Community and Child Physical Activity:

Differential associations by Gender and Age

Lori Kowaleski-Jones[a]

Jessie X. Fan[a]

Ming Wen[b]

[a]Department of Family and Consumer Studies

[b]Department of Sociology

University of Utah

Abstract

To address the physical inactivity (PA) trend and the health consequences, there is a growing interest in the ecological approach. A key assumption about the ecological model is that neighborhood environments exert contextual effects on individual levels of PA over and above individual-level risk or protective factors. The goal of this research is to examine the extent to which facets of neighborhood socio-demographic contexts influence individual-level PA among children. We use multiple data sources to examine our research questions, including the 2000 Census data and the 2003-2004 wave of the NHANES III. We construct diverse measures of neighborhood environment and PA. We develop environmental models of PA that incorporate important aspects of the social environment in residential areas. In doing so, we aim to identify contextual features that have the greatest impact on child PA in order to inform interventions aimed to support child PA and promote health.

Introduction

Important favorable health benefits of physical activity (PA) for adults are well researched. The benefits of PA in youth are less well studied. However, available research has pointed to the health benefits of PA for obesity prevention. The Center for Diseases Control has developed guidelines specifically for youth physical activity, and there is continuing debate over the amount and types of activity needed for health benefits. Recommendations tend to emphasize daily physical activity and encourage young people to accumulate 30 to 60 minutes ranging up to several hours per day.

Estimates of the linkages between features of institutional neighborhood factors and measures of the built environment and child PA are just now starting to emerge in the literature. Studies linking neighborhood effects to childhood PA have been impeded by the lack of data that contains both reliable national estimates on childhood PA, measured both objectively and subjectively and measures of social environment in which the children reside. In addition, there are often confidentiality concerns with data that contain information needed to identify relevant geographic locational data. Moreover, the level of aggregation available is too large for meaningful neighborhood distinctions. Some data contain individual perceptions of neighborhood environment but lacks the ability to link to areal measures of social and physical dimensions of the community environment. There is a need for additional research linking

environment to child PA that incorporates not only census based data measures but takes advantage of relatively recent advances in geographic information systems approach to describing neighborhood environment as well as measures that tap social modeling processes as well.

The neighborhood environment is a key context in which child PA is located as this is a broader context in which individual behaviors are influence by elements of both the physical environment as well as local norms for behavior and attitudes about physical activity and weight related decision making for both parents and their children. Additionally the neighborhood context represents an important context for health policy modification relevant to PA.

We consider whether girls and boys might respond differently to neighborhood environments with respect to their levels of PA.   Parents might place fewer restrictions on boys activities outside of the home based on perceived safety risks of the neighborhood environment. This dynamic might lead to a differing pattern of neighborhood amenities being more salient for boys as compared to girls. Moreover, boys and girls may differ in the patterns of time use and usual activities. Girls generally spend less time than boys in sports and electronic games and more time studying, doing housework, and in unstructured leisure with friends, activities that presage adult differences in time use (Bianchi and Robinson 1997; Larson 2001). Recent research by Sayer and Dywer (2011) has examined time use patterns of boys and girls using time use supplement data available in the Panel Study of Income Dynamics Child Supplement. Early evidence suggests that there may be gender differences in time use associated with neighborhood variation. Boys might be more likely engage in sports but also sedentary activities such as television watching as compared to girls. Thus, features of the built environment such as distance to parks might impact boys' activities more than girls, and perhaps leading differences

in PA. In this analysis, a major aim to determine whether boys and girls PA are differentially impacted by physical and social neighborhood conditions.

The current analysis adds to the literature in a number of ways. First, we use nationally representative data with data on child PA that is the product of both parent report and clinical measurement. We link a variety of data sources to the main data at the census tract level, an improvement on other research that relies on zip code or larger levels of aggregate data. Second, we consider a model of neighborhood influence that simultaneously tests for both institutional and social modeling processes. Many prior investigations have relied on guiding models that test for the influence of either built environment factors or social factors. Rarely does research on neighborhood effects on child obesity consider both equally important aspects of community influence. Finally, we address the question of whether neighborhood factors have different patterns of influence depending on the gender of the child. Results from this research help to refine and extend the knowledge base on the potential role of the larger social environment on children's PA. In doing so, results inform policy efforts to interdict in the growing trend of child inactivity in the United States.

Model of Community Influence

Multiple models have been used in the research literature to describe and explain how neighborhoods might influence individual behavior (Mayer and Jenck, 1990; Schulz and Northridge, 2004; Sampson et al 1997; Shaw and McKay, 1942). Child PA is potentially influenced by multiple factors within the neighborhood. We argue that in particular child PA might be impacted by features of the built environment. This view is informed and supported by prior research (Smith et al, 2008; Zick et al, 2009; Franzini et al, 2009) which find linkages between neighborhood density, diversity and design and an individual health. Prior research

has linked neighborhood socioeconomic conditions to childhood health (Singh et al , 2010; Smith et al, 2008; Liu et al, 2008). However, social conditions within the community might also be important. More recently, social modeling processes have been considered in research on childhood obesity. Investigations have considered the possibility that social modeling processes present at the community level might also be salient in determining child weight (Franzini, 2009). In this analysis we extend these ideas to consider whether boys and girls are differentially responsive to institutional, built environment factors and social modeling processes in their proximate environments.

Institutional factors such as neighborhood economic resources and rurality can impact childhood PA rates. Oliver and Hayes (2005) find evidence of a social gradient in the prevalence in child overweight and inactivity. They conjecture that less affluent neighborhoods have social and physical environments less conducive to maintaining a healthy pattern of PA. Fewer children may be participating in organized physical activity and this might be because a lack of local facilities and resources and also because of a lack of awareness

Shulz and Northridge (2004) have articulated a conceptual model for understanding social and environmental inequalities in health which posits that neighborhood level SES inequalities increase the risk of chronic diseases. The mechanism is that SES inequalities lead to differences in social environments, both in terms of the resources available and the willingness to access them which leads to health exposure and behaviors. The rurality of a community can also act as an institutional factor as rural areas are settings that have been identified to be a barrier to to PA. Some studies have linked a lack of nutrition education and services (Leeper et al, 2001; Omar et al, 2001) while others have observed that rural areas have fewer physical education classes in schools and fewer exercise facilities (Heneghan and Maalakoff, 1997; Hendryx, 1993).

Health promotion models suggest that institutional factors such as neighborhood economic resources and rurality result in environments that exhibit differences in built environment factors. Environmental conditions, such as the built environment, have been identified as intervening factors in the obesity epidemic through their constraining effect on physical activity and perhaps diet.

A growing body of research provides evidence of the potential importance of the built environment for energy balance decisions (Smith et al, 2008; Zick et al, 2009; Brown et al, 2010). One aspect of the built environment that has been identified as important is the walibability of the environment. People who live in sprawled counties, with low-walkability, are less likely to walk in their leisure time, have higher BMIs, and are more likely to have high blood pressure and be obese (Heath et al, 2006). Other research suggests that the majority of people in low walkability neighborhoods are overweight versus those who live in high walkability neighborhoods (Craig et al, 2002; Berrigan and Troiano, 2002). Researchers have used a variety of constructs to capture the potential effects of walkability and opportunities for exercise and diet. Communities where higher proportions of residents commute long distances is likely associated with lower physical activity. These communities are likely to be characterized by remoteness from areas of active transportation and leisure.

Previous research on the interaction between human health and the physical environment suggests that exposure to green landscapes has a positive influence on variety of psychological and physiological processes (Garcia et al, 1995; Wells et al, 2003. Green outdoor settings have been linked to greater supervised use by children for activity. Shade from tree canopy and scenery from green spaces have been associated with reports of increased walking (Sallis, 1997).

Presence and maintenance of green landscape may be a strong indicator of place attachment among residents and this might lead to increased investments of community surveillance that might lead to positive health outcomes. Evidence suggests that residents with greenery in common spaces experience stronger social ties (Coley et al, 2003; Chaudhury, 1994; Taylor et al, 1998). Exposure to green landscapes plays a role in promoting psychological and physiological well-being that can explain, at least in part, spatial patterns of PA in children. Time spent outdoors is a clearly established correlate of physical activity in children; access to parks or other outdoor play spaces has also been associated with increased physical activity in youth. Research linking green spaces within neighborhoods and child health is only beginning to emerge. Liu and others (2010) find that increased neighborhood vegetation was associated with decreased risk for inactivity among children living in higher population density regions.

Exposure to green landscapes plays a role in promoting psychological and physiological well-being that can explain, at least in part, spatial patterns of overweight and obesity in children. Time spent outdoors is a clearly established correlate of physical activity in children; access to parks or other outdoor play spaces has also been associated with increased physical activity in youth. However, research on Canadian children did not provide evidence of a protective association between park and green space at the community level and child PA. These mixed findings suggest the need for more research using a representative national sample of children across a variety of contexts.

Other physical amenities present or absent within the community in which children live might also matter for PA. Access to places to play is important resource for children. The availability of parks and recreational resources are necessary to decrease the levels of childhood obesity. Children with better accessibility to parks and recreational environments may be more

likely to engage in PA regularly. A recent analysis of the 12 Southern California cities studied revealed that many children had a lack of access to local parks; more than half of the children had no parks within 500 meters of their homes. While many neighborhoods do not have the space to create new parks, investments in sidewalks and street trees that promote walking, jogging, biking, and informal play appear warranted. The creation of safe sidewalks and the planting of street trees partially substitute for new parklands by, hopefully, increasing physical activity and complementing additional recreational programming. Not all children have equal access to parks for recreation. Some estimates indicate that fewer than half of American children have a park within walking distance of their homes (Trust for Public Land, 2004). This is alarming given that children who live near parks are less likely to be overweight than children who lack park access.

Cultural norms present within a community are also important in creating an obesogenic environment (Ard, 2007). Elementary school aged children are spending more time in social environments and as such are engaging in social comparison behaviors (Eccles, 1999). Researchers have demonstrated that youth perceptions of their environment affect their psychological well being (Stiffman et al, 1999). Other available research has suggested that individual weight related behaviors may be affected by cultural and social norms present within their community. Neighborhoods with visible evidence of other residents participating in physical activity may influence residents to adopt similar healthy behaviors. Conversely, neighborhoods with higher proportions of overweight residents may contribute to an environment where residents may be more likely to engage in weight behavior and outcomes more consistent with their visible surrounding peers. Crane (1991) has posited an epidemic theory of social contagion in which youth will be more likely to engage in risky behaviors if they

perceive that others in their community are also engaging in risky behaviors.   This theory of contagion could be applied to PA in that youth who do not see residents engaging in PA might be less likely to see the value of regular exercise.

DATA

Data for this analysis were drawn from the 2003–2004 National Health and Examination Surveys (NHANES). The NHANES is an ongoing survey of the general U.S. population conducted by the National Center for Health Statistics within the Centers for Disease Control and Prevention. NHANES participants undergo a survey as well as a medical examination that includes blood work and measured height and weight. Responses to questions were obtained re obtained from the parent or guardian. The study sample for this paper was 1532 youth aged 6–17 years who had valid PA measures.

Measures

PA

The National Health and Nutrition Examination Survey (NHANES) measures the health of the U.S. civilian noninstitutionalized population. In 2003-2006 those who could walk were given accelerometers (Actigraph 7164, LLC, Ft. Walton Beach, FL) to wear for a week, following standard protocols (NHANES, 2004). We focus on youth ages 6 to 17 in our analyses. Nonwear time is defined by ≥ 60 consecutive minutes of zero activity intensity counts, allowing for 1-2 minutes of counts between 0 to 100. Wear time is defined by 24 hours minus nonwear time. A valid wear day is defined as having ≥ 10 hours of monitor wear. Some accelerometer data are

discarded if units were out of calibration when returned or measured unlikely levels of activity (NHANES, 2006; Troiano et al., 2008).

We test two mutually exclusive moderate to vigorous physical activity (MVPA) measures: MVPA8+ and MVPA1-7 bouts. We consider MVPA8+ bouts to be the equivalent of what Troiano et al. (2008) called a modified 10-minute MVPA bout, to represent the recommended Centers for Disease Control and Prevention bouts. Thus MVPA8+ bouts are defined as ≥10 MVPA minutes that allow for interruptions of 1-2 minutes below threshold and are terminated by 3 minutes below the 2020 CPS threshold. MVPA1-7 minute bouts are those over 1 minute of MVPA but less than an MVPA8+ bout. Mean daily time in both bouts are calculated across all valid days.

Neighborhood Context

Structural Environmental features of the neighborhood were measured with two variables: Neighborhood Poverty was measured with a variable from the census that documents the percentage of household in the census tract who are below the poverty line. Rurality was based on the 2000 Rural-Urban Commuting Area Codes, where values range from 1 which is a metropolitan area core to 10 which designates rural areas. These 10 codes offer a relatively straightforward delineation of metropolitan and nonmetropolitan settlement based on the size and direction of primary commuting flows.

Built Environment Factors were measured with three variables. Long commute times were measured as percent of individuals commuting at least one hour per day to work. In addition, two GIS-based measures were constructed. Using the tree canopy data in the 2001

National Land Cover Database, a neighborhood greenery variable was constructed by the percentage of area covered by tree canopy within each 30m pixel. Using the 2009 Public Park Data, accessibility of parks was measured by population weighted distance (in miles) from the neighborhood centroid to the nearest seven parks. GIS techniques were employed to construct neighborhood greenery and access to parks. Both density and distance were considered in constructing the park accessibility measure. An in-depth description of the method used to construct the park access measure is available elsewhere (Zhang, Lu, and Holt 2011). Model-based multilevel small area estimation methods were used to generate tract-level obesity prevalence from individual responses from the BRFSS sample.

Dynamics of Social modeling within the neighborhood were operationalized with two separate variables derived from the Behavioral Risk and Surveillance System (BRFSS). Prevalence of overweight and Prevalence of individuals meeting the CDC PA recommendations were included to tap weight-related normative environment present in the neighborhood, using data from the 2000 Behavioral Risk Factor Surveillance System (BRFSS), an annually conducted cross-sectional nationwide telephone survey of Americans' health behaviors (Center of Disease Control and Prevention 2011). The CDC recommends that adults aged 18 to 64 should participate in at least 20 min of activity per day, and vigorous activity several days per week (Centers for Disease Control & Prevention, 2009).

Key individual controls were also included in these analyses. Race/ethnicity was self-reported; non-Hispanic whites, non-Hispanic blacks and Hispanics were included in the analyses. Child Age in years, gender (male versus female), and household income (11 categories ranging from the lowest level of $4,999 or below to the highest level of $75,000 or above) per capita were also included in all models.

Hypotheses

1. Measures of the institutional neighborhood factors, built environment, and social modeling will have a significant effect on children's PA

2. Patterns of association will vary by gender of the child.

3. Patterns of association may vary by age of child

Statistical Methods

Child PA will be regressed on a set of controls as well as variables capturing elements of the physical environment, built environment and social modeling factors. Three models were fit to test our hypotheses. First, a model for the total sample will be estimated. Second, gender specific models were fit for boys and for girls. Adjustments for statistical dependence among observations were addressed by clustering within census tracts. Intra-clustering correlations (ICC) and likelihood ratio test results were presented along with the regression results. In the main sample as well as in the sub sample analyses, we first test for the associations between Institutional factors and child risk of overweight. Then, we account for measures of the built environment. In a separate step, we add in social modeling variables. Finally, we will test for interactions between age of child and selected neighborhood variables. This is to test hypothesis 3. All analyses control for income, race and child age. .

Results

Table 1 presents descriptive characteristics for the total sample of children from the NHANES. This table reveals that approximately children are more likely to get exercise in shorter bouts than in longer bouts. Youth in this sample get approximately 55 minutes a day in bouts that last less than 8 minutes. Children get about 23 minutes of day spent in PA in bouts that are longer than 8 minutes. On average, the children live in census tracts where approximately 9 percent of the residents have over an hour commute to work. Approximately 14 percent of the census tracts in which the respondents live is covered by green canopy. Residents live on average about 5.5 miles from a park. On average, children from these data live in neighborhoods where approximately 17 percent of residents live in poverty. As measured by the 2000 rural-urban commuting codes from the census, children live in census tracts that are primarily urban core where much of the commuting is within the metropolitan area. Considering the area variables representing social modeling dynamics, children live in census tract neighborhoods where about 22 percent of residents are overweight. Approximately 21 percent of the residents in neighborhoods in which the children live are meeting the CDC recommendation for physical activity.

Turning to individual summary measures, the sample is equally split between boys and girls. Average household income is between 25 and 36 thousand dollars, which is relatively lower than the national average of 43 thousand in 2003 (U.S. Census, 2004). The sample is relatively evenly split across whites, African Americans and Hispanics. A small portion of the sample (6%) is represented by the other race category. Finally, the mean age of child in this sample is about 6 years old.

Expected Outcomes

Multivariate analyses will be conducted in mid December at the National Center for Health Statistics Research Data Center at the Center for Disease Control in Atlanta Georgia. Because this project is using restricted data from NHANES, all analyses must be conducted on site.

Prior work on these data suggests a role for these neighborhood characteristics for measures of child overweight. Structural conditions within the neighborhood appear to matter for child overweight. Living in a census tract higher numbers of residents living in poverty is associated with a 20 percent increase in the odds of a child being classified as overweight. Rural community residence is also associated with a greater odds of child overweight. Specifically living in a census tract that is more rural is associated with a 30 percent increase in the risk of child overweight. We find evidence of significant association between longer commute times within the census tract is associated with a 9 percent increase in child overweight risk. Living amongst neighbors who meet the CDC requirements for physical activity may have a protective effect on child body weight, as there is a 13 percent decrease in risk of childhood overweight associated with this estimate. These results provide a backdrop for our current analyses on child PA.

Boys and girls may have different physical activity patterns. Boys might be more affected by space outside their doors while girls may be more impacted by opportunity costs of suburban area living with respect to recreation access. However, our current analyses do not directly model the effects of increased screen time in rural areas among boys. Differing physical activity and sedentary patterns for girls and boys in rural settings is an important avenue for future research using these data. These analyses have the potential to afford insight about the

ways in which institutional neighborhood factors, built environment factors and social modeling

dynamics might influence risk of youth PA.

References

Ard, J.D. 2007. Unique Perspectives on the Obesogenic Environment. J Gen Intern Med. 2007 July; 22(7): 1058–1060.

Baranowski T, Thompson WO, DuRant RH, et al. Observations on physical activity in physical locations: age, gender, ethnicity, and month effects. Res Q Exerc Sport. 1993;64:127–133.

Bianchi, S.M. and J.P. Robinson. 1997. "What Did You Do Today? Children's Use of Time, Family Composition, and the Acquisition of Social Capital." *Journal of Marriage and the Family* 59:332-344.

Brown, Barbara B., Ikuho Yamada, Ken R. Smith, Cathleen D. Zick, Lori Kowaleski-Jones, and Jessie X. Fan. Measuring mixed land use as a component of neighborhood walkability: Relationships with BMI, overweight, and obesity.@ Health and Place, vol. 15, no. 4 (December 2009), pp. 1130-1141.

Berrigan D, Troiano RP. The association between urban form and physical activity in U.S. adults. *Am J Prev Med.* 2002;23 (2S):74-79.

Center of Disease Control 2009. Vital signs: State-specific prevalence of obesity among adults — United States, 2009. *MMWR* 2010;59:1–5.

Center of Disease Control and Prevention. 2011. "Behavioral Risk Factor Surveillance System." vol. 2011.

Centers for Disease Control and Prevention. 2005. "Perceptions of neighborhood characteristics and leisure-time physical inactivity--Austin/Travis County, Texas, 2004." *Morbidity and Mortality Weekly Report* 54:926-8.

Centers for Disease Control and Prevention. 2006. "National Health and Nutrition Examination Survey." vol. 2011. Atlanta.

Chaudhury H. 1994. Territorial personalization and place-identity: a case study in Rio Grande Valley, Texas. In: Seidel A, ed. Banking on Design. Oklahoma City, Okla: EDRA; 1994:46–54.

Coley R, Kuo F, Sullivan W. 1997. Where does community grow? The social context created by nature in urban public housing. Environ Behav. 29:468–492.

Craig CL, Brownson RC, Cragg SE, Dunn AL. Exploring the effect of the environment on physical activity: a study examining walking to work. *American Journal of Preventive Medicine.* 2002;23:36-43.

Crane, J. (1991) The epidemic theory of ghettos and neighborhood effects on dropping out and teenage childbearing, American Journal of Sociology, 96, pp. 1236–1259.

Eccles, Jacquelynne (1999). The development of children ages 6 to 14 The Future of Children 9(2): 30-44.

Franzini, L., M. Eliottt, P. Cuccaro, M. Schuster, J. Gilliland, J. Grunbaum, F. Franklin, and S. Tortolero. (2009). "Influences of physical and social neighborhood environments on children's physical activity and obesity." Am J Public Health **99**: 271-278.

Garcia AW, Broda MA, Frenn M, et al. 1995. Gender and developmental differences in exercise beliefs among youth and prediction of their exercise behavior. Journal of school Health. ;65:213–219.

Gilbert C. Liu; Jeffrey S. Wilson; Rong Qi; Jun Ying. 2007. Green Neighborhoods, Food Retail and Childhood Overweight: Differences by Population Density American Journal of Health Promotion. 21(4): 317–325.

Heath, G., Brownson, R. Kruger, J., Miles, R., Powerll, K., Ramsey, L. 2006. The effectiviness of urband design and land use and transport policies and practicrs to increase physical activity: A systematic review. Journal of Physical Activity and Health 3(S1): S55-S76.

Heneghan, A.M., and Malakoff, M.E. Availability of school health services for young children. *Journal of School Health* 67(8):327-332, 1997.

Hendryx, M.S. Rural hospital health promotion: Programs, methods, resource limitations. *Journal of Community Health* 18(4):241-250, 1993.

Hill AL, Rand DG, Nowak MA, Christakis NA (2010) Infectious Disease Modeling of Social Contagion in Networks. PLoS Comput Biol 6(11):

Jencks, Christopher and Susan E. Mayer. 1990. "The social consequences of growing up in a poor neighborhood." in *Inner City Poverty in the United States*, edited by L. E. Lynn and M. G. H. McGeary. Washington, DC: National Academy.

Johannsen, DL, Johannsen, NM, and Specker, BL. 2006. Influence of parents eating behavior and child feeding practices on children's weight status. Obesity. 14(3): 431-439.

Klesges RC, Eck LH, Hanson CL, et al. Effects of obesity, social interactions, and physical environment on physical activity in preschoolers. Health Psychol. 1990;9: 435–449.

Kowaleski-Jones, Lori, Zick, Cathleen, Brown, Barbara, Fan, Jessie, Hansen, Heidi, and Ken Smith. 2010. Housing age and overweight: A Propensity score approach. Paper presented at the 2010 annual meetings of the Population Association of America, Dallas, Texas.

Kowaleski-Jones, Lori, Barbara B. Brown, Jessie X. Fan, Ken R. Smith, and Cathleen D. Zick. 2009. Are You What Your Mother Eats? Evaluating the Impact of Maternal Weight Trajectories on Youth Overweight. Maternal and Child Health.

Kuo F, Sullivan W, Coley R, Brunson L. 1998. Fertile ground for community: inner-city neighborhood common spaces. Am J Community Psychol. 26:823–851.

Larson, R.W. and S. Verma. 1999. "How Children and Adolescents Spend Time Across the World: Work, Play, and Developmental Opportunities." *Psychological Bulletin* 125:701- 736.

Leeper, J.; Hullett, S.; and Wang, L. Rural Alabama health professional training consortium: Six-year evaluation results. *Family and Community Health* 24(2):18-26, 2001.

NHANES, 2004. National Health and Nutrition Examination Survey (NHANES): Laboratory procedures manual. Centers for Disease Control and Prevention, Atlanta, GA.

Oliver, L.N. and M.V. Hayes, Neighbourhood socio-economic status and the prevalence of overweight Canadian children and youth, *Canadian Journal of Public Health* **96** (6) (2005), pp. 415–420.

Omar, M.A.; Coleman, G.; and Hoerr, S. Healthy eating for rural low-income toddlers: Caregivers perceptions. *Journal of Community Health Nursing* 18(2):93-106, 2001.

Potestio, M.L. Alka B Patel, Christopher D Powell, Deborah A McNeil, R Daniel Jacobson, and Lindsay McLaren Is there an association between spatial access to parks/green space and childhood overweight/obesity in Calgary, Canada? Int J Behav Nutr Phys Act. 2009; 6: 77.

Ross, C. E. (2000) Walking, exercising, and smoking: does neighborhood matter?, Social Science and Medicine, 51(2), pp. 265–274.

Ross, C. E. and Mirowsky, J. (2001) Neighborhood disadvantage, disorder, and health, Journal of Health and Social Behavior, 42(3), pp. 258–276.

Sallis JF, Johnson MF, Calfas KJ, et al. Assessing perceived physical environmental variables that may influence physical activity. Res Q Exerc Sport. 1997;68:345–351.

Sampson, Robert J., Stephen W. Raudenbush, and Felton Earls. 1997. "Neighborhoods and violent crime: a multilevel study of collective efficacy." *Science* 227:918-923.

Sayer, Liana and Dwyer, Rachel. 2011. Neighborhood Variation in Girls' and Boys' Time Use. Paper presented at the Annual Meetings of the Population Association of America. Washington, D.C.

Shaw, Clifford R. & McKay, Henry D. (1942). *Juvenile Delinquency in Urban Areas*. Chicago: University of Chicago Press.

Smith, Ken., Cathleen Zick, Barbara Brown, Kowaleski-Jones, Lori, Yamada, Ikuho, and Jessie Fan. 2008. Walkability and Body Mass Index: Density, Design, and New Diversity Measures. American Journal of Preventive Medicine 35(3):237-44.

Stiffman, A.R. E.H. Ives, D. Elze, S. Johnson and P. Dore, (1999) Impact of environment on adolescent mental health and behavior: structural equation modeling. *American Journal of Orthopsychiatry* **69** (1999), pp. 73–86.

Taylor A, Wiley A, Kuo F, Sullivan W. 1998. Growing up in the inner city: green spaces as places to grow. Environ Behav. 1998;30:3–27.

Troiano, R.P., Berrigan, D., Dodd, K.W., Mâsse, L.C., Tilert, T., McDowell, M., 2008. Physical activity in the United States measured by accelerometer. Med. Sci. Sports Exerc. 40, 181-188.

Trust for Public Land. 2004. No Place to Play: A comparative analysis of park access in seven major cities.

Wells N, Evans G. 2003. Nearby nature: a buffer of life stress among rural children. Environment and Behavior. 35:311–330.

Wolch J, Jerrett M, Reynolds K, McConnell R, Chang r, Dahmann N, Brady K, Gilliland F, Su JG, Berhane K. Childhood obesity and proximity to urban parks and recreational resources: A longitudinal cohort study. *Health and Place*. 2010;16(3):137-57.

Zick, Cathleen D., Ken R. Smith, Jessie X. Fan, Barbara B. Brown, Ikuho Yamada, and Lori Kowaleski-Jones. Running to the Store? The Relationship between Neighborhood Environments and the Risk of Obesity. Social Science and Medicine, vol. 69, no 10 (November, 2009), pp. 1493-1500.

Table 1. Descriptive Characteristics. 1751 children from the NHANES 2003-2004 release aged 2 to 11.

	Mean	Std. Dev.
MVPA1-7	55.6	46.4
MVPA8+	23.3	29.3
Percent long-commuting residents[a]	.09	.079
Percent space covered by green areas	14.05	16.26
Distance to parks (mile)	5.53	13.57
Prevalence of residents meeting CDC recommendations for Physical Activity	21.15	3.27
Prevalence of overweight	22.13	4.35
Percent residents in poverty	.17	.11
Rurality	1.85	2.02
Male	.48	.50
Income	6.52	2.99
White	.28	.45
Black	.33	.47
Hispanic	.33	.47
Other race	.06	.24
Age	12.3	2.97

Source: 2003-2004 National Health and Nutrition Examination Survey merged with a number of place-based data sets including the 2000 census, 2002 Behavioral Risk Factor Surveillance System (BRFSS), and GIS-based park access and green area data.
Notes: a) Long-commuting residents are defined as those who spend at least an hour commuting to work every day.