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REVIEW

Do Neighborhoods Matter? A Systematic Review of Modifiable Risk Factors for Obesity among Low Socio-Economic Status Black and Hispanic Children

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Abstract

Background: Childhood obesity increases the risk of obesity and harmful comorbidities later in life. It is influenced by characteristics of a child's neighborhood, particularly among underserved groups. Our objective was to systematically review the evidence relating neighborhood environment and obesity risk among urban, low socioeconomic status (SES) Black and Hispanic children.

Methods: We included studies published from 1993 through early 2017 from PubMed, SCOPUS, Web of Science, and Sociological Abstracts databases investigating relationships between empirically measured neighborhood characteristics and obesity risk factors in the populations of interest. Databases were last searched on May 8, 2018. Initial analysis took place during 2014 and was completed during 2017. We extracted data on study population, design, and associations between neighborhood characteristics and obesity risk factors.

Results: We identified 2011 unique studies; 24 were included. Few studies demonstrated consistent patterns of association. Most neighborhood characteristics were not examined across multiple studies. BMI may be related to living in a lower-income neighborhood or convenience store access.

Conclusions: This review found that the body of evidence relating neighborhood exposures and obesity risk factors among urban, low SES Black (also commonly referred to in the literature as ''non-Hispanic Black'' or African American) and Hispanic children is limited. Given the high risk of obesity and cardiovascular disease among these populations throughout the life course, research on neighborhood determinants of obesity should specifically include these populations, ensuring adequate power and methodological rigor to detect differences.

Keywords: African American; childhood obesity; Hispanic; neighborhood; social determinants of health

Background

Childhood obesity affects one in six children in the United States. Low socioeconomic status (SES) and racial and ethnic minority children are disproportionately affected.[1–3] Obesity in childhood is associated with lifelong obesity, which also increases the risk of cardiovascular disease (CVD) in adulthood.[4] A simulation model based on current trends predicted that 57% of children today will be obese at age 35.[5] Neighborhood environments are thought to influence childhood obesity risk in part through their potential effects on physical activity and

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diet. Therefore, the influence of neighborhood environment on obesity risk is a key area of ongoing research.[6] While the literature regarding the types of environmental exposures examined is heterogeneous, most studies describe neighborhood environmental exposures in one or more of the following domains as potentially relevant to childhood obesity: neighborhood SES, food environment, physical activity environment, and social environment (*e.g.*, crime).[7]

Neighborhood environments may also contribute to disparities in childhood obesity. For instance, low SES neighborhoods and neighborhoods with high concentrations of racial/ethnic minority residents tend to have higher concentrations of unhealthy foods and less access to affordable healthy foods; and individuals living in such neighborhoods are exposed to higher levels of crime and violence.[8–16] Increased exposure to neighborhood crime and violence, in particular, has been linked to reduced energy expenditure and lower physical activity levels.[8,14–16] Thus, the potential effects of adverse neighborhood conditions on obesity risk are further compounded among individuals living in low-income, predominantly racial/ethnic minority communities. Other potential mechanisms by which neighborhoods contribute to obesity disparities include chronic psychosocial stress and structural factors such as racial segregation, concentrated poverty, and discrimination that may potentiate material deprivation and stress.[10,11,17,18]

Prior research suggests that both access to larger food stores (*e.g.*, grocery stores) and urban design characteristics (*e.g.*, walkability) may influence obesity risk for Black and Hispanic adults. But, to our knowledge, no prior study has systematically reviewed the evidence for low SES Black and Hispanic children.[13,19] Furthermore, many prior reviews aggregate results across child and adult populations to increase sample size and thus assume similarities in the associations between neighborhood environments and obesity risk across the life course, when in fact the relationships may differ.[7,13,20–22] For instance, the scale at which neighborhood exposures may influence childhood obesity risk may be different compared with adults. In particular, for young children the characteristics of the immediate block where their home is located may have more bearing on outdoor play than neighborhood amenities located several blocks away. In contrast, for some children, planned extracurricular activities may occur largely outside the boundaries that define their neighborhood of residence.[23] As such, the characteristics of a few blocks around the home could matter more than the overall characteristics of a larger area, such as a census tract.[24]

Living in a transit-oriented community may also have less bearing on children's physical activity than adults insofar as children in some settings may not use public transit to commute to school, while adults may use it more regularly for commuting. Additionally, parents may modify the extent to which they encourage their children to be active within their immediate neighborhood based on their perceptions of risk.[25] They may also proactively seek resources outside their neighborhoods to provide their children access to alternative environments for physical activity or healthy eating, which may be different than the efforts that adults are willing to undertake for themselves. Focus group research by Showell et al. supports the notion that parents will compensate for neighborhood deficiencies and may go to great lengths to overcome neighborhood constraints to physical activity or healthy eating when their children's health is involved.

Despite the influence of neighborhood environments on childhood obesity risk, particularly among low-income and/or racial/ethnic minority children, research examining the evidence for environmental strategies to address childhood obesity among racial/ethnic minority children, particularly Black (also commonly referred to in the literature as "non-Hispanic Black" or African American) populations, is lacking.[19] Given the increased lifetime risk of obesity for low SES and racial/ethnic minority children and associated increased risk of CVD and associated morbidity in adulthood,[26] it is critical to examine the specific associations between neighborhood environmental exposures and obesity risk factors for these populations. Examining this association specifically among high-risk populations of children also serves to better inform and target prevention efforts or interventions at the subpopulations in greatest need, which is a necessary strategy for achieving health equity.

Study Purpose

The goal of this study was to systematically review the results of studies that investigated the association between neighborhood environment and obesity risk among urban, low SES Black and Hispanic children.

Methods

Eligibility Criteria

We identified studies that quantitatively analyzed an association between objectively-measured characteristics of residential neighborhoods of children aged 0–22 years (referred to as children) and BMI in a manner that conferred generalizability to Black or Hispanic children. Neighborhood definitions varied by study and included administrative boundaries such as census tracts, political boundaries such as counties, and buffers around the centroid of a zip code, an individual participant's address, or a community-defined neighborhood. Studies were deemed generalizable to Black or Hispanic children if they: (1) reported separate associations for Black and/or Hispanic children; (2) demonstrated no statistical differences in the association of neighborhood exposures and BMI between the overall population and the Black or Hispanic children in the cases where racial/ethnic minority subgroup analyses were performed; or (3) reported a study population ≥50% Black and/or Hispanic, which has been used in other studies seeking to identify relevant associations for a particular racial or ethnic group.[19] Included studies were written in English, conducted in the United States or Canada, and included an urban population with low SES participants without known pre-existing medical conditions.

Literature Search Strategy

We searched PubMed, SCOPUS, Web of Science, and Sociological Abstracts databases to identify articles published between 1993 and early 2017. Prior reviews indicate that the majority of the literature emerged since 2000.[7,13,20–22] The search strategy was developed and databases were chosen in consultation with a clinical librarian. Databases were last searched on May 8, 2018. Because we sought to be comprehensive in including early studies, our search timeframe dated back to 1993. Appendix Table A1 contains the complete strategy for PubMed. Earlier versions of the search strategy did not include all clinical outcomes that were ultimately selected for the final search strategy. The final search strategy yielded the most comprehensive set of relevant studies and included a full set of clinical and behavioral indicators of CVD risk applicable to populations of all ages. This included obesity, CVD and related conditions, eating behaviors, and physical activity behaviors. Search terms were originally developed as part of a larger review inclusive of both adults and children; therefore, some terms such as myocardial infarction and coronary artery disease were included.

This systematic review summarizes a subset of studies included in the overall search with a specific focus on obesity risk among low-income Black and Hispanic children and adolescents for whom age- and gender-specific BMI percentile and related measures (*e.g.*, BMIz score) are appropriate. Our inclusion criteria allowed for studies with children and adolescents aged 0–22 years to be inclusive of older adolescents. However, once we reached the article abstraction phase, we evaluated all studies in our sample and determined that all studies either included children and adolescents between ages 2 and 18 years or high school students of an unspecified age range. We initially abstracted articles on physical activity behaviors as well; however, because of the small number of studies and variability in measurement, we restricted the final review to studies assessing the association of neighborhood characteristics with child BMI.

Of the 2011 unique records identified, 1486 were excluded at the title review stage because they were not original research, did not focus on children, or were not relevant to the exposures or outcomes under study. Of the 525 studies that met the criteria for inclusion at the title review stage, 337 were excluded because of the article type, study population, or exposures and outcomes reported in the abstract. An additional 165 were excluded at the full article review phase for similar reasons. Ultimately, we restricted this analysis to studies with outcomes of BMI or age-appropriate measures derived from BMI (*e.g.*, BMI percentile, weight status categories based on BMI percentile, BMI z-score), as these were, by far, the most consistently reported outcomes and are consistent with the measures routinely used in pediatric clinical practice to assess obesity risk throughout the life course. There were 24 studies included in the final sample; one study was included in the final sample based on expert review, which was not identified by keyword search.

Article Screening and Full-Text Review

Initial search results were imported into RefWorks, and a subsequent search to update the database with articles published after 2013 was imported into Endnote.[27,28] Duplicates were identified and removed in both reference management databases. Reviewers independently screened article titles and abstracts. Full texts of included titles/abstracts were retrieved, and these articles were screened for inclusion using the eligibility criteria described below. Discrepancies were resolved by discussion between reviewers and adjudicated by full-group consensus when needed.

Data Extraction and Management

Articles were reviewed by study author and team member (K.A.J.) and at least one other study team member. Two independent reviewers extracted data from each article, reviewed each field jointly, and adjudicated discrepancies. If agreement could not be reached through discussion and reviewing the source article, a third team member (either N.N.S. or R.L.J.T.) reviewed the article and adjudicated to achieve consensus. An electronic form designed using Qualtrics[29] online survey software was used to extract data. To pilot the form and calibrate coding, all team members extracted data from four test articles using a draft form that was subsequently finalized.

Information regarding study population, study design, and measurements of associations between neighborhood characteristics and obesity risk were extracted from each article, including study population characteristics such as sample racial/ethnic and SES composition.

Neighborhood Exposure Measures

Four groups of neighborhood characteristics were examined: SES, food environment, physical activity environment, and crime. These groups of neighborhood exposures were selected because they represent the most common exposures found in prior reviews and/or are hypothesized to be particularly relevant for the population of interest. Only objectively-measured neighborhood exposures were included. Many of these exposure measures relied on the use of publicly-available data sources (*e.g.*, US Census Data). Neighborhood exposures were considered to be objectively measured if they were derived from data that could be quantified and did not rely on subjective measures such as residents' perceptions. For example, we included neighborhood crime exposures that relied on reported crime counts or rates (*e.g.*, crime data available from the Cincinnati police department[30]) but excluded studies where the neighborhood crime exposure was measured using residents' perceptions of crime or safety. For measures examining access to food retailers or physical activity resources, researchers also identified the methods used to operationalize access (*i.e.*, whether the study examined access in terms of proximity, density, both, or another method).

Outcome Variables

The primary outcome for included studies was BMI. Associations were reported for the overall study population and for Black and Hispanic children, if these were reported separately.

Data Synthesis and Analysis

Initial analyses were completed in 2014 and updated during 2017. We created evidence tables containing information from the included studies. Each reported relationship between a neighborhood factor and outcome of interest in the authors' final, adjusted model was coded as follows: significant and direct (+), significant and inverse (−), not significant (0), mixed results (X), or other. As there was substantial variation in study design and context, significance levels were based on the original authors' definition of significance. Most studies used a $p < 0.05$ significance level; however, several studies used a $p < 0.10$ threshold.

BMI assessments were coded such that a significant inverse association indicated statistically significant decreasing BMI (generally considered a desirable outcome) as the neighborhood factor increased. For example, a study that reported a significant and inverse association between neighborhood income and BMI would show that, with increasing neighborhood income, BMI decreased. ''Mixed results'' was used to identify instances where there were multiple measures of a particular type of outcome, and the direction of the associations with a specific neighborhood factor was inconsistent. ''Other'' was used if the neighborhood factor was included in the final, adjusted model, but the significance and directionality were not reported. Neighborhood factors were always coded such that an increase represented an increase in the specific characteristic as described on the extraction form (Table 1).

To characterize the evidence for each neighborhood factor and BMI, counts and measures of central tendency were calculated. We did not summarize relationships to obesity for neighborhood exposures examined in less than two studies. Researchers identified the articles with results most generalizable to Black and Hispanic children and conducted stratified analyses.

Associations between neighborhood factors and obesity risk were compared manually between studies of different quality, children of different ages, and different measurement modalities for outcome variables. A meta-analysis was not performed due to wide variability in exposure definitions and specific outcomes across studies. For those studies with adequate data reported in the articles reviewed, we graphically displayed effect sizes for the associations between BMI, obesity, or overweight across studies where both effect sizes and 95% confidence intervals were provided. Some effects were reported as regression coefficients (such as the association between standardized BMI and proximity to greenspace), while other studies reported effect sizes as odds ratios (such as the association between obesity and proximity to greenspace).

Table 1. Neighborhood Exposures by Category

Neighborhood SES
Neighborhood income
Neighborhood education
Composite measure of neighborhood SES
Neighborhood food environment
Grocery store/supermarket access
Corner/convenience store access
Fast food access
Composite measure of the food environment
Neighborhood physical activity environment
Walkability
Recreation facility access
Park/playground access
Pedestrian safety measures
Traffic speed/volume
Vegetation
Neighborhood crime[a]

[a]Derived from objectively-measured crime statistics for a specific geographic area.

SES, socioeconomic status.

Study Quality (Risk-of-Bias Assessment)

Study quality was coded as *strong*, *moderate*, or *weak* based on the risk of bias in the study design. We used a modified version of the Quality Assessment Tool from the Effective Public Health Practice Project (EPHPP).[31] A previous study on evaluating natural experiments in obesity used the EPHPP tool; this study cited benefits of using this tool to evaluate quality of obesity studies, including simplicity and interpretability across study designs.[32] Four components of study quality were assessed: selection bias, study design, data collection methods, and analyses.

Selection bias was assessed in reference to the likelihood that the study was representative of the target population of low SES Black and Hispanic children in the United States. Because our study inclusion criteria were to only include studies that had either majority Black or Hispanic children or separate analyses by race, we determined that each study was somewhat likely to be representative of the target population, and thus moderate quality for selection bias.

Study design was rated as moderate quality if it was longitudinal and weak quality if it was cross-sectional. The EPHPP quality measure only categorizes randomized controlled trials as strong quality for the study design category.

Data collection methods were rated in terms of validity and reliability of collection of outcome measures. If BMI was self-reported, it was considered not validated and not

reliable. If BMI was measured by study staff or clinic staff, it was considered valid, and if the measurements were taken by people who were trained or taken multiple times, they were considered reliable. If outcome measurement was determined to be both valid and reliable, it was categorized as strong; if outcome measurement was either valid or reliable, it was categorized as moderate; if it was determined to be neither valid nor reliable, it was categorized as weak.

Analyses were considered strong quality if neighborhood-level clustering was accounted for. A global rating was made for each study based on these four criteria. Studies were considered strong if they had no weak ratings, moderate if they had one weak rating, and weak if they had two or more weak ratings.

Results

Search Results

A total of 24 articles were included (Fig. 1).[30,33–55] We identified 2011 unique records, 23 of which were included in this review after title, abstract and article screening, and an additional article[50] was identified based on expert review that did not come up using our database search strategy.

Study Characteristics

Measurements of association were most commonly reported as odds ratios. Measures used to evaluate the proportion of low SES participants included parental educational attainment, household income, and eligibility for means-tested benefit programs (*e.g.*, Medicaid).

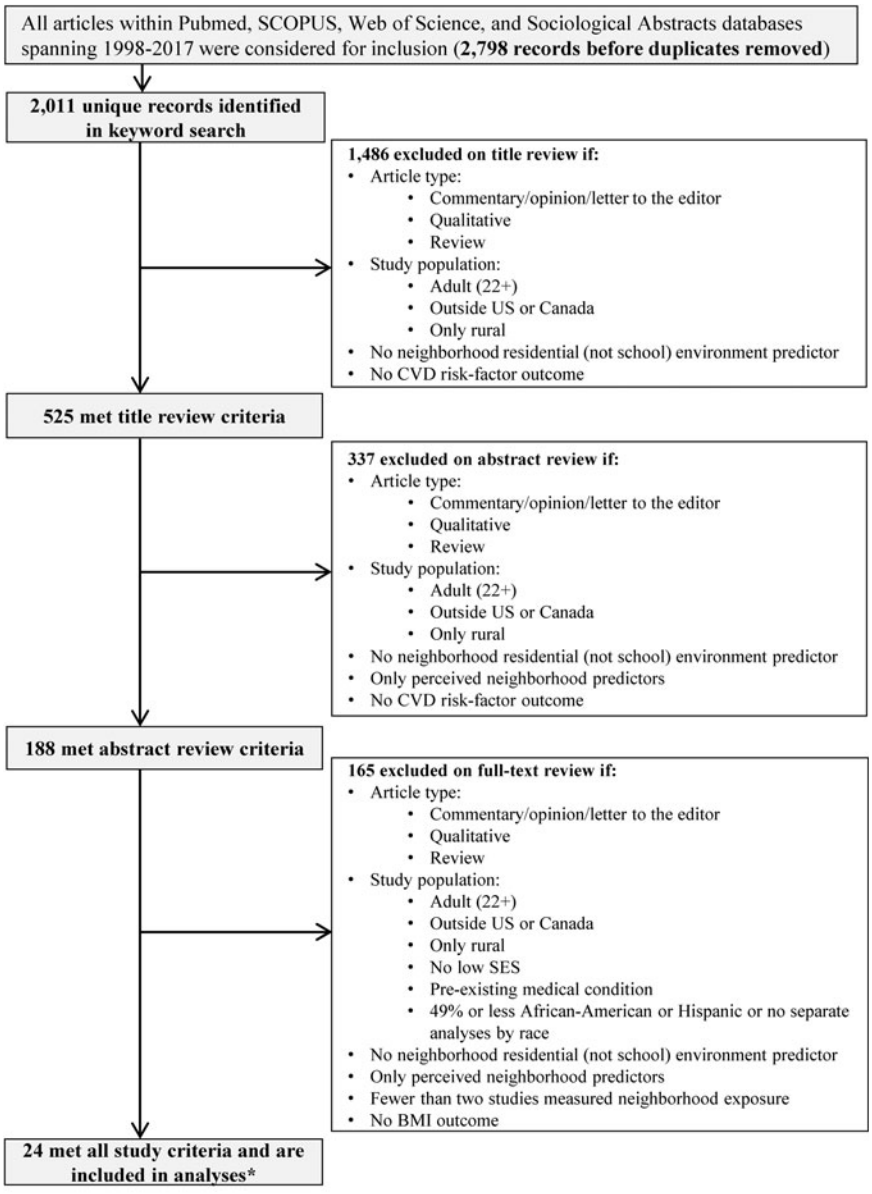


Figure 1. PRISMA flow diagram.

The direction and significance of each reported relationship between neighborhood characteristics (Table 1) and obesity risk were considered. Study designs, methods of defining a child's neighborhood, and other characteristics of included studies are in Table 2. Study quality by category and global rating is shown in Figure 2. Most studies were either low or medium quality[30,33–55]; only four utilized a longitudinal design.[51–54] The vast majority of studies used an administrative boundary or buffer around a child's residence for neighborhood measurement tactics.

Study Population Characteristics

Study populations differed across studies (Table 2). Eight studies (33%) examined relationships among school-aged children (ages 5–14), 6 (25%) among adolescents (ages 12–21), and 3 (13%) in younger children (ages 2–5). Eleven studies of Black children and six of Hispanic children either reported associations separately, or had ≥50% participants who were Black or Hispanic, respectively. These studies comprised the sample for the stratified analyses by race/ethnicity.[30,35–37,39–43,45,47,48,51,53–55]

Table 2. Characteristics of Included Studies ($n = 24$)

Study characteristic	*n* (%)
Study quality (risk of bias)[a]	
Weak quality	9 (38)
Moderate quality	10 (42)
Strong quality	5 (21)
Neighborhood definition(s)[b]	
Administrative boundary[c]	19 (79)
Buffer around residence	11 (46)
Other[d]	8 (33)
Political boundary[e]	2 (8)
Age	
Early childhood (2–5 years)	3 (13)
School age (5–14 years)	8 (33)
Adolescents (12–21 years)	6 (25)
All ages (~2 to ~18 years)	5 (21)
Other	2 (8)
Race/ethnicity	
Separate analysis for Black children	3 (13)
Studies with ≥50% Black participants	11 (46)
Separate analysis for Hispanic children	2 (8)
Studies with ≥50% Hispanic participants	6 (25)

[a]Study quality was determined by risk of bias; see Methods section.

[b]Categories do not sum to 100% as many studies used multiple definitions.

[c]Defined by the census, for example, census tract or zip code.

[d]For example, buffer around centroid of zip code, or community-defined neighborhood.

[e]Defined as political jurisdiction, for example, county, city, or voting district boundaries.

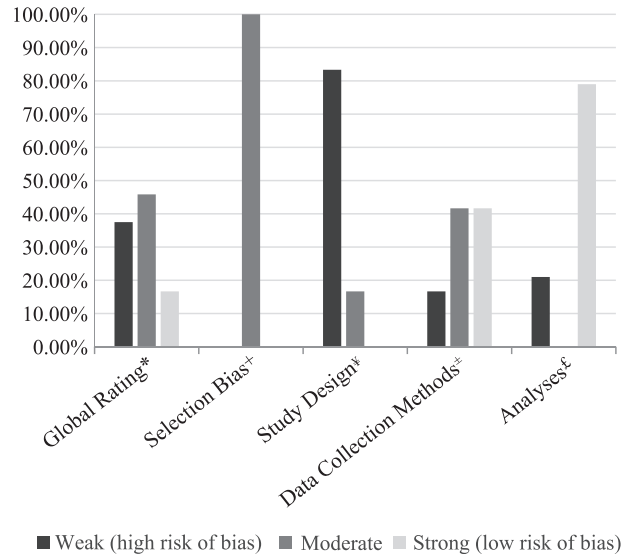


Figure 2. Study quality bar graph. *Global rating: Studies were considered strong if they had no weak ratings, moderate if they had one weak rating, and weak if they had two or more weak ratings. +Selection bias: Selection bias was determined based on the extent to which the study population was deemed representative of the target population. Based on our racial inclusion criteria, the study team deemed all studies to be somewhat likely to be representative; this equated with a moderate quality with respect to selection bias. ¥Study Design: To be rated strong, a study had to involve a randomized controlled design; none of the included studies did. Moderate studies used a longitudinal design. Weak studies used a cross sectional design. ±Data Collection Methods: Strong studies used study or clinic staff to measure height and weight. Moderate studies used BMI measurements that were taken multiple times. Weak studies used self-reported BMI. £Analyses: We dichotomized this criterion into strong and weak to be more applicable for observational studies. Studies were rated as strong if they accounted for neighborhood-level clustering and weak if they did not account for neighborhood-level clustering.

Study Outcomes

Common BMI assessments included BMI percentile and BMI z-score. Other outcomes were infrequently reported and were excluded from subsequent analyses. Relationships are only reported between neighborhood factors and BMI for factors for which there were at least two studies examining their effect on BMI.

Associations between Neighborhood Factors and BMI

Table 3 reports the associations between neighborhood exposures and BMI. Studies that included ≥50% or a separate analysis of Black children (Appendix Table A2), and studies that included ≥50% or a separate analysis of Hispanic children (Appendix Table A3) are included in the

Table 3. Associations between Neighborhood Characteristics and BMI for the Overall Study Population of Included Studies

		BMI study counts				
Neighborhood exposure	**Refs.**	**+**	**0**	**−**	**Mixed**	**Other**
Neighborhood SES						
Neighborhood income	33,38,41,42,44–46,48,50–53	0	3	5	1	3
Neighborhood education	44,53	0	0	1	1	0
Composite SES measure	34,36,37,50,54	0	4	1	0	0
Food environment						
Grocery store/supermarket access	35,39,41,48,52	0	3	0	2	0
Corner/convenience store access	33,35,39–41,46,48,52	3	4	0	1	0
Fast food access	30,33,39,41,46–49,52	0	5	2	1	1
Composite food environment	34,41,48,54,55	1	2	0	2	0
Physical activity environment						
Walkability	33,38,42,51	0	2	1	1	0
Park/playground access	30,38,42,46,55	0	3	1	1	0
Traffic speed/volume	38,42	0	2	0	0	0
Vegetation	41,51	0	0	2	0	0
Neighborhood crime						
Crime	30,42,43,49,54	1	3	0	1	0

Mixed results = multiple types of associations between neighborhood exposure and outcome reported. Other = neighborhood factor was included in the final, adjusted model, but the direction of association and significance were not reported.

Appendix. Findings were mixed overall and for specific age groups and racial/ethnic populations. Few neighborhood factors were examined by multiple studies, and fewer still revealed consistent associations. Frequently, studies reported multiple associations between a specific neighborhood characteristic and outcome—for instance, separately reporting relationships with BMI of fast food restaurant density *and* proximity. Some also provided associations by different subgroups (*e.g.*, by sex), which were included separately. As such, studies where multiple associations were assessed may be categorized as ''mixed results'' if different findings (*e.g.*, both null and direct relationships) between a specific neighborhood exposure and outcome were reported or ''other'' if authors' stated variable was included in adjusted estimates, but results were not reported.

Variations in study quality, measurement modalities, or participant ages did not appear to have consistent or significant effects on the direction or strength of associations detected between neighborhood characteristics and outcomes of interest. Appendix Tables A4–A6 display associations for BMI assessments by study quality.

Neighborhood SES

Sixteen studies reported associations between neighborhood SES and BMI for overall study populations.[33,34,36–38,41,42,44–46,48,50–54] Findings for studies with point estimates and confidence intervals are displayed in a forest plot (Fig. 3). These primarily investigated the relationship between neighborhood SES and BMI as measured by neighborhood income or a composite SES measure. Four studies[36,37,50,54] found no association between a composite SES measure and BMI; one study[34] found an inverse association between composite SES and BMI. Three studies found no association between a neighborhood income and BMI, and five studies found an inverse relationship between neighborhood income and BMI.

Neighborhood Food Environment

Overall, 14 studies[30,33–35,39–41,46–49,52,54,55] reported associations between aspects of neighborhood food environment and BMI outcomes. Findings from these studies are displayed in a forest plot (Fig. 4). The most frequently assessed exposures were corner/convenience store (8 studies[33,35,39–41,46,48,52]) and fast food access (9 studies[30,33,39,41,46–49,52]). The most consistent evidence for a relationship between a characteristic of a child's neighborhood food environment and BMI was corner/convenience store access, particularly among Hispanic children. Three of eight studies[39,41,48] found a direct relationship for

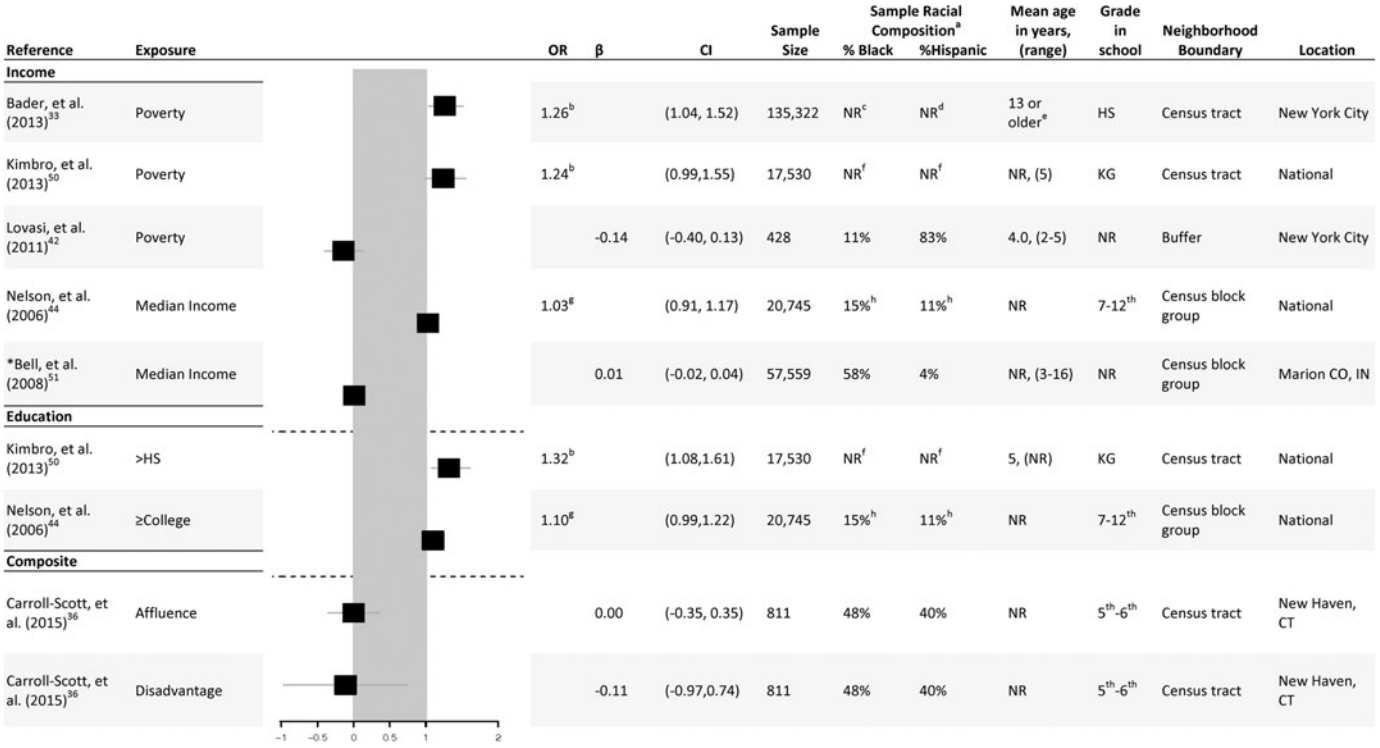


Figure 3. Neighborhood socioeconomic status forest plot. *Longitudinal study design. [a]Studies met inclusion criteria if ≥50% of the study populations were Black or Hispanic, or if the study reported on subgroup analyses by race or evaluated the extent to which a particular neighborhood exposure was associated with child BMI among Black or Hispanic study subpopulations. [b]Odds ratio obese vs. normal weight. [c]This study did not report racial composition for the overall study population; it adjusted for race/ethnicity. The study reported on the proportion of Black participants who were obese. [d]This study did not report racial composition for the overall study population; it adjusted for race/ethnicity. The study reported on the proportion of Hispanic participants who were obese. [e]The study did not report mean age or age range. The study sample consisted of high school students ≥13 years. [f]This study did not report racial composition of the overall study population; it did adjust for race/ethnicity and was composed of a nationally representative sample. [g]Risk ratio of BMI ≥95% percentile (obese). [h]This study adjusted for race/ethnicity in analyses. HS, high school; KG, kindergarten; NR, not reported; OR, odds ratio.

overall study populations, suggesting that BMI may rise as access to corner/convenience stores increases. All three of these studies were low quality.[39,41,48] Both studies examining this relationship specifically among Hispanic children (ages 8–10[39] and 14–16,[48] respectively) found a significant, direct association. There was no consistent relationship between fast food access and BMI in overall study populations or specifically among Black or Hispanic children of any age.

Neighborhood Physical Activity Environment

Eight studies[30,33,38,41,42,46,51,55] measured associations between characteristics of physical activity environment, mainly park/playground access, and BMI within overall study populations. Findings of these studies are displayed in a forest plot in Figure 5.

Two studies[41,51] reported relationships between neighborhood vegetation (measured using Normalized Difference Vegetation Index, a measure of greenness derived from satellite pictures) and BMI. Both these studies reported an inverse relationship between vegetation and BMI overall and for Black children. One study was high quality[51] and one was low quality.[41]

Neighborhood Crime

Five studies[30,42,43,49,54] reported associations between neighborhood crime and BMI. These studies reporting on the association between crime *only* and BMI found no consistent relationships. Findings from these studies are displayed in a forest plot in Figure 6. Three of these studies found no association between crime and BMI[30,42,54]; one[43] had mixed results; and one had a significant, positive relationship.

Conclusion and Discussion

Our systematic review found that the body of research specifically examining the relationship between neighborhood environments and obesity risk among low-income African American and Hispanic children of any age is limited. Of the studies that exist with findings applicable to these populations, the strongest evidence suggests that urban, low SES Black and Hispanic children living in poorer neighborhoods and those with increased access to corner/convenience stores had higher BMIs, while those living in neighborhoods with more vegetation had lower BMIs. There is not enough evidence regarding

Author, (Year)	Exposure	OR	β	CI	Sample size	Sample Racial Composition[a] %Black	%Hispanic	Mean age in years, (range)	Neighborhood Boundary	Location
Grocery Store /Supermarket										
Galvez, et al. (2009)[39]	Density	0.88[b]		(0.30, 2.56)	323	18%	67%	NR, (6-8)	Census block	New York City
Galvez, et al. (2009)[39]	Density	1.09[b]		(0.47, 2.52)	323	18%	67%	NR, (6-8)	Census block	New York City
Corner/Convenience Store										
Ohri-Vachaspati, et al. (2014)[46]	Presence	1.47[c]		(0.35, 6.20)	702	47.8%	40.1%	NR, (3-18)	Buffer[d]	4 NJ cities
Ohri-Vachaspati, et al. (2014)[46]	Presence	1.90[c]		(1.04, 3.45)	702	47.8%	40.1%	NR, (3-18)	Buffer[e]	4 NJ cities
Galvez, et al. (2009)[39]	Density	1.90[b]		(1.15, 3.15)	323	18%	67%	NR, (6-8)	Census block	New York City
Ohri-Vachaspati, et al. (2014)[46]	Density	1.11[c]		(1.00, 1.22)	702	47.8%	40.1%	NR, (3-18)	Buffer[e]	4 NJ cities
Ohri-Vachaspati, et al. (2014)[46]	Proximity	0.32[c]		(0.07, 1.37)	702	47.8%	40.1%	NR, (3-18)	Distance[f]	4 NJ cities
Fast Food										
Ohri-Vachaspati, et al. (2014)[46]	Presence	1.41[c]		(0.47, 4.28)	702	47.8%	40.1%	NR, (3-18)	Buffer[d]	4 NJ cities
Bader, et al. (2013)[33]	Density	0.97[g]		(0.96, 0.99)	135,322	NR[h]	NR[i]	13 or older[j]	Census tract	New York City
Galvez, et al. (2009)[39]	Density	1.11[b]		(0.71, 1.73)	323	18%	67%	NR, (6-8)	Census block	New York City
Oreskovic et al. (2009)[47]	Density	0.95[c]		(0.72, 1.25)	3346	7.0%	68.9%	9.6, (2-18)	Buffer[k]	Eastern MA
Oreskovic et al. (2009)[47]	Density	1.09[l]		(0.82, 1.26)	3346	7.0%	68.9%	9.6, (2-18)	Buffer[k]	Eastern MA
Oreskovic et al. (2009)[47]	Proximity	0.86[c]		(0.82, 1.04)	3346	7.0%	68.9%	9.6, (2-18)	Distance[m]	Eastern MA
Oreskovic et al. (2009)[47]	Proximity	0.93[l]		(0.86,1.00)	3346	7.0%	68.9%	9.6, (2-18)	Distance[m]	Eastern MA
Composite/Other										
Colabianchi, et al. (2014)[55]	Restaurant Density	1.09[g]		(0.91, 1.31)	145	74%	NR[n]	15, (14-17)	Census tract	Cuyahoga CO, OH
Colabianchi, et al. (2014)[55]	Restaurant Density	1.08[l]		(0.98, 1.19)	145	74%	NR[n]	15, (14-17)	Census tract	Cuyahoga CO, OH
Colabianchi, et al. (2014)[55]	Food store Density	1.01[g]		(0.75, 1.35)	145	74%	NR[n]	15, (14-17)	Census tract	Cuyahoga CO, OH
Colabianchi, et al. (2014)[55]	Food store Density	0.98[l]		(0.85, 1.14)	145	74%	NR[n]	15, (14-17)	Census tract	Cuyahoga CO, OH
*Rossen, et al. (2013)[54]	Healthy Food Availability Composite		-0.15	(-0.26,-0.03)	237	86.8%	NR[n]	9.6, (8-13)	Buffer[o]	Baltimore City

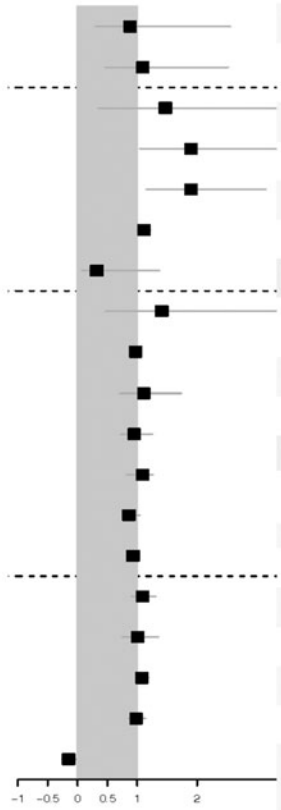


Figure 4. Neighborhood food environment forest plot. *Longitudinal study design. [a]Studies met inclusion criteria if ≥50% of the study populations were Black or Hispanic, or if the study reported on subgroup analyses by race or evaluated the extent to which a particular neighborhood exposure was associated with child BMI among Black or Hispanic study subpopulations. [b]OR child's BMI percentile being in the top tertile. [c]OR overweight or obese vs. normal weight. [d]0.5 mile radius buffer around child's residence. 0.25 mile radius buffer around child's residence. [f]Distance to nearest convenience store from child's home was measured in roadway network miles. [g]OR obese vs. normal weight. [h]This study did not report racial composition of the overall study population; it adjusted for race/ethnicity. The study reported on the proportion of Black participants who were obese. [i]This study did not report racial composition of the overall study population; it adjusted for race/ethnicity. The study reported on the proportion of Hispanic participants who were obese. [j]The study did not report mean age or age range. The study sample consisted of high school students ≥13 years. [k]400 m buffer zone around child's residence. [l]Overweight vs. normal weight. [m]Distance to the nearest fast food restaurant was measured via street networks from child's residence. [n]Racial composition of the sample was not reported for all participants; only the percentage of Black was reported. [o]100 m buffer of path between child's home and school.

neighborhood social environment, particularly neighborhood crime, to suggest an association with increased BMI. Grocery store access, one of the most common proxies in the literature for a healthful food environment,[8] was not related to BMI for the focal populations.

Perhaps the most striking finding of this review is the dearth of research specifically examining the association between neighborhood environments and obesity risk for urban, low SES Black and Hispanic children of all ages. Less than 2% of the 2011 studies identified in our literature search provided relevant findings for urban, low SES Black or Hispanic children. Only 11 of these studies had either a majority Black study population or conducted separate analyses for Black children, and only 6 had either a majority of Hispanic children or conducted separate analyses for Hispanic children. Of the studies that reached the article review phase ($n = 188$), only 24 met all study criteria (13%). This is a very small evidence base, particularly given that these populations are known to be at increased risk of obesity throughout the life course, and may also experience differences in neighborhood context that further potentiate this risk compared with other socioeconomic and racial/ethnic groups of children within the United States.

Other limitations of this evidence base relate to the fact that these studies span multiple age groups for whom the mechanisms by which neighborhood environments impact obesity risk may be different. For example, toddlers and young children (ages 2–5 years) are likely to interact with neighborhood environments, particularly with respect to physical activity and its impacts on obesity, with their surroundings very differently than adolescents or school-aged children for whom fast food or healthy food access may be more strongly associated with obesity risk. Thus, the size of

Author, (Year)	Exposure	OR	β	CI	Sample size	Sample Racial Composition[a] %Black	Sample Racial Composition[a] %Hispanic	Mean age, (range) in years	Neighborhood Boundary	Location
Walkability										
Bader, et al. (2013)[33]	Walkability index	0.99[b]		(0.99,1.01)	135,322	NR[c]	NR[d]	13 or older[e]	Census tract	New York City
*Bell, et al. (2008)[51]	Residential density		-0.01	(-0.01, 0.01)	57,559	58%	4%	NR, (3-16)	Census block group	Marion CO, IN
Lovasi, et al. (2011)[42]	Population density		-0.08	(-0.38, 0.22)	428	11%	83%	4.0, (2-5)	Buffer[f]	New York City
Lovasi, et al. (2011)[42]	Land use mix		-0.11	(-0.28, 0.17)	428	11%	83%	4.0, (2-5)	Buffer[f]	New York City
Lovasi, et al. (2011)[42]	Subway stop density		-0.16	(-0.33, 0.01)	428	11%	83%	4.0, (2-5)	Buffer[f]	New York City
Lovasi, et al. (2011)[42]	Bus stop density		0.10	(-0.09, 0.30)	428	11%	83%	4.0, (2-5)	Buffer[f]	New York City
Lovasi, et al. (2011)[42]	Intersection density		0.05	(-0.12, 0.22)	428	11%	83%	4.0, (2-5)	Buffer[f]	New York City
Park/Playground Access										
Ohri-Vachaspati, et al. (2014)[46]	Park presence	0.41[g]		(0.21, 0.81)	702	47.8%	40.1%	NR, (3-18)	Distance[h]	4 NJ cities
Colabianchi, et al. (2014)[55]	Park density	1.02[b]		(0.80, 1.30)	145	74%	NR[i]	15, (14-17)	Census tract	Cuyahoga CO, OH
Colabianchi, et al. (2014)[55]	Park density	1.01[j]		(0.87, 1.17)	145	74%	NR[i]	15, (14-17)	Census tract	Cuyahoga CO, OH
Lovasi, et al. (2011)[42]	Park density		0.04	(-0.19,0.11)	428	11%	83%	4.0, (2-5)	Buffer[f]	New York City
Lovasi, et al. (2011)[42]	Playground density		0.03	(-0.23,0.29)	428	11%	83%	4.0, (2-5)	Buffer[f]	New York City
Traffic Speed/Volume										
Lovasi, et al. (2011)[42]	Traffic volume		0.22	(-0.40, 0.83)	428	11%	83%	4.0, (2-5)	Buffer[f]	New York City
Vegetation										
*Bell, et al. (2008)[51]	Greenness	0.87[k]		(0.79, 0.97)	57,559	58%	4%	NR, (3-16)	Buffer[j]	Marion CO, IN

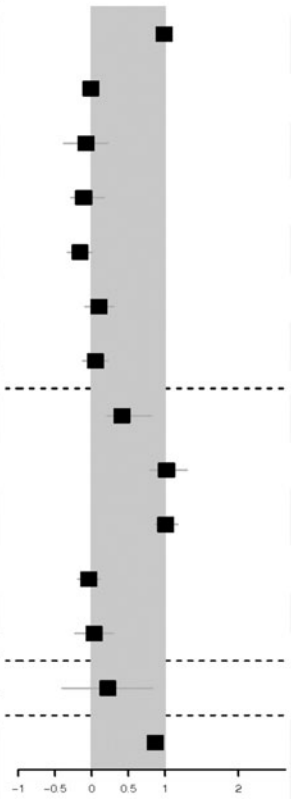
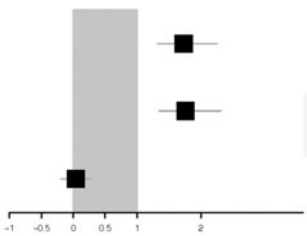


Figure 5. Neighborhood physical activity environment forest plot. *Longitudinal study design. [a]Studies met inclusion criteria if ≥50% of the study populations were Black or Hispanic, or if the study reported on subgroup analyses by race or evaluated the extent to which a particular neighborhood exposure was associated with child BMI among Black or Hispanic study subpopulations. [b]Obese vs. normal weight. [c]This study did not report racial composition of the overall study population; it adjusted for race/ethnicity. The study reported on the proportion of Black participants who were obese. [d]This study did not report racial composition of the overall study population; it adjusted for race/ethnicity. The study reported on the proportion of Hispanic participants who were obese. [e]The study did not report mean age or age range. The study sample consisted of high school students ≥13 years. [f]Buffer drawn as a 0.5 km buffer around a line between the child's home and school. [g]OR overweight or obese vs. normal weight. [h]Park presence within half a mile radius of child's home. [i]Racial composition of the sample was not reported for all participants; only the percentage of Black was reported. [j]Overweight vs. normal weight. [k]OR of increasing BMI-z over time. [l]1 km straight line circular buffer surrounding child's residence.

Author, (Year)	Exposure	OR	β	CI	Sample size	Sample Racial Composition[a] %Black	Sample Racial Composition[a] %Hispanic	Mean age in years, (range)	Neighborhood Boundary	Location
Crime										
Miranda, et al. (2012)[43]	High violent crime	1.73[b]		(1.32, 2.26)	1,785	66.2%	11.9%	NR, (2-18)	Other[c]	Durham, NC
Miranda, et al (2012)[43]	High total crime	1.76[b]		(1.34, 2.31)	1,785	66.2%	11.9%	NR, (2-18)	Other[c]	Durham, NC
Lovasi, et al. (2011)[42]	Homicide rate		0.04	(-0.19, 0.26)	428	11%	83%	4.0, (2-5)	Buffer[d]	New York City



NR: Not reported

[a]Studies met inclusion criteria if ≥50% of the study populations was Black or Hispanic, or if the study reported on subgroup analyses by race or evaluated the extent to which study findings regarding the association of a particular neighborhood exposure was associated with child BMI among Black or Hispanic study subpopulations

[b]OR for overweight or obese vs. normal weight

[c]Neighborhoods were measured as primary adjacency communities (PACs), which include the block in which a child resided and adjacent blocks sharing a line segment or vertex

[d]0.5-km buffer around a line between child's home and school

Figure 6. Neighborhood crime forest plot. [a]Studies met inclusion criteria if ≥50% of the study populations were Black or Hispanic, or if the study reported on subgroup analyses by race or evaluated the extent to which a particular neighborhood exposure was associated with child BMI among Black or Hispanic study subpopulations. [b]OR for overweight or obese vs. normal weight. [c]Neighborhoods were measured as PACs, which include the block in which a child resided and adjacent blocks sharing a line segment or vertex. [d]0.5 km buffer around a line between child's home and school. NR, not reported; PAC, primary adjacency community.

the relevant evidence base generalizable to low-income Black and Hispanic children in urban areas is quite low compared with the burden of disease among this population.

Similarly, this review points out the lack of a consistent approach to understanding environmental determinants of obesity risk among these high-risk populations and emphasizes the importance in future research of ensuring that the sample size of Black and Hispanic children in such studies is adequate to detect effects, whether in studies tailored to look at relationships only in these populations or in nationally representative studies where subgroup analyses to assess relationships for these specific groups are examined.

Thus, despite widespread interest in implementing policies to support healthy weight among these high-risk children, there is a need to invest in additional research to inform such policies.[7]

Limitations

There are several potential sources of bias in this review, as well as in the underlying studies. The majority of studies reviewed used cross-sectional analyses that cannot assess temporality, and many did not properly statistically control for the clustering of children in neighborhoods, which can bias results and inflate effect sizes.[8] The interpretation of study results may be limited because most studies relied on school- and clinic-based sampling frames, which may result in a sample of children whose health outcomes or exposures are not fully representative of a given neighborhood.

Additionally, this review demonstrates the variability of neighborhood definitions in this body of research. This variability in measurement of neighborhood exposures using administrative data sources highlights the need for theory-driven research and further efforts within the scientific community to develop, disseminate, and implement a set of recommendations regarding best practices for measuring neighborhood environments for health disparities and childhood obesity research. A recent systematic review of natural experiments and obesity may provide concrete guidance to this field regarding measurement of environmental factors, and it also outlines key methodological considerations for future research examining the association between environmental factors and obesity whether through natural experiments or observational studies.[32]

Our decision to use a select approach to determine study quality brings about certain limitations as well. We chose to use this approach as it is a standardized, organized method of study quality assessment. However, this approach did not allow for a consideration of individual- and neighborhood-level confounders. These confounders could introduce a risk of bias in our studies that is not captured in our study quality categorization.

Given that the true causally-relevant geographic area is unknown, future research should use strategies to reduce the effects of uncertain geographic context problem on inference.[56] Some of the studies included did make attempts to do this, though these findings were not a focus of the review. Future reviews specifically focused on relevant geography for environmental effects among low-income Black and Hispanic children are also needed. Studies included in this review operationalized neighborhood boundaries in multiple ways. For example, one study compared the association between several neighborhood factors and obesity using three different neighborhood boundaries: self-defined, 0.75 mile buffer around participants' home addresses, and census tracts.[55] Other studies used zip code[48] or other municipal boundaries.[47]

Similarly, this review did not examine neighborhood segregation or neighborhood racial/ethnic composition as it relates to obesity risk. There is a growing body of childhood obesity research in this area, and it warrants attention in future reviews. Also, the results of this review may overstate the evidence for statistically significant relationships between neighborhood exposures and obesity risk because studies reporting null results are less likely to be published (publication bias). Yet, the challenges of measuring neighborhood exposures with precision would tend to bias the results of such analyses toward the null, assuming that measurement error is nondifferential. Thus, any significant findings may be suggestive of an even stronger ''true'' association between neighborhood exposures and obesity risk. Given the variability in the research summarized in this review, we did not conduct a formal meta-analysis or funnel plot analysis to assess publication bias, which should be part of future meta-analyses in this area.

Some included studies reported pooled results for children across SES strata and for children of different urbanicity; so the results of these studies may be less generalizable to the low SES Black and Hispanic children who are the focus of this review. This may be particularly problematic for SES, as race and SES are strongly correlated in the United States and Canada. In the case of a study stratified by urbanicity, we presented results for children from an urban area and excluded studies focusing only on rural populations from the review.[35] However, most studies in this review focused on urban populations or aggregated across different urbanicities; so future research should explore whether and how relationships between neighborhood environments and obesity vary in rural, suburban, and urban contexts for low SES Black and Hispanic children. Similarly, relevant studies were excluded if adiposity measures other than BMI-derived measures were used, which may result in missing important information about neighborhood environments and growth patterns among children relevant to childhood obesity risk.

To our knowledge, this is the first study to systematically review the evidence linking neighborhood characteristics to BMI among urban, low SES Black and Hispanic children. While there are limitations to this review, it fills a critical gap in the literature and highlights the need for additional, rigorous research assessing the association between neighborhood characteristics and CVD risk factors for high-risk children from early childhood through adolescents. This includes a need for more longitudinal studies and those that assess possible effects of exposure at critical

times in a child's development, such as in early childhood when lifelong taste preferences, dietary habits, and physical activity patterns are being formed.[57]

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(*Appendix follows* →)

Appendix Table A1. Complete Literature Search Strategy and Search Terms for PubMed

PubMed

("Urban Health"[Mesh] OR "City Planning"[Mesh] OR "Environment Design"[Mesh] OR "Urban Renewal"[Mesh] OR "Cities"[Mesh] OR "urban"[tiab] OR "inner city")

AND

("transit" OR "mixed use" OR "pedestrian" OR "environment design" OR "environmental design" OR "built environment" OR "walkability" OR "walkable" OR "green space" OR "park"[tiab] OR "parks"[tiab] OR "community garden" OR "community gardens" OR "food environment" OR "food security" OR "food desert" OR "fast food" OR "restaurant density" OR "Healthy Food Availability Index"[all] OR "HFAI" OR "nutrition environment measures survey"[all] OR "NEMS" OR "nutrition environment"[all] OR "alcohol outlets" OR "alcohol sales" OR "alcohol availability" OR "taverns" OR "tavern" OR "vehicle ownership" OR "car ownership" OR "automobile ownership"[all] OR "social environment" OR "social context" OR "neighborhood")

AND

("Cardiovascular Diseases"[Mesh] OR "Hyperlipidemias"[Mesh] OR "Diabetes Mellitus, Type 2"[Mesh] OR "Obesity"[Mesh] OR "Exercise"[Mesh] OR "cardiovascular disease" OR "cardiovascular diseases" OR "hyperlipidemias" OR "hyperlipidemia" OR "diabetes mellitus" OR "obesity" OR "obese" OR "exercise" OR "physical activity" OR "fruit" OR "vegetable" OR "vegetables" OR "Healthy eating index" OR "dietary outcome" OR "dietary outcomes" OR "diet" OR "BMI" OR "weight" OR "overweight" OR "prediabetes" OR "Coronary Artery Disease"[Mesh] OR "Myocardial Infarction"[Mesh] OR "coronary artery disease" OR "myocardial infarction" OR "Life Style"[Mesh] OR "Sedentary Lifestyle"[Mesh] OR "Diet"[Mesh] OR "life style" OR "lifestyle" OR "lifestyles" OR "life styles" OR "Hypertension"[Mesh] OR "hypertension" OR "high blood pressure")

AND

("Child"[mh] OR "Infant"[mh] OR "Infant, Newborn"[mh] OR "Adolescent"[mh] OR "Child, Preschool"[mh] OR "child"[tiab] OR "infant"[all] OR "adolescent"[all] OR "children"[all] OR "infants"[all] OR "adolescents"[all] OR "pediatric patient"[all] OR "pediatric patients"[all] OR "adolescence"[all] OR "youth"[all] OR "youths"[all] OR "juvenile"[all] OR "childhood"[all] OR "teenager"[all] OR "teenagers"[all] OR "teen"[all] OR "teens"[all] OR "preschool child"[all] OR "neonate"[all] OR "newborn"[all] OR "baby"[all] OR "pediatric"[tiab] OR "pediatrics"[tiab] OR "paediatric"[tiab] OR "paediatrics"[tiab])

AND

("US"[tw] OR "United States"[tw] OR "America"[tw] OR "american"[tw] OR "U.S."[tw] OR "U. S."[tw] OR "USA"[tw] OR "U.S.A."[tw] OR "U. S. A."[tw] OR "Canada"[mh] OR "Canada"[tw] OR "Canadian"[tw])

Updated search February 23, 2017, limited to 2014–2017/English, 397 results.

Appendix Table A2. Associations between Neighborhood Characteristics and BMI for Black Youth

		BMI study counts				
Neighborhood exposure	**Refs.**	**+**	**0**	**−**	**Mixed**	**Other**
Neighborhood SES						
Neighborhood income	41,48,51,53	0	2	1	1	0
Neighborhood education	53	0	0	1	0	0
Composite SES measure	36,54	0	2	0	0	0
Food environment						
Grocery store/supermarket access	41,48	0	1	0	1	0
Corner/convenience store access	35,41,49	1	2	0	0	0
Fast food access	30,41,48	0	2	0	1	0
Composite food environment	41,48,54,55	0	1	0	2	1
Physical activity environment						
Walkability	51	0	0	1	0	0
Park/playground access	30, 55	0	1	0	1	0
Traffic speed/volume	—					
Vegetation	41,51	0	0	2	0	0
Crime						
Crime	30,43,54	0	2	0	1	0

Mixed results = multiple types of associations between neighborhood exposure and outcome reported. Other = neighborhood factor was included in the final, adjusted model, but the direction of association and significance were not reported.

SES, socioeconomic status.

Appendix Table A3. Associations between Neighborhood Characteristics and BMI for Hispanic Youth

		BMI study counts				
Neighborhood exposure	**Refs.**	**+**	**0**	**–**	**Mixed**	**Other**
Neighborhood SES						
Neighborhood income	42,45,48	0	1	1	1	0
Neighborhood education	—					
Composite SES measure	37	0	1	0	0	0
Food environment						
Grocery store/supermarket access	39,48	0	1	0	1	0
Corner/convenience store access	39,48	2	0	0	0	0
Fast food access	39,47,48	0	1	0	1	1
Composite food environment	48	0	0	0	0	1
Physical activity environment						
Walkability	42	0	1	0	0	0
Park/playground access	42	0	1	0	0	0
Traffic speed/volume	42	0	1	0	0	0
Vegetation	—	0	0	0	0	0
Neighborhood crime						
Crime	42	0	1	0	0	0

Mixed results = multiple types of associations between neighborhood exposure and outcome reported. Other = neighborhood factor was included in the final, adjusted model, but the direction of association and significance was not reported.

Appendix Table A4. Associations between Neighborhood Characteristics and BMI Among Strong-Quality Studies

		BMI study counts				
Neighborhood exposure	**Refs.**	**+**	**0**	**–**	**Mixed**	**Other**
Neighborhood SES						
Neighborhood income	51–53	0	1	2	0	0
Neighborhood education	53	0	0	1	0	0
Composite SES measure	54	0	1	0	0	0
Food environment						
Grocery store/supermarket access	52	0	1	0	0	0
Corner/convenience store access	52	0	1	0	0	0
Fast food access	52	0	1	0	0	0
Composite food environment	54	0	0	0	1	0
Physical activity environment						
Walkability	51	0	0	1	0	0
Park/playground access	—	0	0	0	0	0
Traffic speed/volume	—	0	0	0	0	0
Vegetation	51	0	0	1	0	0
Neighborhood crime						
Crime	54	0	1	0	0	0

Studies were considered strong quality if they had no weak ratings for selection bias, study design, data collection methods, or analyses.

Mixed results = multiple types of associations between neighborhood exposure and outcome reported. Other = neighborhood factor was included in the final, adjusted model, but the direction of association and significance were not reported.

Appendix Table A5. Associations between Neighborhood Characteristics and BMI among Moderate-Quality Studies

		BMI study counts				
Neighborhood exposure	**Refs.**	**+**	**0**	**–**	**Mixed**	**Other**
Neighborhood SES						
Neighborhood income	33,42,45,50	0	1	3	0	0
Neighborhood education	—	0	0	0	0	0
Composite SES measure	34,36,50	0	2	1	0	0
Food environment						
Grocery store/supermarket access	—	0	0	0	0	0
Corner/convenience store access	33	0	1	0	0	0
Fast food access	30,33,47,49	0	1	2	1	0
Composite food environment	34,55	1	1	0	0	0
Physical activity environment						
Walkability	33,42	0	2	0	0	0
Park/playground access	30,42,55	0	2	0	1	0
Traffic speed/volume	42	0	1	0	0	0
Vegetation	–	0	0	0	0	0
Neighborhood crime						
Crime	30,42,43,49	1	2	0	1	0

Studies were considered moderate quality if they had one weak rating on selection bias, study design, data collection methods, and analyses.

Mixed results = multiple types of associations between neighborhood exposure and outcome reported. Other = neighborhood factor was included in the final, adjusted model, but the direction of association and significance were not reported.

Appendix Table A6. Associations between Neighborhood Characteristics and BMI among Weak-Quality Studies

		BMI study counts				
Neighborhood exposure	**Refs.**	**+**	**0**	**–**	**Mixed**	**Other**
Neighborhood SES						
Neighborhood income	38,41,44,46,48	0	1	0	1	3
Neighborhood education	44	0	0	0	1	0
Composite SES measure	37	0	1	0	0	0
Food environment						
Grocery store/supermarket access	35,39,41,48	0	2	0	2	0
Corner/convenience store access	35,39–41,46,48	3	2	0	1	0
Fast food access	39,41,46,48	0	3	0	0	1
Composite food environment	41,48	0	1	0	1	0
Physical activity environment						
Walkability	38	0	0	0	1	0
Park/playground access	38,46	0	1	1	0	0
Traffic speed/volume	38	0	1	0	0	0
Vegetation	41	0	0	1	0	0
Neighborhood crime						
Crime	—	0	0	0	0	0

Studies were considered weak quality if they had two or more weak ratings on selection bias, study design, data collection methods, and analyses.

Mixed results = multiple types of associations between neighborhood exposure and outcome reported. Other = neighborhood factor was included in the final, adjusted model, but the direction of association and significance were not reported.