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Physical Activity and Neighborhood Resources in High School Girls

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Abstract

Background—Physical activity behavior is influenced by a person's physical environment, but few studies have used objective measures to study the influences of the physical environment on physical activity behavior in youth. The purpose of this study was to examine the relationship between selected neighborhood physical activity resources and physical activity levels in high school girls.

Methods—Participants were students in schools that had participated in a large physical activity intervention trial. The 3-Day Physical Activity Recall was completed by 1506 12th-grade girls. Data on physical activity facilities and resources in the participating communities were collected using a variety of methods. Physical activity resources within a 0.75-mile street-network buffer around each girl's home were counted using ArcGIS, version 9.1. Mixed-model regression models were used to determine if there was a relationship between three physical activity variables and the number of physical activity resources within the 0.75-mile buffer. Data were collected in 2002–2003 and analyzed in 2006–2007.

Results—On average, 3.5 physical activity resources (e.g., schools, parks, commercial facilities) were located within the 0.75-mile street-network buffer. Thirty-six percent of the girls had no physical activity resource within the buffer. When multiple physical activity resources were considered, the number of commercial physical activity facilities was significantly associated with reported vigorous physical activity, and the number of parks was associated with total METs in white girls.

Conclusions—Multiple physical activity resources within a 0.75-mile street-network buffer around adolescent girls' homes are associated physical activity in those girls. Several types of resources are associated with vigorous physical activity and total activity in adolescent girls. Future studies should examine the temporal and causal relationships between the physical environment, physical activity, and health outcomes related to physical activity.

Introduction

Physical activity is known to exert a powerful influence on all-cause mortality and chronic-disease morbidity in adults.[1] In youth, mounting evidence indicates that physical activity is related to risk factors for chronic disease.[2] Recent marked increases in the prevalence of obesity in U.S. youth have prompted medical and public health authorities to call for large-scale efforts

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to increase physical activity in young people.[3] Such public health interventions appear to be particularly needed for adolescent girls, among whom the prevalence of overweight and obesity (≥85th percentile BMI for age) has risen to 30.4% in whites and 42.1% in African Americans.[4]

Previous research has shown that numerous factors correlate with physical activity behavior in youth.[5–9] It has been suggested that a social–ecologic model of health behavior may provide a useful theoretical framework for studying physical activity in young people. This model, based on social cognitive theory, posits that physical activity behavior is likely to be influenced by a comprehensive set of personal, social–environmental, and physical–environmental factors.[10] Most previous research on physical activity behavior in youth has focused on personal characteristics such as demographic, physical, and psychosocial factors.[7,11] Some research has addressed the roles of social factors such as peer and parental influences on physical activity.[12–14] However, very little previous research has examined the influence of physical environmental factors on physical activity in young people. Particularly limited are studies that utilize objective measures of the physical environment.[15]

It is known that school-based factors influence students' physical activity,[16] but surveys have shown that most of a typical young person's physical activity is performed outside of the school setting and during nonschool hours.[17] Accordingly, it is logical to hypothesize that the physical characteristics of a young person's neighborhood may influence his or her physical activity behavior. Similar hypotheses have been tested in adults,[18] but few previous studies have used objective measures of physical environmental factors to study influences on physical activity in youth.[15] Accordingly, the purpose of the present study was to examine the relationship between selected neighborhood physical activity resources and physical activity levels of high school girls. It was hypothesized that the availability of physical activity resources within walking distance of girls' homes would be positively associated with their physical activity levels.

Methods

Subjects

All 12th-grade girls in 22 high schools in South Carolina during two school years were asked to participate (N=5752; 42% African American, 54% white). The high schools, which were located in urban, suburban, and rural areas of the state, had participated in a physical activity intervention trial.[19] Schools were chosen for the trial with the goal of having approximately 50% African-American girls in the study population. Of the 2136 girls who consented (aged ≥18) or obtained parent/guardian consent (37.1%), 1609 completed at least a portion of the study measures, and 1503 (54.6% African American, 41.4% white) completed the physical activity measures. Girls also provided their age, race, address, and parent education. All data were collected during the spring semester. The procedures were approved by the IRB at the University of South Carolina. Girls aged 18 and older provided written informed consent. For girls aged <18, a parent or guardian provided informed consent and the girl gave assent to participate. Data were collected in 2003–2003 and analyzed in 2006–2007.

Physical Activity

Physical activity was assessed using the 3-Day Physical Activity Recall (3DPAR), which has been validated in 8th- and 9th-grade girls.[20] The 3DPAR is a self-report instrument that requires participants to recall physical activity behavior from the previous 3 days, beginning with the most recent day. The instrument was always administered on a Wednesday; participants recalled their activities on Tuesday, Monday, and Sunday, and completed a grid for each day. The grid was divided into 30-minute time blocks, beginning at 7:00 AM and ending

at 12 MN. Girls reported their predominant activity in each block, using a list of 55 common activities grouped into categories (sleep/bathing, eating, work, after-school/spare-time/hobbies, transportation, and physical activities/sports) to facilitate identifying and reporting the predominant activity. Data were reduced to summary variables: number of 30-minute blocks of vigorous physical activity (VPA, ≥6 METs) per day, number of 30-minute blocks of moderate-to-vigorous physical activity (MVPA, ≥3 METs) per day, and total METs per day. MET values were obtained from the Compendium of Physical Activities.[21]

Approximately 50% of the girls reported working during the 3-day period. Because girls could not be participating in physical activity at a neighborhood facility while they were at work, physical activity reported during work hours was not included in the analyses.

Body Mass Index

Height was measured to the nearest 1.0 cm with a portable stadiometer, and weight was measured to the nearest 0.1 kg with a digital scale. BMI was calculated by dividing weight in kilograms by height in meters squared.

Socioeconomic Status and Race

There were two socioeconomic variables. The first was the highest level of reported parent education, which was dichotomized into high school graduate or less and greater than a high school education. The second socioeconomic variable was median household income of the U.S. Census tract where a girl lived. A self-reported race variable was dichotomized into white and African-American participants; the small number of girls who reported other races or ethnicities was excluded from the analyses.

Facilities for Physical Activity

The 22 participating high schools were located in 13 counties in South Carolina. The addresses of physical activity facilities in those counties, including colleges and universities, schools, churches, parks, and commercial facilities were collected through a variety of methods. Internet search engines, Internet Yellow Pages, data from the South Carolina Department of Education, the South Carolina state parks website, surveys of and interviews with park directors, and handheld GPS units were used to identify and confirm facilities' addresses. Commercial facilities were placed into three categories: team, individual, and multipurpose. Athletic organizations, sports clubs (baseball/softball, basketball, and soccer), and facilities for cheerleading, golf, gymnastics, hockey, paintball, and swimming were grouped as team commercial facilities (n=160). Facilities for bowling, dance, diving, martial arts, racquetball, self-defense instruction, skating, tennis, yoga, horseback riding, sky-diving instruction, SCUBA diving, sailing, rock climbing, and health clubs were classified as individual commercial facilities (n=736). Recreation centers, youth organizations, and clubs were grouped as multipurpose commercial facilities (n=76). Overall, 91.6% of the addresses were successfully geocoded.

Statistical Analyses

Physical activity resources within a 0.75-mile street-network buffer around each girl's home were counted using ArcGIS, version 9.1s. The 0.75-mile street-network buffer was chosen because it represents approximately a 15-minute walk. The total number of each type of physical activity resource within this buffer was calculated for each participant. Skewed variables (MVPA, VPA, and all physical activity resources) were transformed by taking the square root. Descriptive statistics for the neighborhood physical activity resources were calculated for the total group and by race.

Mixed-regression models (SAS, version 9.1) were used to determine if there was a relationship between the number of physical activity resources and the three physical activity variables.[22] Unadjusted and adjusted models were run for each type of physical activity resource (i.e., churches, parks, schools, commercial facilities). Covariates in the adjusted models included race, parent education, BMI, and median household income. A final set of adjusted models for total METs, MVPA, and VPA were completed with all physical activity resources simultaneously considered. Also, interactions of race and neighborhood physical activity resources were tested in the final set of models and interactions with $p<0.5$ were retained. All models controlled for group (control or intervention), and school was treated as a random variable. After deletions for girls whose addresses were not geocoded ($n=202$), who reported race other than white or African American ($n=57$), or who were missing data for race, parent education, or median household income ($n=5$), 1234 girls were included in the analyses.

Results

Fifty-six percent of the girls were African American, and 64.2% had a parent with greater-than-high school education. The mean age of the girls was 17.7 (SD=0.6) years, mean BMI was 25.1 (SD=6.4), and the median household income was $40,531 (SD=$15,175).

On average, two churches were located within the 0.75-mile street-network buffer of a girl's home. Approximately 25% of the girls lived within the 0.75-mile street network of at least one commercial facility. Similarly, 26% of girls lived within the 0.75-mile street network of one or more parks, and 28% lived within 0.75-mile of one or more schools (Table 1). There were 3.5 physical activity resources for each girl on average. Thirty-six percent of the girls had no physical activity resources within the 0.75-mile street-network buffer of their homes. Across each of the three physical activity measures (total METs, VPA, and MVPA), white girls were more physically active than African-American girls (Table 2).

Table 3 shows the results of regression analyses for both the unadjusted (with school as a random variable) and adjusted models that examined the relationships between the three physical activity variables and churches, parks, and types of schools examined separately (i.e., facility-specific analyses). The number of colleges was significantly associated with total METs in both the unadjusted and the adjusted model. Both the number of parks and the number of churches were associated with the number of reported 30-minute blocks of VPA in the adjusted but not the unadjusted models. The number of individual, multipurpose, and total number of commercial facilities was significantly related to the number of reported 30-minute blocks of VPA in both the unadjusted and adjusted models (Table 4).

Results of the combined neighborhood facility analysis are shown in Table 5. This model simultaneously considered commercial facilities, schools, parks, and churches as well as the interacting effects between facilities and race while controlling for race, BMI, parent education, and median household income. The commercial facilities variable was significantly associated with the number of blocks of VPA ($p=0.02$). For white girls there was an increase in total METs with an increase in the number of parks. The interaction of parks with race was significantly associated with total METs ($p=0.01$).

Discussion

In the present study, direct associations between GIS-derived physical–environmental factors and self-reported physical activity were detected at the individual level among high school girls. An association was found between VPA in 12th-grade girls and several physical activity resources, including churches, parks, and individual and multipurpose commercial facilities. In addition, the number of colleges was associated with total METs. When all physical activity

resources were combined in a single model, total commercial facilities remained significantly associated with number of 30-minute blocks of VPA. The availability of parks was significantly associated with total METs for white adolescent girls. These findings are consistent with the premises of the social–ecologic model for physical activity, which proposes that the physical environment exerts an influence on the physical activity behaviors of individuals.[7,23]

Vigorous physical activity was significantly related to the number of commercial facilities within the 0.75-mile street-network buffer in both the facility-specific and combined facility analyses in this study. Activities performed in facilities such as dance studios, recreation centers, and tennis courts are often of vigorous intensity. Others studies have found positive relationships between commercial facilities and physical activity in girls, most notably Norman et al.,[24] who found that the number of private recreational facilities was associated with MVPA as measured by accelerometry in girls aged 11–15. The relationship between the number of facilities and physical activity also was supported in work completed by Gordon-Larsen and colleagues,[25] although in their study the operational definition of facilities included not only commercial facilities but also schools and parks.

This study also confirms previous research that shows a relationship between the number of available parks nearby and physical activity in adolescent girls.[26] In the facility-specific analyses, the number of parks was associated with the number of blocks of VPA. In the combined facility analysis, parks were associated with total METs in white girls only. For each park within the 0.75-mile street-network buffer of a white girl's home, there was an increase in total METs. Racial differences in the use of parks have been reported previously in the adult literature.[27] Racial differences seen in this study also may be a function of differential access to and subsequent use of quality parks, safe parks, or both. It should be noted that other studies have failed to find an association between physical activity and the number of nearby parks in all-boy samples[28] and in multivariate models of girls.[24] In addition, one study found that the distance to the nearest park was significantly associated with physical activity in boys but not girls in inner-city youth.[29] Given these contradictory studies, further research is needed to explore additional factors (i.e., quality and safety of parks) that may explain the differential results across racial and gender subgroups.

After adjusting for race, BMI, SES, and median household income, there was a significant relationship between churches and VPA. Many churches have physical activity teams and facilities such as gyms or outdoor basketball goals, or they provide open spaces in which to be active. This is the first study to examine objective measures of the number of churches nearby and physical activity. White girls reported more activity than African-American girls, but more African-American girls had a church near their homes, and they attended church more often than white girls.[30] In a study of adult, church-going African-American women, physical activity programs at a woman's church were significantly associated with meeting MVPA recommendations.[31] Churches could serve as sites for interventions designed to help African-American adolescent girls become more active, as was attempted in Go Girls!, a church-based nutrition and physical activity program designed for African-American girls.[32]

Finally, the number of colleges nearby was significantly associated with total METs. We cannot determine from this study why proximity to college campuses was associated with increased METs for this population. College campuses may offer increased access to physical activity facilities, may be located in areas of high walkability or mixed land use, or may provide for differential social norms for physical activity. They also may provide open spaces for physical activity or offer lessons and programs in sports, dance, or other types of physical activity for children and youth. Future studies should examine these possibilities.

To date, this study is one of the most comprehensive investigations that has examined, at the individual level, the association between physical activity and objectively measured physical activity resources in adolescent girls. The study is particularly interesting because it focuses on adolescents who are in transition from childhood and dependence on parents for decision-making and resources to young adulthood and the increased independence of college or employment. The study included a wide range of neighborhood facilities that have particular importance as physical activity resources in this age group, as well as physical activity resources that have not been considered previously (e.g., churches). In addition, the study found that certain types of physical activity resources may be associated with VPA. These include individual and multipurpose commercial facilities, parks, and churches.

This study was unique because it examined the association of physical activity with a wide range of community resources, including schools and churches, where girls can be physically active. The study had a number of strengths, including the diverse sample and the diverse geographic areas studied. The study included nearly equal numbers of white and African-American adolescent females, allowing for tests of interactions across race. The study area encompassed 13 counties, with widely varied levels of access to physical activity resources. Previous studies have cited limited geographic variability as a shortcoming.[24]

The findings of the study should be interpreted in light of the following limitations. First, the study examined the availability of physical activity facilities rather than the actual use of facilities by study participants. Further, the study could not categorize facilities as safe, high quality, attractive to girls, or affordable, characteristics that may be important predictors of use. Second, physical activity was measured by a self-report instrument, which may be subject to response bias; however, the instrument has been validated against accelerometry in adolescent girls.[20] Third, multiple statistical tests were performed, and a small percentage of the observed significant associations may have been due to chance. Fourth, the study population was not selected at random. Finally, the study included only adolescent girls, and therefore conclusions about boys or other age groups are not possible.

In the present study, correlations between physical activity resources and nonwork physical activity were significant but small in magnitude. This is consistent with previous research that has reported that the physical environment per se, either perceived or objectively measured, consistently explains a significant but small (usually <5%) portion of the variance in physical activity among adolescents.[7,24,33,34] Nevertheless, these relationships are likely to influence health outcomes linked to physical activity because the physical environment affects all individuals in a population over extended periods of time. Studies assessing the temporal and causal relationships between the physical environment (and its changes) and health-related outcomes are an important next step in this research.

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Table 1

Number of neighborhood facilities proximal to homes of high school girls (N=1234)

Variables	Number					
	Mean	SD	Range	% girls with ≥1		
				White	AA	Total
Churches	2.08	3.80	0–32	46.2	60.2	54.1
Commercial facilities	0.48	1.09	0–9	24.4	25.4	25.0
Individual-activity facilities[a]	0.38	0.93	0–9	20.7	21.0	20.9
Team-activity facilities[b]	0.03	0.16	0–2	2.8	2.2	2.4
Multipurpose-activity facilities[c]	0.08	0.31	0–3	6.4	6.7	6.6
Parks	0.46	1.01	0–7	20.4	30.8	26.2
Schools[d]	0.50	1.01	0–8	27.5	28.6	28.1
Colleges	0.02	0.15	0–2	0.9	2.8	1.9
Private	0.18	0.59	0–8	12.7	12.1	12.3
Public	0.30	0.65	0–4	20.7	21.9	21.4
Total	3.52	5.77	0–45	57.8	69.5	64.3

[a] Dance studios, diving, health clubs, martial arts, racquetball courts, rock climbing, sailing, SCUBA diving, self-defense instruction, skating rinks, sky-diving instruction, stables, tennis, yoga.

[b] Athletic organizations, baseball/softball clubs, basketball clubs, cheerleading, golf, gymnastics, hockey, paintball, soccer clubs, swimming pool.

[c] Recreation centers, youth organizations, and clubs.

[d] Includes public, private, charter, and colleges.

AA, African American

Table 2

Physical activity variables in high school girls (N=1234)

Physical activity variable	Total	White (*n*=545)	African American (*n*=689)
Total METs	53.5 (11.9)	55.5 (12.0)	**51.9 (11.6)** *
Number blocks of MVPA	2.5 (2.3)	2.9 (2.3)	**2.2 (2.2)** *
Number blocks of VPA	0.7 (1.2)	1.0 (1.4)	**0.6 (1.1)** *

Note: Mixed-model regression with school as a random variable with square-root transformed MVPA and VPA, but untransformed means reported.

* $p<0.001$.

MVPA, moderate-to-vigorous physical activity; VPA, vigorous physical activity

Table 3

Regression models for relationships between physical activity and number of neighborhood facilities and their proximity to girls' homes (unstandardized beta)

Variable	Churches[a]			Parks[a]			Schools[a]											
							Colleges			Private			Public			All		
	β	(SE)	*p*	β	(SE)	*p*	β	(SE)	*p*	β	(SE)	*p*	β	(SE)	*p*	β	(SE)	*p*
												Unadjusted						
Total METs	0.229	(0.32)	0.48	0.175	(0.59)	0.76	**4.6**	**(2.4)**	**0.05**	0.056	(0.86)	0.95	0.610	(0.70)	0.39	0.385	(0.57)	0.53
# blocks MVPA[a]	0.017	(0.02)	0.45	−0.01	(0.04)	0.74	0.084	(0.17)	0.61	−0.014	(0.06)	0.82	0.054	(0.05)	0.27	0.028	(0.04)	0.47
# blocks VPA[a]	0.004	(0.02)	0.83	0.017	(0.03)	0.63	0.125	(0.14)	0.37	0.016	(0.05)	0.74	0.020	(0.04)	0.63	0.011	(0.03)	0.74
												Adjusted						
Total METs	0.567	(0.32)	0.09	0.711	(0.59)	0.23	**5.7**	**(2.3)**	**0.02**	0.033	(0.85)	0.97	0.970	(0.70)	0.17	0.531	(0.56)	0.35
# blocks MVPA[a]	0.044	(0.02)	0.06	0.021	(0.04)	0.61	0.185	(0.06)	0.26	−0.015	(0.06)	0.79	0.078	(0.05)	0.79	0.042	(0.04)	0.29
# blocks VPA[a]	**0.040**	**(0.02)**	**0.04**	**0.071**	**(0.03)**	**0.04**	0.245	(0.14)	0.07	0.015	(0.05)	0.76	0.062	(0.04)	0.76	0.036	(0.03)	0.28

Note: Mixed-model regression with school as a random variable and controlling for group, race, SES (parent education), median household income, and BMI.

[a]Square-root transformed.

MVPA, moderate-to-vigorous physical activity; VPA, vigorous physical activity

Table 4

Regression models for relationships between physical activity and number of commercial facilities proximal to girls' homes (unstandardized beta)

	Commercial facilities											
	Individual facilities			Team facilities			Multipurpose facilities			All		
Variable	**β**	**(SE)**	***p***	**β**	**(SE)**	***p***	**β**	**(SE)**	***p***	**β**	**(SE)**	***p***
	Unadjusted											
Total METs	0.993	(0.62)	0.11	10.19	(2.2)	0.58	1.40	(1.3)	0.27	0.83	(0.56)	0.14
# blocks MVPA[a]	0.017	(0.04)	0.70	0.270	(0.15)	0.08	0.069	(0.09)	0.44	0.024	(0.04)	0.54
# blocks VPA[a]	0.088	(0.04)	0.02	0.122	(0.13)	0.27	0.195	(0.07)	0.01	0.097	(0.03)	<0.01
	Adjusted											
Total METs	0.908	(0.62)	0.14	1.78	(2.2)	0.42	1.41	(1.3)	0.26	0.82	(0.56)	0.14
# blocks MVPA[a]	0.016	(0.04)	0.72	0.293	(0.16)	0.06	0.075	(0.09)	0.39	0.026	(0.04)	0.50
# blocks VPA[a]	0.090	(0.04)	0.01	0.109	(0.13)	0.39	0.201	(0.07)	0.01	0.10	(0.03)	<0.01

Note: Mixed-model regression with school as a random variable and controlling for race, SES (parent education), median household income, and BMI.

[a]Square-root transformed.

MVPA, moderate-to-vigorous physical activity; VPA, vigorous physical activity

Table 5

Results of mixed regression analyses for relationships between total METs, MVPA, VPA, and neighborhood physical activity resources

Independent variable	Total METs		MVPA[a]		VPA[a]	
	β (SE)	*p* value	β (SE)	*p* value	β (SE)	*p* value
Intercept	54.88 (2.00)	<0.001	1.20(0.14)	<0.001	0.45 (0.12)	0.001
Group (control)	0.62 (0.76)	0.42	0.00 (0.05)	0.95	0.03 (0.05)	0.60
Total commercial PA facilities[a]	0.41 (0.67)	0.55	−0.01 (0.05)	0.90	0.09(0.04)	0.02
Total schools[a]	−0.34 (0.72)	0.64	−0.00 (0.05)	0.93	−0.03 (0.04)	0.43
Churches[a]	0.47 (0.45)	0.29	0.05 (0.03)	0.09	0.02 (0.03)	0.48
Parks[a]	−0.88 (0.83)	0.29	−0.03 (0.05)	0.56	0.02 (0.04)	0.57
Race (white)	2.04 (0.83)	0.01	0.25 (0.5)	<0.001	0.20 (0.04)	<0.001
Race X parks (white)	3.34 (1.26)	0.01	—	—	—	—
BMI	−0.12 (0.05)	0.03	−0.00 (0.00)	0.74	−0.01 (0.00)	0.02
Parent education (<high school)	−0.94 (0.73)	0.20	−0.03 (0.05)	0.52	−0.09(0.04)	0.04
Median household income	0.00 (0.00)	0.72	0.00 (0.00)	0.32	0.00 (0.00)	0.02

Note: Results adjusted for group, BMI, race, parent education, and median household income, and with school as a random variable.

[a]Square-root transformed.

MVPA, moderate-to-vigorous physical activity; PA, physical activity; VPA, vigorous physical activity