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Childhood Obesity and the Built Environment: A Review of the Literature from 2008-2009

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Abstract

Purpose of review—Neighborhood factors are increasingly examined for their role in the childhood obesity epidemic. While studies on the impacts of neighborhood factors on adult obesity are relatively common, studies examining these same factors on childhood obesity are far fewer.

Recent findings—Using the Ecological Systems Theory (EST) as a model, we sought to examine the strength of the literature with respect to neighborhood factors as outlined in EST. This includes factors related to the family and the school, which are embedded in larger social contexts of the community and society. These factors are often referred to in the literature as the “built environment” which encompasses the entire range of structural elements in a residential setting including, for example, housing mix, transportation networks, public resources, and presences of sidewalks or trails.

Summary—While progress has been made with respect to the body of evidence supporting the role of neighborhood factors on childhood obesity and obesity related behaviors, much work remains to be done to enhance our understanding of neighborhood level factors. As the body of evidence grows, these studies will inform multi-level interventions which are urgently needed to tackle the growing epidemic of childhood obesity in the US.

Keywords

built environment; neighborhood; diet; physical activity; childhood obesity

Introduction

The Ecological Systems Theory highlights the need to consider the contextual influences on childhood obesity, including family and school, which are embedded in the community and society at large. Figure 1 [1] This is commonly referred to as the built environment, defined as the range of structural elements in a residential setting: housing, roads, walkways, density, transportation networks, shops, parks, and public spaces.[2] We sought to review the strength of the most current evidence with respect to the built environment and childhood obesity, using the Ecological Systems Theory as a guiding framework. These data can inform evidence based multi-level obesity interventions.

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Methods

A search was conducted in PubMed, PsychInfo, Web of Science, and CINAHL using search terms related to the pediatric population, built environment, obesity measures, and obesity related behavior measures such as diet and physical activity. The following combination of terms was found to include relevant articles: (“adolescent or child or children or childhood”) AND (“physical environment” or “built environment” or “population density” or “land use” or “street connectivity” or “neighborhood” or “neighborhood” or “urban design” or “urban sprawl” or “community design” or “urban form”) AND (BMI or “body mass index” or “body-mass index” or adiposity or overweight or “body fat” or “body composition” or “body weight” or “body shape” or “waist circumference” or “skinfold” or “physical activity” or exercise or walking or biking or “fast food” or “food resources” or “supermarket” or “restaurant” or diet).” In order to include only the most recent articles published in English, searches were restricted to January 2008 through August 2009. This yielded 162, 34, 178, and 63 articles in the respective above databases.

Articles were included that 1) provided data on pediatric populations ≥ 18 years of age, 2) measured built environmental variables such as physical structures, walkability, or safety, and 3) had specific outcome measures of childhood obesity or obesity related behavior such as diet or physical activity. Articles were excluded if they described future studies or methodological tools, were not relevant to developed countries, examined only large scale geographic trends, or compared areas solely by urban and rural categories rather than at the individual child level. Articles focused on factors related to the built environment such as socioeconomic status, racial/ethnic demographics, and social environment were considered outside the scope of this review and were therefore excluded. This left 48 recent articles measuring built environmental variables and obesity outcomes in children for analysis.

Diet

Five articles focused on diet.[3-7] The Hackett article was particularly notable for featuring a relatively new method of kernel density estimation. This method was used to translate children's survey responses about their dietary behaviors to mapped areas that featured four types of dietary groups: low positive / low negative, high positive / high negative, low positive / high negative, and high positive / low negative. Positive refers to a list of foods that children are encouraged to eat; negative refers to a list of foods that are discouraged. Low and high cut points were made based on above and below median for the two lists of foods. After the areas were mapped, the authors went to the locations and noted the built environment characteristics. They reported that area with the less desirable eating habits had small streets bounded by busy roads and little open space. There were many food outlets in this area. The area with the more desirable eating habits had more green open spaces and wider streets. There were few food outlets in this area. Also of interest, the Veugelers article found that children in neighborhoods with perceived best access to shops compared to neighborhoods with the worst access to shops reported more consumption of fruit and vegetables, less consumption of dietary fat, a higher diet quality index, and were less likely to be overweight or obese.[6]

Physical Activity

Fifteen articles focused on physical activity, representing the predominant area of focus over the past year with respect to studies assessing environmental factors and childhood obesity related behaviors.[8-22] A primary objective of these studies is to identify neighborhood features, either perceived or objective, that promote physical activity behaviors. These studies were conducted in diverse areas including Europe (England,[14] Portugal, [12,22] and Belgium,[18]) the US (California,[16,19] Ohio,[8] and South Carolina,[9,21]), Canada,[6,11] Asia (Vietnam, [17]) Australia,[20] and New Zealand.[15] Two studies compared 3 distinct

geographic areas in the US, including Boston, Cincinnati and San Diego.[10,13] In a study of rural versus urban areas in England, children who spent more time outside the home were more active, with farmland and grassland use accounting for 40% of moderate to vigorous physical activity bouts in rural areas while gardens and street environments account for 40% of physical activity bouts in urban areas.[14] In California, access to a safe park was associated with regular physical activity for adolescents in urban not rural areas, though this relationship differed by socio-demographic factors, housing type and neighborhood characteristics.[19] In Canada, children in neighborhoods with best access to parks, playgrounds, and recreational facilities engaged in more sports with a coach and had less screen time.[6]

Gender differences have been assessed in a number of studies.[9,12,17,20-22] Seeing others exercising,[12] residing on a cul de sac compared with a through road, and presence of traffic calming measures e.g., speed bumps,[20] have been associated with increased physical activity in boys, while automobile transportation to school, length of annual school sports meetings, availability of game shops near the home and time spent playing video games were associated with boys' physical inactivity.[17] In girls, perceived availability of free or low cost recreational facilities available in the neighborhood was associated with increased physical activity,[12] and similarly, perceived accessibility to facilities, aesthetics, presence of walking and cycling infrastructure, and street connectivity have also been associated with girls' physical activity specifically in non-organized activities.[22] Objective measures assessed include number of commercial physical activity facilities and the number of parks within a 0.75 mile buffer around a girl's home address which were associated with reported vigorous physical activity and total metabolic equivalents (METs) (for white adolescent girls only) respectively. [21]

Two studies have specifically assessed the impact of changes to the physical environment on physical activity levels.[8,16] These studies have important implications with respect to specific physical features that promote increased activity. Ideally, incorporation of evaluation measures of specific design features is needed early on in the design phase of recreational facilities and sports fields. The first study demonstrated low utilization of all playgrounds despite renovation. Furthermore, results were mixed with increased vigorous physical activity in overall children and boys at renovated playgrounds. There was an unexpected increase in moderate activity in girls at unrenovated playgrounds.[8] The second study, however, of two California parks that underwent field renovations, demonstrated a 4 fold increase in the average number of visitors per observation including children and adults of both genders and a significant increase in sedentary, moderately active and vigorously active visitors to the intervention park playfields as compared to a control park.[16] Of note, only the park with additional programming changes saw a statistically significant increase in female teen presence highlighting the complex relationship between individual characteristics and park use.

Active Commuting

Eight articles examined factors that determine active commuting to and from school.[23-30] Active commuting is a particularly interesting area within the built environment and children's health literature because it highlights the multi-layered nature of the key components of the research: city planning (e.g. street connectivity, traffic calming), parents' attitudes and behaviors (e.g. parents' own walking/biking behaviors, parents' perception of safety for children), and children's characteristics and perceptions. The eight studies were conducted with data from seven different locations in the US, UK, Ireland, and Australia. Each study highlighted a specific association (seven of the eight studies were cross-sectional) such as street connectedness near schools was associated with biking or walking to school,[24] children who had many friends in their area were more than twice as likely to increase their active commuting compared to other children,[25] distance between home and school was the most important

factor,[26] boys are more likely to actively commute than girls,[24,26] population density is associated with higher likelihood of walking to school[McDonald], and children with parents with safety concerns were less likely to actively commute.[27] McDonald suggests the policy approach of locating schools close to students (or community schools), as an application of her findings.

Two studies assessed active commuting and physical activity levels.[10,13] The first study found that total neighborhood environment, recreation facilities, walking and cycling facilities, and land use mix-access had the most consistent relationships with active commuting to different locations and recreational physical activity.[10] Similarly, the second study looked at twelve types of park facilities (e.g. swimming pool, playground) and found that active commuting to some facilities was associated with being active in those facilities in both children and adolescents. Traffic safety, pedestrian infrastructure, and lower crime threat increased likelihood of active commuting to facilities by adolescents.[13]

Neighborhood Walkability

Seven studies examined neighborhood walkability and obesity as measured by body mass index or BMI.[31-37] Factors used to determine walkability varied by study but included structural components (e.g. street connectivity, sidewalks), road safety, aesthetics (e.g. land use mix, greenness) and residential density. One study found a negative relationship between childhood overweight/obesity and overall walkability.[35] Overall, most individual walkability variables did not have associations with childhood obesity. However, associations in the expected direction were found for intersection density and girls BMI,[35] living in a neighborhood built after 1969 (a marker of decreased walkability),[33] and overall neighborhood greenness.[31]

Obesity

Fifteen articles used childhood obesity as the primary outcome measure.[6,31-44] Six studies measured distances from home or school and/or density of food sources (e.g. convenience stores, supermarkets), physical activity resources (e.g. parks, playgrounds), and facilitators of active commuting (e.g. sidewalks, subway stations, home to school distance).[33,36,37,40, 42,44] Though these studies have the advantage of objective data, they can only estimate access as they do not measure individual behaviors. Most variables demonstrated no significant association, however, associations in the anticipated direction were found between distance to fast food restaurants in high and low income populations and density of fast food restaurants in low income populations only,[36] presence and density of convenience stores,[33,42] distance to playgrounds,[44] and density of subway stations.[37] Three studies used “perceived access” to examine comparable variables.[6,34,43] In children, negative associations with childhood overweight status were found between perceived access to gardens, playgrounds, parks, and shops.[6,43] Perceived access to recreational facilities was associated with less obesity/overweight in children and adolescents.[6,34,36]

Neighborhood Safety

Neighborhood safety is a unique factor because it can be considered within both the built and social environment. Studies have examined the relationship between both perceived safety (including personal, crime, and road) and objective measures of crime rates and/or physical disorder and childhood obesity outcomes.

There were eight articles examining the relationship between neighborhood safety and physical activity.[6,10,45-50] Four articles found evidence that perceived safety was related to some forms of physical activity including time spent playing outdoors in 10-12 year olds,[50] being active in the street in 5-11 year olds,[10] walking to shops in 5-18 year olds,[10], use of indoor

exercise equipment in 11-15 year old girls,[48] and playing sports without a coach.[6] Another article found no relationship between any measure of safety and moderate to vigorous physical activity (MVPA) by accelerometer in 8-9 year olds, but did find road safety and personal safety to be associated with MVPA in 13-15 year old girls and boys respectively.[47] Interestingly, the largest study found that parent's perception of neighborhood safety was positively associated with physical activity in 5-6 year olds and that any effect of neighborhood quality (e.g. litter, perceived crime) on physical activity was mediated by perception of safety.[45] This finding may partially explain the lack of association between physical activity and any particular neighborhood hazard (e.g. crime, litter, gangs) in inner city 10-14 year olds in another study.[49] Only one study examined local crime rates, finding that some types of crimes are associated with increased sedentary behavior in 4th graders.[46]

Eight studies investigated the relationship between neighborhood safety and BMI.[32-34, 37-39,41,43] Studies examining neighborhood conditions or physical disorder produced differing results with two finding associations using perceived measures (one positive one negative),[33,43] and one finding no association by objective measure.[32] No associations were found for crime rates [33,37] or neighborhood deprivation.[43] Three studies showed associations with parent perception of safety and healthy weight of a fifth grade population, [32] in school age girls,[38] and children 11 and older,[39] and one study found no association. [6] The Cecil-Karb study is of interest because it examines longitudinal data. Additionally, this study found that adding TV viewing to the model negated the association between neighborhood safety and obesity suggesting sedentary behavior as a possible mediator of this relationship. Two studies looked at safety as perceived by adolescents,[41,34] one finding a negative association in the "other" race group which included non-Hispanic bi- or multi-racial students, Asians, American Indians, and other racial groups.[41]

The Ecological Systems Theory Model

As outlined above, many features of the EST have been examined in the built environment literature over the past year. Community level factors featured prominently, specifically, accessibility of recreational facilities (included in 22 studies), crime rates and neighborhood safety (17 studies), accessibility of convenience foods and restaurants (11 studies), and school lunch programs (1 study). Community level factors not specifically detailed in the EST model which were included in this review include features that promote active commuting (8 studies) and neighborhood walkability (6 studies). General parenting styles and family characteristics was the second major area of the EST model featured, defined as parent encouragement of child activity (2 studies), parent's own activity patterns (1 study), parent food preferences (1 study), and child feeding practices (2 studies).

Several studies combined multiple features across the EST model as well as multiple outcomes (diet, physical activity and BMI), and this represents an important area of future research. Given the complex nature of the etiology of obesity and obesity related behaviors, it is not surprising that findings varied across studies by individual and community level characteristics. However, these studies suggest that there are sufficient data to support the incorporation of the EST model in future childhood obesity studies. Interdisciplinary/multidisciplinary work is critical for the success of these studies and may involve epidemiologists, pediatric health care providers, behavioral psychologists, nutritionists, public health officials, urban planners, city planning, parks departments, landscape architects, departments of transportation, local food stores and physical activity programs, schools, community boards, community organizations, and neighborhood residents. Collaborative efforts with interdisciplinary groups are ideally initiated early on in the design phase of the studies through interpretation of the results and ultimately dissemination of study findings.

Conclusion

Novel research examining the built environment and childhood obesity continues to build with the bulk of the evidence examining physical activity, active commuting, and obesity outcomes. Fewer studies have examined the impact of the built environment on children's dietary behaviors. Further studies are needed in diverse populations that vary by key socio-demographics including gender, race/ethnicity, income, while combining individual level dietary and physical activity behaviors, as well as subjective and objective measures of neighborhood level factors across urban, suburban and rural areas. These studies can inform multi-level obesity interventions targeting the epidemic of childhood obesity and support policy changes that promote healthy communities in the United States and across the globe.

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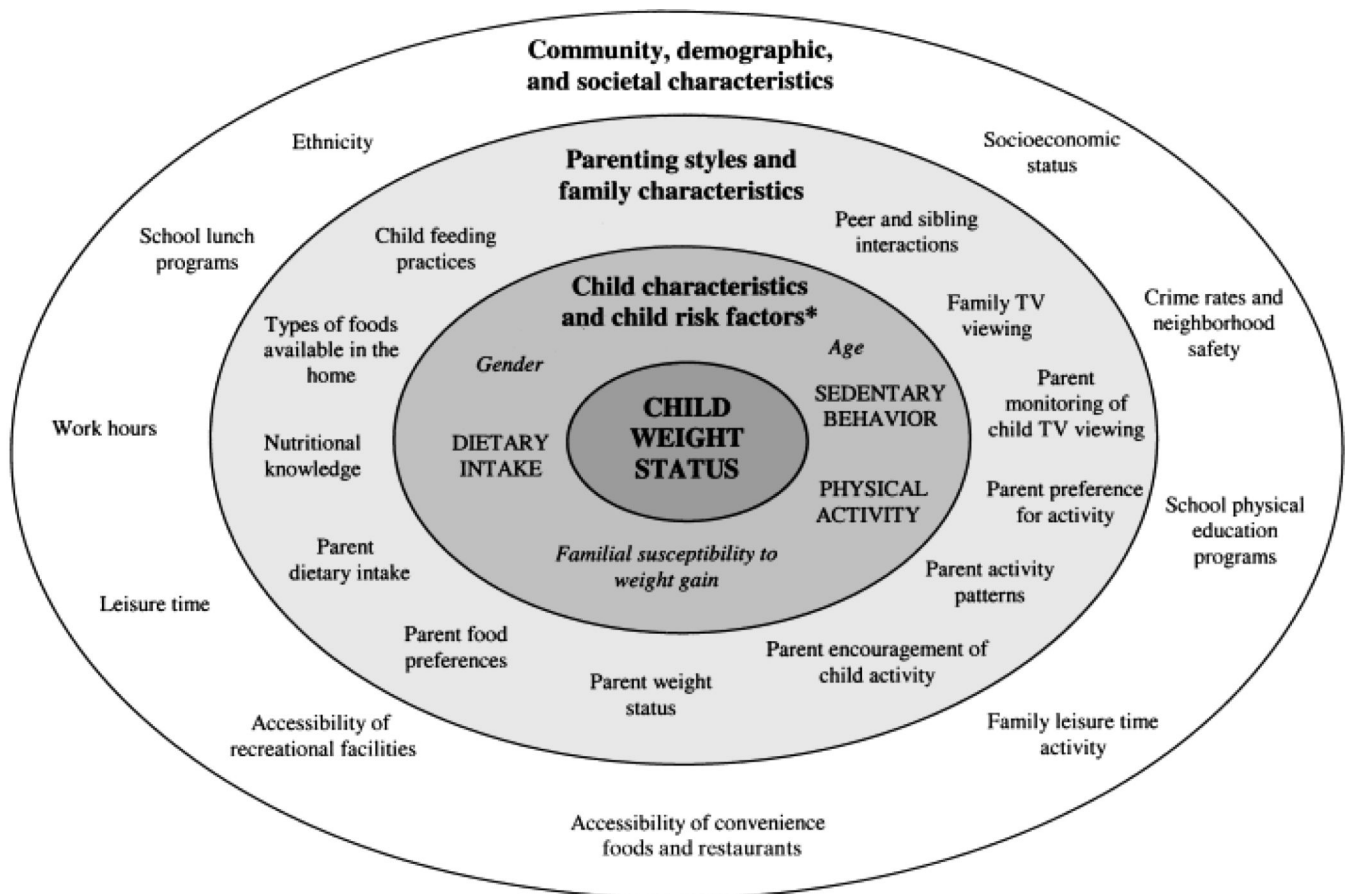
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Figure 1.
Ecological Systems Theory [1]