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Association of access to parks and recreational facilities with the physical activity of young children

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Abstract

Objective. To determine associations of the neighborhood and home television environments with young children's physical activity.

Method. 32 boys and 27 girls age 4 to 7 years wore accelerometers for 3 weekdays and 1 weekend day. The number of televisions in the home and television watching of the child were monitored using TV Allowance™ units for 3 weeks. A geographic information system was used to measure neighborhood environment variables.

Results. Hierarchical regression analysis was used to predict physical activity, initially controlling for sex, age, socioeconomic status, adiposity, and child television watching in step 1. In step 2, the number of televisions did not significantly increase the amount of variability accounted for in the prediction of physical activity. In step 3, housing density and the interaction of housing density by sex accounted for an incremental 12% ($p<0.05$) of the variability and in step 4 percentage park plus recreation area accounted for a further 10% ($p<0.05$) of the variability. Greater housing density predicted increased physical activity of boys, but not girls.

Conclusion. Neighborhoods with increased proximity between homes and a greater proportion of park area are associated with greater physical activity in young children.

Keywords: Physical activity; Play; Environment design; Television; Sedentary; Health behavior; Child

Introduction

The increased prevalence of obesity in young children (Ogden et al., 1997, 2002) has been attributed to environmental changes that encourage sedentary behaviors and reduced physical activity (Burdette and Whitaker, 2005; Ewing et al., 2003; Frank et al., 2004; French et al., 2001; Hill et al., 2003; Lopez, 2004; Saelens et al., 2002, 2003). Homes and neighborhoods may have a great impact on the health behaviors of young children as they spend much time in these environments. Access to reinforcing activities in the home, such as television, compete with the choice to be active outside and children choose to watch television rather than be active when given the choice (Epstein et al., 1991; Johnson et al., 1978; Smith and Epstein, 1991). However, television watching is not necessarily associated with the activity levels of youth (Biddle et al., 2004; Marshall et al., 2005) and this area requires further study.

More dense neighborhoods are associated with greater physical activity in adults (Ewing, 2005; Frank et al., 2005), but the influence of housing density on young children's activity has not yet been studied. Greater housing density reduces the walking distance between homes. Parents may be more willing to facilitate play by walking with the child to a friend's home or by letting young children walk to a friend's home if they live nearby.

Neighborhoods with greater accessibility to reinforcing physical activities such as those provided at parks could also

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increase young children's physical activity by increasing children's motivation to be active outside (Epstein et al., in press; Roemmich et al., in press). Neighborhood park and recreation facilities could also provide a place for parent's with young children to meet and allow their children to play.

The purpose of this study was to determine the association of the home and neighborhood environments with physical activity in young children. The number of televisions in the home was recorded during home visits. Geographic information systems (GIS) analysis was used to assess neighborhood environment variables. These objective measures were then used to predict physical activity measured with accelerometers.

Methods

Study participants

The data are a cross-sectional analysis of the run-in period from a longitudinal study to evaluate the effects of modifying the home television watching environment of 4- to 7-year-old children with a body mass index (BMI) ≥75th percentile. Eligibility criteria included the child participating in 14 h or more per week of television, and no conditions that would limit participation in physical activity. A total of 32 boys and 27 girls that completed the run-in processes lived in Erie county, NY for which we had GIS databases and were included in the statistical analyses.

Procedures

Parents, who were recruited through direct mailing, newspaper advertisements, posters and brochures, and word of mouth, completed a phone screen that preliminarily assessed the child's height and weight. Families that appeared eligible attended an orientation session and a parent provided written informed consent approved by the University at Buffalo Social and Behavioral Sciences Institutional Review Board. The child's height and weight were then measured by a research assistant to assure they met the BMI percentile entry criterion. Parents completed a questionnaire to determine family socioeconomic status (SES). Children were fitted with accelerometers (Computer Science and Applications, Inc. (CSA), Shalimar, FL) to measure their physical activity on 3 weekdays and 1 weekend day for the following week. Electronic television time managers (TV Allowance™, Mindmaster Inc., Miami, FL) were attached to each television in the home and each child and parent entered an individual code to turn-on the device each time for 3 weeks. The TV Allowance™ provided objective data regarding weekly minutes of child television watching. Characteristics of the children's neighborhood environment were determined using GIS, after geocoding each child's primary residence. Children were measured in the summer ($n=3$) and fall ($n=17$) of 2003 and in the spring ($n=10$), summer ($n=20$), and winter ($n=9$) of 2004.

Measurement

Demographics

Race and ethnic background were obtained using a standardized questionnaire. SES was assessed using the four factor index of social status (Hollingshead, 1975).

Height and weight

Weight was assessed to the nearest 0.1 kg using a calibrated scale. Height was assessed using a SECA stadiometer (Hanover, MD) to the nearest 1.0 mm. Body mass index was calculated according to the following formula: (BMI=kg/m^2). Percentage overweight (BMI−BMI at 50th percentile)/BMI at 50th percentile*100) was calculated in relationship to the 50th BMI percentile for children based on their sex and age (Kuczmarski et al., 2000).

Objective physical activity

Children wore a CSA accelerometer and data were collected at an epoch of 1 min. The monitor was worn snug against the hip from the time children returned home from school until they went to bed on weekdays and for the time they got out of bed in the morning until they went to bed at night on weekends. The accelerometer data are reported as average counts per minute over all 4 days. We did not calculate minutes in moderate-to-vigorous because there are no valid counts per minute cutpoints for young children.

Neighborhood environment characteristics

GIS was used to build a spatial database to measure each child's neighborhood environment attributes as previously described (Roemmich et al., in press). Computations were completed using ArcGIS 9 and ArcView 3.3 and extensions such as Network Analyst (ESRI). The parcel data layer was obtained from New York State GIS Clearinghouse. The street GIS layer was obtained from Tele Atlas (Boston, MA). Family residences were geocoded to a unique parcel of land within the GIS database. Neighborhood environments were defined as the area within a ½ mile radius of child's residence using a straight-line distance (Unterman, 1990).

Housing density was assessed as housing units per residential acre within the child's neighborhood. A single family housing unit was measured as housing with one unit. A duplex was measured as having two units, and so on. Street connectivity was computed as the number of intersections per mile of street length network. To test the hypothesis that access to parks and parks plus recreation facilities is associated with the physical activity of young children, the percentage of total park area/total area (ft^2) of residential land use in a neighborhood (percentage park area) and the percentage of total area of park plus non-park recreation land (ft^2)/total area (ft^2) of residential land use in a neighborhood (percentage park+recreation area) were calculated. Park area included nature trails, bike paths, playgrounds, athletic fields, and state, county, and town owned parks. Recreational area was defined as the area of land used for ice or rolling skating rinks, swimming pools, health clubs, tennis courts, and camping facilities.

Statistical analyses

The primary-dependent variable, physical activity was assessed for skewness and kurtosis and found to be approximately normal for each sex. One-way analyses of variance (ANOVA) tested differences in physical characteristics, home and neighborhood environments, television use, and physical activity of boys and girls with sex as a between variable. Univariate correlations were used to determine the strength of relationships between predictor variables and physical activity. Hierarchical regression models were developed to determine if addition of information regarding the home and neighborhood environments improved prediction of total physical activity. Confidence intervals were calculated for the incremental increase in R^2 at each step (Steiger and Fouladi, 1992; Wuensch, 2006). The child's sex, age, family SES, percentage overweight, and television watching were included in step 1. Television watching was included in step 1 to demonstrate that associations of neighborhood environment variables with physical activity, which were entered in later blocks, were independent of the association of television watching with physical activity. Season of measurement was not a significant predictor of physical activity and had no effect on any of the estimates so it was not included in the final models. The number of televisions in the home (home environment measure) was added in step 2. Only those blocks of neighborhood environment variables that produced a significant incremental increase in R^2 were added in the remaining steps. Each of the neighborhood environment predictors was interacted with sex to determine if there were differential associations of these variables with the physical activity of boys and girls. Only significant ($p<0.05$) interaction terms were maintained in the models. Careful attention was paid to multicollinearity between variables and detected by examining the correlation matrix of regression coefficients assuring that no values were greater than 0.50.

Results

The boys and girls were not significantly different ($p>0.05$) for age, SES, number of televisions in the home, physical activity, and television use (Table 1). The girls were taller,

Table 1
Physical characteristics of the subjects

	Boys, $n=32$	Girls, $n=27$
Age (years)	5.8 (1.3)	6.2 (1.2)
Height (cm) *	115.2 (8.9)	120.1 (9.8)
Weight (kg) *	24.9 (5.4)	29.9 (10.5)
BMI (kg/m^2) *	18.5 (1.7)	20.1 (3.7)
%Overweight *	19.1 (10.9)	30.9 (23.1)
Socioeconomic status	42.4 (11.9)	43.9 (9.8)
Television sets (#)	3.0 (1.1)	2.7 (1.5)
Physical activity (average counts/min)	778.8 (229.5)	682.7 (178.1)
Television watching (h/wk)	24.3 (9.1)	23.7 (9.0)

Data are mean (SD).
SES: socioeconomic status. An SES of 46 through 48 is equivalent to medium size business owners, minor professionals and technical jobs, such as computer programmers, real estate agents, sales managers, social workers and teachers.
Subjects were children who lived in Erie county, New York between the summer of 2003 and winter of 2004.
* Boys significantly different than girls ($p<0.05$).

heavier ($p=0.02$), and had a greater BMI ($p=0.03$) and percentage overweight ($p=0.01$) than the boys. As shown in Table 2, there were no differences ($p>0.05$) between the boys' and girls' neighborhood environment characteristics.

For the prediction of total physical activity (Table 3), step 1 variables produced an R^2 of 0.14 ($p=0.28$). Addition of the number of televisions in the home in step 2 did not produce a significant incremental increase in R^2 ($p=0.37$). Housing density and the interaction of housing density by sex incrementally increased R^2 by 0.12 units ($p<0.05$) in step 3 and the percentage park plus recreation area incrementally increased R^2 by an additional 0.10 units ($p<0.01$) in step 4. The physical activity of girls and boys who live in neighborhoods with low (mean of 3.3 housing units/acre) and high (mean of 12.6 housing units/acre) housing density based on median splits of the housing density data is shown in Fig. 1. Greater housing density was associated with greater physical activity in boys, but not in girls. Boys who lived in neighborhoods with a high housing density engaged in greater ($p<0.01$) physical activity than girls who lived in neighborhoods with a high housing density. As shown in Table 4 similar results were found if percentage park area was used as a predictor rather than percentage park plus recreation area.

Table 2
Neighborhood built environment characteristics within a one-half mile radius of the subject's home

	Boys, $n=32$	Girls, $n=27$
Density (housing units/acre)	7.5 (5.5)	8.6 (6.6)
Street connectivity (intersections/mile)	5.9 (1.3)	5.8 (1.3)
Park area (feet$^2\times10^6$)	0.34 (0.70)	0.31 (0.60)
Recreation area (feet$^2\times10^6$)	0.42 (0.94)	0.24 (0.69)
Residential area (feet$^2\times10^6$)	10.78 (0.31)	9.27 (2.85)
Park area/residential area (%)	3.76 (7.66)	3.43 (6.94)
(Park area+recreation area)/residential area (%)	7.78 (10.19)	5.81 (7.95)

Data are mean (SD).
There were no differences ($p>0.05$) between the neighborhood characteristics of the boys and girls.
Subjects were children who lived in Erie county, New York between the summer of 2003 and winter of 2004.

Table 3
Univariate correlations of the predictor variables with physical activity and hierarchical regression model predicting total physical activity using percentage park plus recreation area as a predictor

	r	B	β	R^2 (unique)	95% CI R^2
Step 1				0.14	0.00–0.25
Sex		−43.74	−0.26		
Age	−0.21	2.59	0.13		
SES	−0.09	0.67	0.06		
%Overweight	−0.10	91.58	0.22		
Child television watching	0.22	0.74	0.03		
Step 2				0.01	0.00–0.13
# Televisions in home	0.12	11.82	0.07		
Step 3				0.12 *	0.00–0.30
Housing density	0.30 *	21.33	0.60		
Housing density by Sex		−18.94	−0.55		
Step 4					
%Park+recreation area	0.31 *	9.11	0.40	0.10 *	0.01–0.31
				Model R^2: 0.37	
				Final multiple $R=0.661$, $p<0.005$	

Sex: boys=0, girls=1.
r: Univariate correlation coefficient of independent variable with physical activity.
B: regression coefficient.
β: standardized regression coefficient.
R^2 (unique): incremental increase in R^2 at each step of the model.
95% CI R^2: 95% confidence interval of the incremental increase in R^2 at each step of the model.
Subjects were children who lived in Erie county, New York between the summer of 2003 and winter of 2004.
* $p<0.05$.

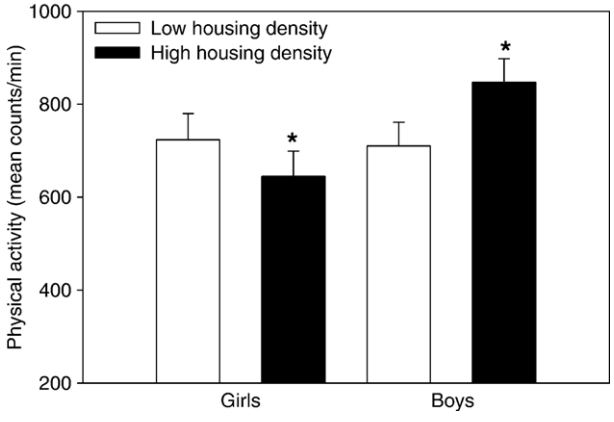

Fig. 1. Physical activity of 4- to 7-year-old boys and girls who live in neighborhoods with low and high housing density. Groups with a asterisk (*) engaged in significantly different amounts of physical activity. Boys who lived in neighborhoods with a high housing density engaged in greater ($p<0.01$) physical activity than girls who lived in neighborhoods with a high housing density. Subjects were children who lived in Erie county, New York between the summer of 2003 and winter of 2004.

Discussion

Consistent with previous work in two independent samples of 8- to 12-year-old youth, greater neighborhood park and recreation areas were associated with greater physical activity (Epstein et al., in press; Roemmich et al., in press). The percentage park area accounted for 9% of the variance in physical activity of older youth (Roemmich et al., in press) and for 10% in the present study. Based on the adjusted β coefficients from the hierarchical regression models and an overall mean physical activity of 734.8 counts/min, 1% increases in park+recreation area and park area were associated with 1.2% (9.1/734.8) and 1.4% (9.9/734.8) average increases in physical activity. In toto, these studies provide evidence that neighborhood parks are an important resource for providing opportunities for physical activity of youth (Bedimo-Rung et al., 2005).

In contrast to older youth (Epstein et al., in press; Roemmich et al., in press), neighborhood parks were not more strongly associated with boys' than girls' physical activity. A child's decision to stay in the home or play outside depends, in part, on the available alternatives at each location (Epstein and Roemmich, 2001). The lack of a sex by park area interaction in the present study suggests that commonly available park playground equipment or organized physical activities at parks are equally reinforcing for young boys and girls.

Greater housing density was also independently related to young children's physical activity. Increased proximity between homes may increase young children's ability and motivation and their parent's willingness to let their child walk to play with friends living in the neighborhood. Parents may also be more willing to facilitate play by walking with the child to a friend's home, if they live nearby. More dense neighborhoods are associated with greater physical activity in adults (Ewing, 2005; Frank et al., 2005), but an independent association of housing density with physical activity was not found in a previous study of older youth (Roemmich et al., in press). Housing density had a stronger effect on boys' than girls' physical activity. Future research should determine why housing density has a differential impact on young children's physical activity.

Table 4
Hierarchical regression model predicting total physical activity when separating the effects of percentage recreation area and percentage park area

	B	β	R^2 (unique)	95% CI R^2
Step 1			0.14	0.00–0.25
Sex	88.33	0.21		
Age	−41.70	−0.25		
SES	2.25	0.12		
%Overweight	0.43	0.04		
Child television watching	2.65	0.11		
Step 2			0.01	0.00–0.13
# Televisions in home	4.77	0.03		
Step 3			0.12 *	0.00–0.30
Housing density	20.64	0.59		
Housing density by Sex	−20.64	−0.460		
Step 4			0.02	0.00–0.16
%Recreation area	6.24	0.21		
Step 5				
%Park area	9.86	0.34	0.09 *	0.01–0.30
			Model R^2: 0.38	
			Final multiple R=0.61, p<0.01	

Sex: boys=0, girls=1.
B: regression coefficient.
β: standardized regression coefficient.
R^2 (unique): incremental increase in R^2 at each step of the model.
95% CI R^2: 95% confidence interval of the incremental increase in R^2 at each step of the model.
Subjects were children who lived in Erie county, New York between the summer of 2003 and winter of 2004.
* p<0.05.

We also tested whether physical activity was inversely related to the number of televisions or television watching. Increased access to reinforcing sedentary behaviors within the home increases time youth spend watching television (Dennison et al., 2002; Saelens et al., 2002), which decreases time that can be allocated to physical activity. However, neither the number of televisions or television watching were related to physical activity in young children who have a lot of free time to be active even if they do watch television. A recent quantitative review (Gorely et al., 2004) also concluded that television watching and physical activity are unrelated.

Study limitations and strengths

Study limitations include the lack of concurrent measures of whether additional physical activity that occurs in neighborhoods with parks is the result of walking to or playing at the park. Not including measures of parent physical activity prohibited studying the association of parent modeling of active behaviors on youth physical activity. Limiting the range of adiposity of the children at study entry prevented studying the associations of the home and neighborhood environments with BMI percentile.

Strengths include the focus on how the home and neighborhood environments are associated with young children's physical activity. The impact of the neighborhood environment on young children's physical activity was found to be different than older children who have greater autonomy to walk or bicycle in their neighborhood (Roemmich et al., in press). Objective measures of physical activity and of the home and neighborhood environments are also a major strength. These objective measures strengthen the validity of the reported relationships. Inclusion of environment attributes at the neighborhood scale is likely more predictive of young children's physical activity than county or metropolitan level attributes. A child's limited autonomy to travel forces them to make choices

between being physically active outdoors and watching television indoors at the neighborhood scale.

Conclusion

Neighborhoods with parks and denser housing are associated with greater physical activity in young children. The association of neighborhood parks on young children's physical activity is consistent with data from older youth and emphasizes the importance of designing neighborhood environments that support active living of children and their parents. Future research should include clinical trials that study differences in treatment efficacy of increasing youth physical activity based on differences in neighborhood park access.

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