9)*	6.5 (0.9)*
Age	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)
Race (referent = White)							
African-American	6.9 (1.1)*	6.9 (1.1)*	6.9 (1.1)*	7.0 (1.1)*	7.0 (1.1)*	7.2 (1.2)*	7.0 (1.1)*
Hispanic	11.2 (1.2)*	11.2 (1.2)*	11.8 (1.2)*	11.2 (1.2)*	11.2 (1.2)*	10.8 (1.3)*	11.1 (1.2)*
Other	5.9 (1.4)*	5.9 (1.4)*	4.8 (1.6)*	5.9 (1.4)*	5.9 (1.4)*	4.7 (1.5)*	5.9 (1.4)*
Block group characteristics							
Size of block group	0.2 (0.1)	0.2 (0.1)	0.2 (0.1)	0.2 (0.1)	0.2 (0.1)	0.2 (0.1)	0.2 (0.1)
Population	0.3 (0.5)	0.3 (0.5)	0.3 (0.5)	0.3 (0.5)	0.3 (0.5)	0.3 (0.5)	0.3 (0.5)
Percent minority	−0.4 (0.3)	−0.5 (0.3)	−0.5 (0.3)	−0.4 (0.03)	−0.4 (0.3)	−0.4 (0.3)	−0.4 (0.3)
Median household income	−1.0 (0.2)*	−1.0 (0.2)*	−1.0 (0.2)*	−1.0 (0.2)*	−1.0 (0.2)*	−1.0 (0.2)*	−1.0 (0.2)*
Number of parks		0.3 (0.6)	0.3 (0.7)	1.5 (0.8)	–	–	–
Number of playgrounds			–	–	−0.4 (0.4)	−0.6 (0.7)	0.1 (0.6)
Cross-level interactions							
Parks*African-American			−0.03 (1.1)				
Parks*Hispanic			−1.7 (1.6)				
Parks*Other Race			3.2 (2.0)				
Parks*youth SES				−2.0 (1.0)*			
Playgrounds*African-American						−0.2 (0.9)	
Playgrounds*Hispanic						0.7 (1.3)	
Playgrounds*Other Race						3.3 (1.7)	
Playgrounds*youth SES							−0.9 (0.8)
Model fit Δ-2LL†	–	−0.2	−4.2	−4.4*	−0.9	−5.6	−2.2

† = Change in -2LL compares Model 2 to Model 1; Models 3a and 3b to Model 2; Model 4 to Model 1; Models 5a and 5b to Model 4.
* $p < 0.05$, ICC = 0.042.

Table 3
Estimates from two-level linear modeling predicting female youth weight status in 2013, n = 6623.

		Park availability			Playground availability		
	Model 1 *b* (SE)	Model 2 *b* (SE)	Model 3a *b* (SE)	Model 3b *b* (SE)	Model 4 *b* (SE)	Model 5a *b* (SE)	Model 5b *b* (SE)
Fixed effects							
Intercept	60.8 (0.8)*	61.0 (0.8)*	61.0 (0.8)*	61.5 (0.8)*	60.9 (0.8)*	61.2 (0.8)*	61.4 (0.83)*
Individual characteristics							
Youth SES (referent = high SES)	4.9 (0.9)*	4.9 (0.9)*	4.9 (0.9)*	3.8 (1.0)*	4.9 (0.9)*	4.8 (0.9)*	4.0 (1.0)*
Age	0.8 (0.4)*	0.7 (0.4)*	0.7 (0.4)*	0.8 (0.4)*	0.8 (0.4)*	0.8 (0.4)*	0.8 (0.4)*
Race (referent = White)							
African-American	6.5 (1.1)*	6.5 (1.1)*	6.1 (1.1)*	6.4 (1.1)*	6.5 (1.1)*	5.5 (1.2)*	6.3 (1.1)*
Hispanic	8.3 (1.3)*	8.2 (1.3)*	8.3 (1.3)*	8.4 (1.3)*	8.3 (1.3)*	8.2 (1.4)*	8.3 (1.3)*
Other	0.6 (1.4)	0.6 (1.4)	1.3 (1.4)	0.6 (1.4)	0.6 (1.4)	1.6 (1.5)	0.5 (1.4)
Neighborhood characteristics							
Size of block group	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Population	0.02 (0.4)	0.002 (0.4)	0.02 (0.4)	0.02 (0.4)	0.003 (0.4)	0.1 (0.4)	0.04 (0.4)
Percent minority	−0.4 (0.2)	−0.3 (0.2)	−0.4 (0.2)	−0.4 (0.2)	−0.3 (0.2)	−0.4 (0.2)	−0.4 (0.2)
Median household income	−1.2 (0.2)*	−1.2 (0.2)*	−1.2 (0.2)*	−1.3 (0.2)*	−1.2 (0.2)*	−1.2 (0.2)*	−1.2 (0.2)*
Number of parks		−0.9 (0.5)	−1.0 (0.8)	−2.2 (0.9)*	–	–	–
Number of playgrounds			–	–	−0.6 (0.4)	−1.1 (0.5)*	−1.5 (0.5)*
Cross-level interactions							
Parks*African-American			0.7 (1.1)				
Parks*Hispanic			−0.2 (1.9)				
Parks*Other Race			−1.8 (2.0)				
Parks*youth SES				2.3 (1.0)*			
Playgrounds*African-American						1.9 (0.8)*	
Playgrounds*Hispanic						0.3 (1.5)	
Playgrounds*Other Race						−2.8 (1.8)	
Playgrounds*youth SES							1.8 (0.76)*
Model fit Δ-2LL†	–	−2.9	−4.3	−8.0*	−2.2	−11.0*	−8.0*

† = Change in -2LL compares Model 2 to Model 1; Models 3a and 3b to Model 2; Model 4 to Model 1; Models 5a and 5b to Model 4.
* $p < 0.05$, ICC = 0.038.

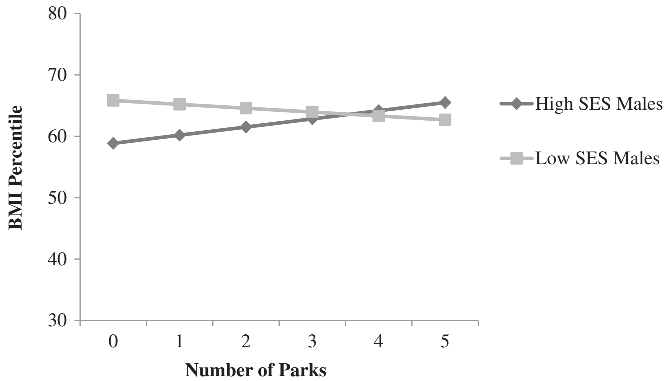

Fig. 1. BMI percentile for high and low SES boys based on block group park availability. Notes: Adjusted for youth age, gender, race/ethnicity, SES and neighborhood size, population, median household income, and percent racial/ethnic minority.

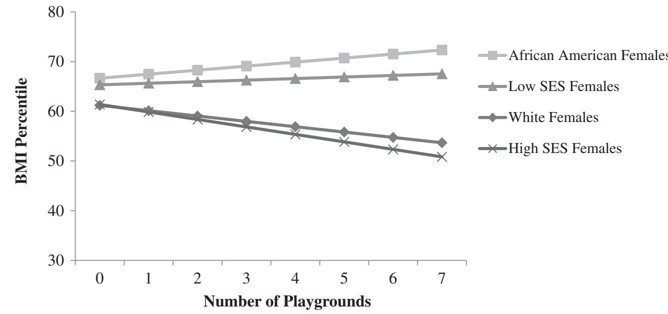

Fig. 3. BMI percentile for high and low SES and African American and White girls based on block group playground availability. Notes: Adjusted for youth age, gender, race/ethnicity, SES and neighborhood size, population, median household income, and percent racial/ethnic minority.

4, indicating that both interactions should be interpreted. For female youth, the number of playgrounds was significantly associated with lower BMI percentile ($b = -1.1$, $p < 0.05$) after adjusting for youth and block group characteristics. As seen in Table 3, Models 5a and 5b, youth race/ethnicity and SES moderated the association between playground availability and BMI percentile for females ($b = 1.9$ and $b = 1.8$, respectively, both $p < 0.05$). Specifically, higher neighborhood playground availability was associated with lower BMI percentiles for White and high SES females but higher BMI percentiles for African American and low SES females (Fig. 3).

4. Discussion

Parks are recognized as key components of communities that can promote health (Cohen et al., 2007; Kaczynski and Henderson, 2007; Bedimo-Rung et al., 2005; Broyles et al., 2011; Peters et al., 2010). Although several studies have examined how park availability is related to youth PA (Roemmich et al., 2006; Epstein et al., 2006; Ries et al., 2009; Timperio et al., 2008), less research has investigated associations between parks, playgrounds, and youth obesity. Among studies that have explored these relationships, findings have been mixed, with several authors reporting no associations between park availability and youth obesity (Burdette and Whitaker, 2004; Kligerman et al., 2007). One potential explanation for these inconsistent results is that the associations between park and playground availability and youth obesity are moderated by individual characteristics such as race/ethnicity or SES, which is consistent with a primary principle of ecological models that dynamic interactions exist across multiple levels (McLeroy et al., 1988). Using a large sample of elementary-aged youth from a southeastern US county, this study explored associations between park and playground availability and youth obesity and whether these relationships varied by youth race/ethnicity and SES. Overall, the current findings suggest considerable differences in neighborhood park and playground availability and youth obesity based on youth characteristics, thereby contributing to our understanding of how social and physical environments may contribute to disparities in youth weight status.

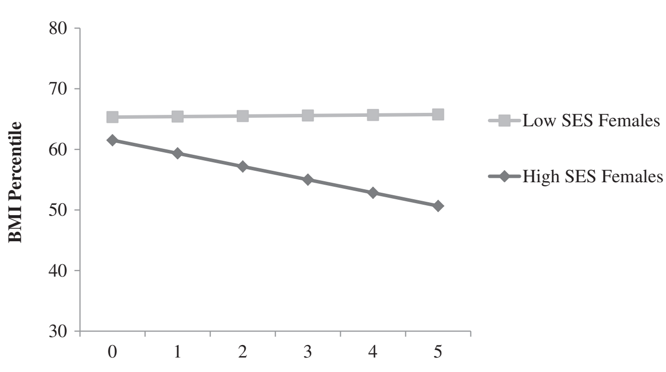

Fig. 2. BMI percentile for high and low SES girls based on block group park availability. Notes: Adjusted for youth age, gender, race/ethnicity, SES and neighborhood size, population, median household income, and percent racial/ethnic minority.

In the present study, there were no significant main effects for park or playground availability and youth obesity among males. This finding is inconsistent with previous research that has demonstrated that park and green space availability has a stronger health effect for males, compared to females (Sanders et al., 2015; Wolch et al., 2011). Despite no main effects being observed, there was a significant interaction detected between park availability and youth SES among males. To our knowledge, no other studies, including those reporting gender differences, have examined whether SES may moderate the association between park availability and youth obesity. According to our findings, higher neighborhood park availability was associated with lower BMI percentile for low SES males. It might be argued that proximal and affordable parks and green spaces have stronger impacts on PA and obesity prevention among lower income youth and neighborhoods given lesser financial or transportation access to pay-for-use resources outside their neighborhoods (Godbey et al., 2005; Taylor et al., 2006).

Interestingly, youth SES also moderated the association between park availability and youth obesity for females, but in a different way than was observed for boys. Specifically, higher neighborhood park availability was associated with lower BMI for high SES females but not low SES females. The observed differences in the nature of the interactions for males versus females could be related to perceptions of safety that are particularly concerning for girls' PA and sedentary time (Evenson et al., 2007). Some research has posited that girls have less autonomy compared to boys to be active in neighborhoods due to higher number of safety concerns from parents/guardians (Moore et al., 2014; Timperio et al., 2004). Even further, neighborhood safety, whether actual or perceived, is usually less favorable in lower SES neighborhoods, which, in turn, may deter children's – especially girls' – use of neighborhood amenities like parks (Weir et al., 2006). Indeed, studies have reported that parental and youth perceptions of safety from crime were associated with greater youth PA levels in public recreation spaces (Tappe et al., 2013; Gómez et al., 2004), especially for youth from lower income households (Westley et al., 2013), while additional research showed that higher crime has been related to lower PA and higher obesity levels for girls (Gómez et al., 2004; Carroll-Scott et al., 2013; Forsyth et al., 2015). Exploring how safety impacts the relationship between park availability and youth obesity represents an important direction for future research.

This study also found that playground availability was significantly associated with lower BMI percentile for females, which resonates with a previous study which reported that youth with a playground within 1 km from home were five times more likely to be a healthy weight (Potwarka et al., 2008). This association was also moderated by both race/ethnicity and socioeconomic status. Specifically, higher neighborhood playground availability was associated with lower BMI percentile for high SES and white females but higher BMI percentile for African American and low SES females. As described previously, it is possible that neighborhood safety concerns may be impacting the direction of these associations, such that minority or low-income youth have greater exposure to unsafe neighborhood circumstances that might limit park and playground active visitation (Tappe et al., 2013; Gómez et al., 2004; Carroll-Scott et al., 2013). In addition, the quality of the parks and playgrounds could be at play as some studies have reported poorer condition park facilities in high minority or lower-income neighborhoods, such that lesser quality parks may deter youth and families from utilizing park facilities (Vaughan et al., 2013; Franzini et al., 2010). Future research is needed to understand which park features and quality concerns are important for consistent park use.

Consistent with broader childhood obesity patterns (Ogden et al., 2010; Ogden et al., 2014), we found that African American, Hispanic, and low SES youth had significantly higher BMI compared to white and high SES youth in all adjusted models. However, our study highlighted a nuanced relationship between BMI, playground availability, race/ethnicity, and SES, especially among young girls. The differences in BMI between African American and white girls, as well as between low SES and high SES girls, widened with higher neighborhood playground availability highlighting the importance of cultural, social, and historical perspectives of both racial/ethnic minorities and lower SES populations within parks, recreation, and urban planning (Byrne and Wolch, 2009). Research has demonstrated that racial and ethnic groups often have different preferences for activity spaces, which can influence the degree to which key populations utilize certain types of parks (Byrne and Wolch, 2009). At the same time, many studies have documented that racial/ethnic minority populations use parks less compared to dominant groups (Tierney et al., 2001; Floyd et al., 2008), potentially suggesting that these public spaces, or facilities within them, may have less acceptability (i.e., part of the social and cultural norms; Blankenship et al., 2000). Indeed, historically, racial/ethnic minority and low SES populations have often been marginalized politically and economically, including exclusion from important processes regarding parks and recreation development and urban planning of neighborhoods (Byrne and Wolch, 2009). It is important for multidisciplinary researchers and practitioners (e.g., public health, parks and recreation, urban planning) further explore perceptions of park spaces and facilities among minorities to understand barriers to park use and how those can be overcome. Some work has employed a community-based participatory research approach where multiple stakeholders contribute to key decision-making processes, such as renovating or changing a park environment through programming (Cohen et al., 2013, Besenyi et al., 2015, Greer et al., 2014, DeBate et al., 2011). This collaborative approach to understanding how neighborhood features impact health behaviors and outcomes is both critical and necessary to support environmental justice aspects of community engagement and better understand and address inequities related to obesity and health.

4.1. Study limitations and strengths

This study was subject to several limitations. First, due to the cross-sectional design, causality cannot be attributed to the observed findings (Shadish et al., 2002). Some research has emerged describing the relationships between parks and green space and youth obesity over time (Bell et al., 2008; Sanders et al., 2015; Wolch et al., 2011), but more studies are needed (Brownson et al., 2009). Specifically, longitudinal studies should continue to explore whether certain subgroups garner increased health benefits compared to others with similar access to build environment features. Also, while this study had a large sample of youth, the narrow geographic area of the study setting potentially limits the generalizability of the findings for youth in other places (cities, states, countries; Shadish et al., 2002). Similarly, although we captured an important outcome (BMI) objectively for all youth in the study, several other variables, such as PA, may be key mediators in the parks-obesity relationship. Objectively measuring PA for over 13,000 youth would be challenging, but additional research should include multiple health behavior and outcome measures to better explicate the relationship between key environmental features and obesity (Sallis and Glanz, 2006; Sallis et al., 2012; Han et al., 2010). While some studies have examined multiple environments (i.e., PA and food) that impact obesity, it is imperative that researchers continue to investigate whether these environments have synergistic or counteracting effects on health behaviors and outcomes. Lastly, block groups were used as our level-2 indicators and to define the two key independent variables related to parks. Though used in other large research studies, (Frank et al., 2012; Saelens et al., 2012) these units are administratively-defined, which may not align with how residents define their neighborhood. However, using these units allowed for us to assess the novel cross-level interactions between individual and block group characteristics.

Overall, this study identified variations by gender, race/ethnicity, and SES in the association between neighborhood park and playground availability and youth obesity. These findings and future directions identified will help researchers and practitioners better understand environmental influences on obesity in order to create more equitable and healthy communities.

Conflict of interest

The authors declare there is no conflict of interest.

Transparency document

The Transparency document associated with this article can be found, in the online version.

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