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Obesity and the Built Environment

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Biological, psychological, behavioral, and social factors are unable to fully explain or curtail the obesity epidemic. The goal of this paper is to provide a review of research on the influence of the built environment on obesity. Studies were evaluated with regard to their methods of assessing the environment and obesity, as well as to their effects. Methods used to investigate the relationships between the built environment and obesity were found to be dissimilar across studies and varied from indirect to direct. Levels of assessment between and within studies varied from entire counties down to the individual level. Despite this, obesity was linked with area of residence, resources, television, walkability, land use, sprawl, and level of deprivation, showing promise for research utilizing more consistent assessment methods. Recommendations were made to use more direct methods of assessing the environment which would include specific targeting of instituitions thought to vary widely in relation to area characteristics and have a more influential effect on obesity-related behaviors. Interventions should be developed from the individual to the neighborhood level, specifically focusing on the effects of eliminating barriers and making neighborhood level improvements that would facilitate the elimination of obesogenic environments.

Many investigators have attempted to explain the obesity epidemic, yet no single theory has sufficiently explained all of the factors contributing to overweight and obesity. For instance, while genes may increase susceptibility for obesity, no dominant genes have been discovered whose presence is necessary or sufficient to cause obesity (1). Despite the emphasis on understanding and intervening on individual characteristics that influence dietary and physical activity patterns (2-4), little progress has been made in stemming the obesity epidemic. As a result, researchers also have begun to focus on the interaction between environmental factors and the development of overweight and obesity. The purpose of this article is to provide an overview of the current research assessing the relationship between the built environment and obesity.

Influence of the Built Environment on Obesity

The built environment includes urban design factors, land use, and available public transportation of an area, as well as the available activity options for people within that space (5). The built environment can both facilitate and hinder physical activity and healthy eating (6-7). For example, areas with few recreational facilities, safety concerns, uneven and hilly terrain, and insufficient lighting can hinder physical activity (8). Many areas in the U.S. are designed specifically for vehicles with no concessions for pedestrians (6) and zoning restrictions often lead to land use where specific distinctions exist between commercial and residential properties (i.e., low land use mix) (5). In contrast, areas with high connectivity, i.e., the directness or connectedness of travel in a neighborhood with multiple pedestrian access points, result in greater walking and bicycling for transportation (8). An increasingly high density of fast food restaurants, convenience stores, bars, food distribution programs with high fat foods, and concentrated media marketing, all promoting unhealthy food choices, hinder good nutrition (9).

Neighborhood Influences

Neighborhoods are commonly defined by census boundaries (i.e., block groups or tracts) and have been linked to residents' health outcomes (10). Census tracts include approximately 4,000 people, and boundaries are delineated to include a comparatively homogenous population (11). Census data are aggregated to represent the exposure to neighborhood environments that may independently affect human behavior, unique from measures of individual attributes (e.g., individual income) (10). Thus, physical environments can influence the health of individuals above and beyond that of individual health risk factors (12).

For example, safer neighborhoods, which include a mixture of houses, commercial, retail, and recreation destinations, often result in greater physical activity and social capital, and less overweight and obesity (8, 13). Along with various available neighborhood destinations, pedestrian facilities and public transportation help facilitate walking and bicycling for transportation (8).

Neighborhoods with low socioeconomic status (SES) usually have fewer physical activity resources than medium to high SES neighborhoods, leading to greater inactivity of neighborhood residents (3, 6). In low SES neighborhoods, many incivilities (e.g., physical decay, litter, graffiti) and unsafe conditions are commonplace, leading to unappealing and even dangerous neighborhood environments (14). However, high levels of walking behavior are reported in low SES neighborhoods, likely due to high population density, walking to work, and a greater reliance on public transportation (3).

Neighborhoods with a greater number of available physical activity resources, including streets and sidewalks, have residents who report higher activity levels (2). The proximity of these resources is important, because people are more likely to use nearby resources (8). Making neighborhoods more walkable (i.e., pedestrian oriented design and land use) might help to improve physical activity. However, previous walkability studies (e.g., 13) have used self-report of neighborhood environment variables instead of direct, objective measurements.

Research on Obesity and the Built Environment

In the emerging field of investigating “obesogenic” environments, a range of assessment methods have been employed, with few studies using similar methods. Methods for assessing the built environment or neighborhoods level include direct assessments (e.g., in-person audits by trained observers), intermediate measures (e.g., use of telephone book yellow pages or marketing databases to identify institutions), and indirect measures (e.g., aggregation of census data to approximate neighborhood SES). Figure 1 illustrates the continuum of methods used to assess environmental factors in the current research.

Insert Figure 1 here

Studies reviewed in this article investigated the relationship between characteristics of the built environment and obesity. The studies were evaluated according to their attempts to define the obesogenic environment through aspects of community design, the prevalence of food stores, and neighborhood and material deprivation. Table 1 outlines the purposes of the studies and categorizes them by the type of environmental assessment method (i.e., indirect, intermediate, indirect) that was utilized to define individual and environmental variables, as well as summarizing the limitations of the studies.

Insert Table 1 here

The primary question facing researchers investigating the built environment and obesity is whether or not community design factors may prevent individuals from engaging in physical activity (15) while encouraging them to select and eat more energy dense and low nutrient value foods, thus contributing to the obesity epidemic. Giles-Corti and associates (7) included both indirect and intermediate environmental measures in their study and found that overweight, yet healthy and working Australian adults were more likely to live near highways. In addition, both overweight and obese adults were more likely to live in neighborhoods that lacked adequate sidewalks and proximal places for physical activity. In fact, participants with poor access to recreational facilities had a 68% greater chance of being obese. Interestingly, residents without access to a motor vehicle were twice as likely to be obese than residents who always had access to a motor vehicle. Finally, participants who watched ≥ three hours of TV per day almost doubled their odds of being overweight and were likely to be obese when compared to non-TV watchers. Although the self-reported sedentary activity of TV watching and the lack of proximal places for physical activity were associated with greater levels of overweight and obesity, this study did not find that the SES of healthy and working neighborhoods was related to overweight and obesity (7).

The density and land use mix (i.e., types of zoning) of areas also has been found to impact obesity risk. Saelens and associates (8) first identified residents of high-walkable (single and multiple family residences) and low-walkable (single-family residences) neighborhoods with comparable SES using census data. They compared neighborhood residents on physical activity measurements, weight status, and self-reported neighborhood perceptions. Residents then directly recorded their own physical activity using accelerometers. Results indicated that residents from high-walkability neighborhoods lived in neighborhoods more conducive to physical activity (i.e., higher residential density and street connectivity, more diverse and accessible land use, better aesthetics and pedestrian safety) than did residents from low-walkability neighborhoods. Accordingly, residents of low-walkability neighborhoods tended to report higher average BMIs and have higher rates of overweight than high-walkability neighborhood residents. In addition, residents in the high-walkability neighborhood walked significantly more (e.g., a difference of 63 minutes per week of moderate to vigorous physical activity) than residents in the low-walkability neighborhood (8).

Frank and associates (16) investigated the impact of community design and physical activity on obesity in Atlanta using both indirect and intermediate environmental data sources. Neighborhoods were designated as connected or disconnected (i.e., high- or low-walkability) using land use mix data from the county tax assessor and the 2000 census within a GIS framework. Participant data within each neighborhood were drawn from a transportation and air quality survey, which measured individual level factors. After adjusting for the effects of age, income, and level of education, a significant relationship was found between land use mix and the prevalence of obesity, although this relationship was mediated by physical activity (i.e., distance walked over a two-day time period). For instance, researchers found that a single quartile increase in land use mix was related to a 12.2% reduction (OR = 0.878; 95% CI = 0.839 – 0.919) in the probability of being obese.

Ewing and colleagues (15) used only indirect environmental assessment methods when they investigated the relationship between sprawl (i.e., low-housing density, low land-use mix, no strong centers of activity, poor connectivity) and physical activity level and prevalence of obesity. Self-reports of behavioral and health-status questions from the BRFSS (Behavioral Risk Factor Surveillance System) and the Smart Growth America's metropolitan sprawl index, adapted to the county level, indicated that residents of sprawling counties walked less, had higher BMIs, and higher obesity and hypertension prevalence than residents of more compact counties.

County-level analyses controlling for minutes walked indicated that sprawl seemed to have a linear relationship to BMI and obesity (i.e., more sprawl = higher BMIs and obesity rates) and an indirect relationship with minutes walked. When the same outcomes were measured at the metropolitan level, no significant relationship was found between obesity and the sprawl index. The authors reported that the county level analysis was more representative of daily lifestyles of residents rather than the metropolitan level, which consists of multiple counties with varying built environments. Although this study viewed the environment at the county and metropolitan levels and examined its relationship to physical activity and health, further research should examine the same information at the community or neighborhood level to specifically define the living and working environments of individuals.

Another aspect of community design is the role of access to areas promoting physical activity, such as walking and bicycling trails, parks, and playgrounds. Burdette and Whitaker (17) used both intermediate and indirect environmental assessments when they investigated the effects of community design for children. They hypothesized that overweight children would be less proximal to playgrounds, closer to fast food restaurants, and have lower neighborhood safety than non-overweight children. BMI was determined from measured weights and heights while intermediate measurement methods were used to identify playgrounds (i.e., database of playground addresses) and fast food restaurants (i.e., yellow pages). Neighborhood safety was determined by police records of serious crimes and emergency phone calls for each neighborhood. Children's home addresses, the playgrounds, and the fast food restaurants were mapped using GIS, and spatial distances were calculated. Not all children had access to either a playground or a fast food restaurant in their neighborhood. Contrary to findings in the adult literature, Burdette and Whitaker (17) found no relationship between overall neighborhood safety, playground and fast food restaurant proximity and overweight status. Children with higher poverty levels also did not differ by weight status as related to neighborhood safety or to the proximity of the neighborhoods to playgrounds and fast food restaurants.

Ellaway and associates (18) used only indirect environmental measures to examine the relationship between neighborhood material deprivation and resident body mass and obesity risk, independent of other individual factors (i.e., demographics, social factors). Face-to face interviews were conducted in four different SES neighborhoods, and participants were weighed and measured to gain actual weights and body sizes. Participants in lower social classes had a higher overweight prevalence than participants in higher social classes. Similarly, the most deprived areas (i.e., lower income, less housing tenure, less car ownership) had twice the proportion of obese residents as compared to the more affluent areas. Further, independent of other factors, neighborhood of residence was associated with BMI, waist circumference, and waist-hip ratio, indicating that it can influence body size and shape. Similarly, a study by van Lenthe and Mackenbach (19) also used indirect measurements with data from a self-report questionnaire of residents in 84 different neighborhoods (i.e., administrative units) in The Netherlands. Increasing levels of neighborhood deprivation (i.e., educational level, occupational level, and employment status) were associated with increasing mean BMIs and overweight prevalence, although neighborhood deprivation had a stronger relationship for women and older individuals who were overweight when compared to men and younger individuals.

Cubbin and associates (11), using indirect environmental assessments, investigated the relationship between neighborhood material deprivation (i.e., Townsend deprivation index measured by using unemployment, no car ownership, renter occupied housing, and overcrowding) and the frequency of cardiovascular disease (CVD) risk behaviors (i.e., physical inactivity, higher BMI) among US adults (ages 25-64) who completed the Third National Health and Nutrition Examination Survey (NHANES III). Both household interviews and on-site medical examinations were utilized in NHANES III to collect individual level outcome data. The individual data was linked with Census neighborhood data to examine differences between ethnicities, while controlling for individual SES. A one-unit increase in the neighborhood deprivation index was associated with an 18% increase in physical inactivity for White men, a 12% increase in physical inactivity for White women, and a 10% increase in physical inactivity for African American and Mexican-American men. After controlling for individual education and income, African American women were disproportionately at a higher risk for CVD including presence of higher BMIs when living in neighborhoods of more material deprivation. Overall, residing in a deprived area or neighborhood was associated with a higher probability of having an adverse CVD risk profile. While the risk profile varied by ethnic group and gender, neighborhood deprivation consistently exerted an independent effect on CHD risk factors, even after adjusting for individual SES (11).

Similar results have been demonstrated using adolescent and child populations. Kinra and associates (20) utilized indirect environmental methods to study the relationship between neighborhood deprivation (i.e., using four Census variables) and the measured heights and weights of 20,973 children between the ages of 5 and 14 years in the UK. Children's weights and heights were directly assessed, but the built environment was estimated by using an census index of material deprivation (i.e., unemployment, overcrowding, owner occupation, and car ownership). Results demonstrated that children who lived in more deprived areas had rates of obesity 2.5 times greater than the national rate of obesity in the UK, showing a linear association between obesity and neighborhood material deprivation.

Applications and Limitations of the Current Literature

As evidenced by the reviewed studies, there is promising data linking neighborhood of residence and obesity risk. However, a variety of methods have been used to assess the obesity-related outcomes and the built environment. More consistent methods still need to be developed and applied in the field.

Measurement of Obesity Prevalence

Many studies used self-reported height and weight to calculate BMI to determine obesity prevalence (see 7, 13, 15-16, 19). This is problematic because people tend to underreport their weight, leading to inaccurate BMI estimates and likely underestimation of obesity prevalence and risk, particularly among lower SES groups (19). Subsequently, this results in an underestimation of the actual extent of overweight and obesity. Obviously, it is better to directly measure the height and weight of study participants (17-18), although body composition and body shape measurements also should be incorporated into research studies when practical (18).

Measurement of the Built Environment

Studies investigating the built environment and its relationship with obesity typically did not directly measure the environment. Instead, indirect measures of the environment were used to represent it, such as Census data (10, 16, 20-21), GIS (Geographic Information Systems) data (e.g., road network distance, steep hill barrier, grid of city blocks) (7, 16), and street network data (16). Although these methods can approximate conditions of the built environment, they may not be as accurate as direct measurements, as database information often is dated and might not correctly reflect conditions at the time of the study. Other studies using indirect methods have created indices such as material deprivation, neighborhood deprivation, neighborhood safety (6, 17, 19-20) to distinguish between neighborhood SES levels, thereby reflecting the conditions of the people who live in the neighborhoods and not the built environment itself.

Intermediate measures of the built environment have included self-reported perceptions of neighborhood residents (7, 12-13, 19). As Kirtland and associates (22) point out, this is problematic because only fair to low agreement has been demonstrated between self-reports of neighborhood and community environments and objective environmental audits. It is possible that neighborhood residents are unable to correctly perceive distances (i.e., which items lie within neighborhood boundaries) and have a perception bias that leads them to judge their environments based on their own expectations and lifestyles. Neighborhood residents also might have a different definition than the researchers of what makes up their “neighborhood.”

Other intermediate measurements of the built environment that have been used are regional land use data from tax assessors and aerial photography (16). While these measurements can approximate the built environment, tax data is self-reported by individuals and aerial photography cannot show actual uses of buildings. Various databases (e.g., departments of environmental health, state departments of agriculture, phone book, yellow pages online, police websites, school district lists) also have been used to track specific entities (e.g., places where people can buy food, public playgrounds, fast food restaurants) that are available within certain areas (17, 21). The limitation of these studies, however, is that they did not audit the actual site of the entities reported within the built environment; therefore, they made assumptions of availability within the environment without actually verifying the accuracy of these data sources.

Direct measurement through environmental audits has only been used in one study with obesity as the primary outcome (7). Measurements included the type of street and the presence of sidewalks for each study participant. Although these measures specifically verified what was in the physical environment, they were not sophisticated enough to adequately capture enough characteristics of the built environment to account for all environmental factors that have influenced obesity, such as the types and frequency of different institutions available in the areas.

Mechanisms for how the Built Environment Influences Obesity Risk

The reviewed studies typically demonstrated a cross-sectional association between indirect indices of neighborhood context and obesity risk. However, it also is important to incorporate assessments of institutions that may vary across environments and impact obesity risk. For example, food store density and location may vary in high vs. low SES neighborhoods, contributing to the availability of food options for individuals and helping to explain the differences in obesity risk based on level of neighborhood deprivation. Morland and associates (21) used both indirect and intermediate measurement data sources to investigate the the relationship between prevalence of food stores (e.g., supermarkets, corner stores, convenience stores) and restaurants and neighborhood SES, with a secondary analysis of differences between racially segregated neighborhoods. Information from the 1990 census (i.e., indirect measurement) was used to approximate neighborhood SES and individual level variables while the addresses of food stores were collected from local health departments and state agriculture departments (i.e., intermediate measurement). Each type of food store or food service was classified according to the 1997 North America Industrial Classification System (NA-ICS).

Morland et al. (21) found three times as many supermarkets (e.g., defined as having the healthiest food options compared with other food stores existed in the wealthier neighborhoods, though more convenience stores, small grocery stores, and specialty food stores were in the lower wealth neighborhoods. Further, fast food restaurants were more prevalent in the lower and medium wealth neighborhoods than in the higher wealth neighborhoods. For comparisons by race, results indicated that more Black residents lived in lower SES neighborhoods than did White residents, and four times as many supermarkets were located in White neighborhoods than in Black neighborhoods (21). In fact, the ratio of supermarkets for predominantly White neighborhoods was 1:3,816 per resident, while the ratio of supermarkets for predominantly Black neighborhoods was only 1:23,582 per resident. Unfortunately, they did not collect data on obesity risk, so they were unable to demonstrate a relationship between the differences in the socioeconomic distribution of food sources and obesity risk and SES stratification.

Future Directions

The current review provides sufficient evidence to support the need for further research into the “obesogenic” environment. Implications for the interaction between public health and community design have been established in this growing field of research. As defined previously, the built environment includes the design, land use, and available public transportation of an area, as well as the available activity options for people within that space (5). As these areas are defined more explicitly through research, interventions can be tailored to encompass each aspect from a neighborhood and individual perspective.

Before the merger of public health research and community planning can be successful, further investigations need to be developed for effective changes to be made within neighborhoods. Future research should strive to strictly define an individual's neighborhood based on both objective and perceived measures of the neighborhoods. By doing so, research can provide a strong foundation for understanding the interaction between individuals and their environment. As noted in the limitations section of this paper, much of the current research has used indirect or intermediate methods for investigating neighborhood features. Although direct methods may be more time consuming and costly, they are necessary as they provide the most accurate and consistent descriptions of the neighborhood environment.

Concurrent with the research, resulting interventions should target factors at both the community level and the individual level with a focus on barriers to healthy behaviors of residents in the neighborhoods. From a neighborhood perspective, city planners and public health officials must work together to promote agendas at a public policy level for changes in the built environment to occur. At an individual level, health care professionals are encouraged to evaluate the barriers their clients face within their neighborhoods which prevent them from pursuing adequate physical activity and healthy food options, thus leading to declines in health (6). Further, as suggested by Saelens and colleagues, the design of neighborhoods should focus on preventing material deprivation and improving the walkability conditions of the neighborhoods as a means for increasing physical activity (8).

The sum of the results of the research presented in our review clearly demonstrate strong preliminary evidence of a relationship between built environment features and the prevalence of obesity, primarily in lower SES neighborhoods which may have less access to recreational facilities, food stores with healthy, affordable options, and may have neighborhoods designed around humans rather than automobiles. This information is very important in the efforts of researchers to impact public policy decisions about the built environment that affect communities and health outcomes.

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Figure 1. Continuum of Methods for Measuring the Built Environment

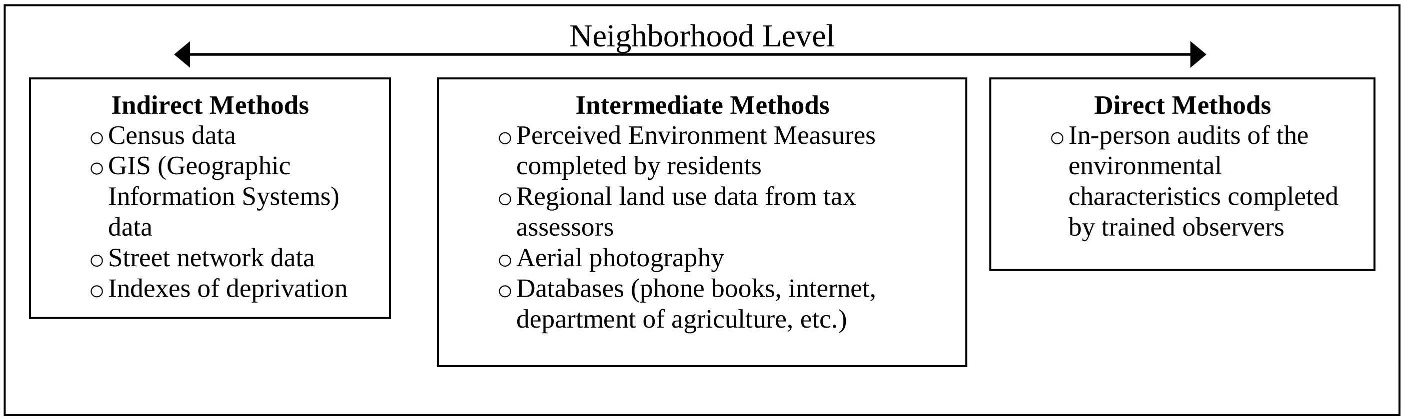

Table 1. Review of Studies where the Built Environment was Investigated in Relationship to BMI.

Article	Purpose	Outcomes	Environmental Assessment Methods		Findings	Limitations
			Type of Measurement	**Category**		
(17) Burdette HL & Whitaker RC. Neighborhood playgrounds, fast food restaurants, and crime: Relationships to overweight in low-income preschool children. *Prev Med.* 2004; 38:57-63.	*Examined the relationship between overweight in preschool children and 3 factors: the proximity of the children's residences to playgrounds, to fast food restaurants and the safety of the neighborhoods*	○ Height – real height obtained ○ Weight – real weight obtained ○ BMI ○ Demographics – WIC database	○ Prevalence of playgrounds - Health Department database ○ Identification of fast food restaurants - Yellow pages from the phone book and internet ○ Crime data from the Police Departments website ○ GIS used to analyze the spatial relationships	Intermediate	○ No relationship between overweight or non-overweight low income children and distance to playgrounds or fast food restaurants and level of safety.	○ Lack of variation in the environmental exposure variables ○ Categorized exposures at a neighborhood level ○ Limited mobility of the study population—no idea how long they had lived at address
(11) Cubbin C, Hadden WC, & Winkleby MA. Neighborhood context and cardiovascular disease risk factors: The contribution of material deprivation. *Ethn Dis.* 2001; 11:687-700.	*Examined the relationship btw neighborhood material deprivation and CVD risk factors as independent of SES in minority participants.*	○ Physical inactivity – NHANES III§ ○ Type II diabetes– NHANES III ○ Smoking status– NHANES III ○ BMI ○ Systolic Blood pressure– NHANES III – blood tests ○ Cholesterol (Non-HDL-C)– NHANES III – blood tests ○ Age, education, income– NHANES III	○ Townsend material deprivation index derived from the 1990 Census - occupation status - car ownership - renter occupied housing - overcrowding	Indirect	○ African American women with highest BMI in materially deprived neighborhoods ○ Other CVD factors found among different ethnic groups	○ Self-report ○ Cross-sectional ○ Neighborhood effects possibly due to self-selection ○ No information of length of residency

Article	Purpose	Outcomes	Environmental Assessment Methods		Findings	Limitations
			Type of Measurement	Category		
(18) Ellaway A, Anderson A, & Macintyre S. Does area of residence affect body size and shape? *Int J Obes Relat Metab Disord.* 1997; 21:304-308.	*Examined if neighborhood is associated with body size and shape*	○ Height – real height obtained ○ Weight – real weight obtained ○ BMI ○ Waist circumference – real circumference obtained ○ Waist-hip ratio ○ Social class – self-report of occupation	○ Neighborhood material deprivation index – self-report of housing tenure, car ownership, and income	Indirect	○ Lower social class had higher BMIs ○ Participants in the most deprived areas had higher BMIs, larger waists, and higher waist-to-hip ratios than participants from the non-deprived areas. ○ Neighborhood of residence associated with BMI and other physical factors	○ No measure of the built environment
(15) Ewing R, Schmid T, Killingsworth R, Zlot A, & Raudenbush S. Relationship between urban sprawl and physical activity, obesity, and morbidity. *Am J Health Promot.* 2003; 18:47-57.	*Examined the relationship between urban sprawl, health, and health-related behaviors.*	○ Physical Activity Outcomes including leisure time physical activity – BRFSS* ○ Weight-related Outcomes (BMI, obesity) – BRFSS ○ Morbidity Outcomes (hypertension, diabetes, coronary heart disease) – BRFSS	○ Smart Growth America's metropolitan sprawl index - residential density - land use mix - degree of centering - street accessibility ○ County sprawl index (based on U.S. Census data and data from the Natural Resources Inventory of the U.S. Dept. of Agriculture) - low residential density - poor street accessibility	Indirect	Individuals in sprawling counties: ○ Weighed more ○ Exercised less ○ Had hypertension	○ Completed at a county level rather than neighborhood level ○ Cross-sectional, cannot suggest causal relationship ○ Characterization of physical activity ○ Other sprawl indices not measured ○ Did not examine caloric intake ○ BRFSS is self-report

Article	Purpose	Outcomes	Environmental Assessment Methods		Findings	Limitations
			Type of Measurement	Category		
(16) Frank LD, Andresen MA, & Schmid TL. Obesity relationships with community design, physical activity, and time spent in cars. *Am J Prev Med*. 2004; *27*:87-96.	*Examined the relationship between the built environment and travel patterns and compared with BMI, and obesity.*	SMARTRAQ study¤ ○ Height – self-report ○ Weight – self-report ○ BMI ○ Demographics	SMARTRAQ study ○ Sociodemographic variables – self-report ○ Minutes spent in car ○ Km walked ○ Built Environment with GIS = - County level tax assessor's data - Digital aerial photography - Street network map - Census data	Intermediate Mix of intermediate and indirect	○ Obesity associated with land use mix as mediated by physical activity and distance walked	○ Participation bias ○ Self-reported BMI ○ Limited range of urban form ○ No account of time in transit use ○ Cross-sectional, cannot suggest causal relationship
(7) Giles-Corti B, Macintyre S, Clarkson JP, Pikora T, & Donovan RJ. Environmental and lifestyle factors associated with overweight and obesity in Perth, Australia. *American Journal of Health Promotion*. 2003; 18:93-102.	*Examined the relationship between environmental and lifestyle factors and overweight and obesity.*	○ BMI – self-reported weight and height	○ Demographics – self-report ○ Lifestyle factors – self-report ○ Recreational physical activity – self-report ○ Social environmental factors – self-report ○ Perception of sidewalks – self-report ○ Physical environmental factors - GIS surveying of neighborhoods	Intermediate Indirect	○ Quality of physical environment related to overweight and obesity: ○ Overweight participants lived on streets w/o sidewalks ○ Overweight and obese participants reported not living within walking distance to stores	○ Self-report ○ Possibility that those who are sedentary to begin with might not notice areas to do physical activity ○ Perceptions of the environment were not validated ○ High standard of living environment sampled from (i.e., the working well)

Article	Purpose	Outcomes	Environmental Assessment Methods		Findings	Limitations
			Type of Measurement	Category		
(20) Kinra S, Nelder RP, & Lewendon GJ. Deprivation and childhood obesity: A cross sectional study of 20 973 children in Plymouth, United Kingdom. *J Epidemiol Community Health.* 2000; 54:456-460.	*Examined the relationship between socioeconomic deprivation and childhood obesity*	○ Height – real height obtained ○ Weight – real weight obtained ○ BMI	○ Townsend Material Deprivation Score derived from 1991 Census data: - unemployment - overcrowding - wealth - income	Indirect	○ Children in more deprived areas were 2.5 times more obese than the rest of the population of the UK.	○ Sample was limited to Caucasians ○ Sample was from only state schools ○ Townsend index used, rather than asking individual level questions
(13) Saelens BE, Sallis JF, Black JB, & Chen D. Neighborhood-based differences in physical activity: An environment scale evaluation. *American Journal of Public Health*. 2003; 93:1552-1558.	*Examined physical activity and weight status of residents compared with neighborhood environmental survey.*	○ Physical activity – accelerometers and self-report ○ Height and weight – self-report ○ Demographics – self-report	○ Neighborhoods determined using 1990 census data to gain high- and low-walkability neighborhoods ○ Neighborhood Environment Walkability Scale (NEWS) – self-report survey	Indirect Intermediate	○ Trend found that residents of low walkability neighborhoods had higher BMIs than those with high walkability neighborhoods ○ Low walkability neighborhood residents walked significantly less than those residents from high walkability neighborhoods	○ Unable to determine if one's neighborhood can be defined as area of physical activity ○ Low recruitment rate ○ Demographic differences between neighborhoods ○ Did not validate environments ○ Self-report data
(19) van Lenthe FJ & Mackenbach JP. Neighbourhood deprivation and overweight: The GLOBE study. *International Journal of Obesity*. 2002; 26:234-240.	*Examined the relationship between neighborhood deprivation and overweight and looked to see if this association was modified by education, age, or sex.*	○ BMI – self-report on a postal questionnire from GLOBE larger study	○ Neighborhood deprivation based on: - educational level - occupational level - employment status	Indirect	○ As neighborhood deprivation increased, prevalence of overweight increased	○ Self-report data ○ Neighborhoods defined by aggregates of samples

§NHANES III = Third National Health and Nutrition Examination Survey (1988 – 1994) – Self-report survey
*BRFSS = Behavioral Risk Factor Surveillance System (1998 – 2000) – Self-report survey
¤SMARTRAQ = Strategies for Metro Atlanta's Regional Transportation and Air Quality study – Self-report survey