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ORIGINAL ARTICLE

Commercial Facilities, Social Cognitive Variables, and Physical Activity of 12th Grade Girls

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Abstract
Background Recent studies have found a relationship between access to neighborhood physical activity (PA) facilities and physical activity in youth.
Purpose The purpose of this study was to assess whether proximity of commercial PA facilities was related to vigorous physical activity (VPA) in 12th grade girls, independent of sport participation and social-cognitive influences, including perceived features of the social and physical environment.
Methods Girls (N=1,126 girls; 55% black, body mass index=25.0±6.4) in 22 high schools completed questionnaires and provided home addresses. Using geographic information systems technology, commercial PA facilities were mapped and counted within 0.75- and 2.0-mile street network buffers around each girl's home. Girls self-reported PA using the 3-day physical activity recall.
Results Approximately 25% of girls had at least one PA facility within the 0.75-mile buffer, and 65% of girls had at least one PA facility within the 2.0-mile buffer. Models of the direct and indirect relations of commercial PA facilities at 0.75- and 2.0-mile buffers, sport participation, self-efficacy for overcoming barriers and perceived physical and social environment with VPA both had acceptable fit to data (root mean square error of approximation=0.049 and comparative fit index=0.91).
Conclusions The results indicate that proximity to multi-purpose commercial PA facilities is a correlate of VPA independent of sport participation and perceived features of the social and physical environment.

Keywords Physical activity · Girls · Neighborhood · Facilities

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Introduction

Physical activity (PA) decreases during adolescence, especially among girls [1, 2]. The decline in PA may help to explain the recent increase in overweight among youth [3]. Kimm et al. [2] reported a decline in PA that occurred in girls followed from age 9 or 10 to age 18 or 19. Each decline in PA of ten metabolic equivalents (MET)-times per week was associated with an increase in body mass index (BMI) of 0.14 kg/m^2 [4]. The built environment (structures that people have assembled in which to live, work, travel, and play) may be one factor that influences PA and adiposity of adolescents [5, 6].

Both the perception of living near PA facilities and the objective measure of facilities derived using geographic information systems (GIS) are related to PA in both adults and youth [7, 8]. Using GIS, Norman et al. [9] reported that

the number of recreational facilities within a 1-mile buffer of the homes of 11- to 15-year-old youth correlated positively with girls' PA.

It has been suggested that more complex models be used to study the relationship between PA and the attributes of the environment [8]. One way to do this is to use a social cognitive framework that considers personal factors as well as social and physical environment factors simultaneously. The use of social cognitive theory is one approach used to study PA correlates [10]. Social cognitive theory proposes that behavior change is affected by social- and physical–environmental influences (e.g., social support, perceived and actual opportunities and barriers), personal factors (e.g., self-efficacy for overcoming barriers), and attributes of the behavior itself [11]. These factors have been associated with PA in adolescent girls [12, 13].

Several recent publications have reported on the LEAP intervention [14] and follow-up of 12th grade girls from 22 high schools in South Carolina. Self-efficacy for overcoming barriers to physical activity accounted for the cross-sectional relation between physical activity and girls' perceptions of environmental access in the 9th [15] and the 12th grades [16] and accounted for part of the relation between perceived social support and physical activity in the 12th grade. In another LEAP study using GIS technology, the number of 30-min blocks of vigorous physical activity (VPA) was associated with proximity to the total number of commercial PA facilities (individual, multipurpose, and team facilities) within 0.75-mile street network buffer of the homes of 1,234 12th grade girls [17].

The purpose of this study was to assess whether proximity of commercial PA facilities was related to VPA in 12th grade girls, independent of sport participation and social-cognitive influences on PA (perceived social and physical environment and self-efficacy for overcoming barriers to PA). Direct and indirect relations among the variables were estimated using structural equation modeling. Data were collected from 12th grade girls enrolled in LEAP 2 (2002–2003), a follow-up study of girls from 22 schools that had participated in the LEAP physical activity intervention [14].

Methods

Participants and Study Design

Twenty-four schools (12 intervention and 12 control) which were located in urban, suburban, and rural areas of South Carolina participated in a ninth grade physical activity intervention [14]. Two of the control schools merged during the study, and one of the intervention schools was an extended middle school that included ninth grade, but no other high school grades. Therefore, 22 schools were available to participate in the 12th grade follow-up data collection, and all 12th grade girls were invited to participate (N=5,752; 42% black, 54% white). A total of 1,655 12th grade girls participated in the measurement protocol.

Trained data collectors administered the measures to participants in groups of 20–30 girls. The data collectors employed standardized protocols and scripts when administering the measures. Of 1,655 participants, 1,503 completed the physical activity measure (54.3% black, 41.1% white, 4.6% other race/ethnicity or missing race). Girls also provided home addresses, race, parent education, and age and completed questionnaires. The procedures were approved by the Institutional Review board of the University of South Carolina. Each participant and her parent or guardian (girls <18 years) provided written informed consent.

Physical Activity and Sport Participation

Twelfth grade girls completed the 3-day physical activity recall (3DPAR) This instrument has been validated against accelerometry in eight and ninth grade girls [18]. VPA as measured by the 3DPAR was correlated (r=0.41, p<0.001) with log-transformed VPA by accelerometry. The 3DPAR uses a script and graphic figures to explain the intensity level of common activities. Light activities are described as requiring little or no movement with slow breathing, moderate activities as some movement and normal breathing, hard activities as moderate movement and increased breathing, and very hard activities as quick movements and hard breathing. The instrument was administered by trained research assistants in the spring of each study year on a Wednesday. Participants were asked to recall their activities on the previous 3 days (first Tuesday, then Monday, then Sunday). For each day recalled, participants completed a grid, which was divided into 30-min time blocks, beginning at 7 A.M. and ending at midnight. Participants reported the predominant activity in each 30-min block. A list of 58 common physical activities and sedentary behaviors was provided. There was an option on the list to add an 'other' activity they had performed. Participants entered the number of an activity and indicated whether the activity was performed at a light, moderate, hard, or very hard intensity. Because many of the girls reported employment and girls would not be able to use commercial PA facilities while at work, activity accumulated while at work was deleted for this study. The average number of 30-min blocks of VPA (six or more METs) was calculated and whether or not girls accumulated one or more 30-min blocks of VPA per day, and two or more blocks of MVPA (three or more METs) was determined. MET values were obtained from the Compendium of Physical Activities [19].

Girls were also asked about school and other sport team participation within the past year using questions adopted

from the Youth Risk Behavior Surveillance Survey [20]: "During the past 12 months, how many sports teams run by your school did you play on? (DO NOT include PE classes)" and "During the past 12 months, how many sports teams run by organizations outside your school did you play on?" Girls who responded yes to either question were considered sport team members.

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.

PA Commercial Facilities and Geocoding

Concurrent with the 2-year period when girls were being consented and measured, commercial PA facilities were identified in the 13 counties where the 22 high schools were located. A total of 972 commercial PA facilities (individual=736, multipurpose=76, and team=160) were identified through selected search engines (SmartPages, WhitePages, QwestDex, reversedirectory, the-internet-yellowpages) and telephone books, and the two methods were used to confirm each other. For identified facilities with names or descriptions seemingly questionable as PA supports, telephone calls were made to verify the nature of the facility. Athletic organizations, baseball/softball, basketball, soccer clubs, cheerleading, golf, gymnastic, hockey, paintball, and swimming PA commercial facilities were grouped as team facilities. Bowling, dance, diving, martial arts, racquetball, self-defense instruction, skating, tennis, yoga, horseback riding, sky diving instruction, scuba diving, sailing, rock climbing facilities, and health clubs were grouped as individual PA commercial facilities. Recreation centers and youth organizations and clubs were grouped as multipurpose PA commercial facilities. Overall, 85% of the addresses of the commercial PA facilities were successfully geocoded.

Addresses for 1,309 (53.1% black, 41.9% white) of the 1,503 girls were successfully geocoded (87%). Commercial PA facilities around each of the girls' homes were counted within a 0.75- and 2.0-mile street network buffers using GIS. A 0.75-mile buffer was chosen because it represents approximately a 15-min walk and the 2.0-mile a short drive [21].

Socioeconomic Status

Two measures of socioeconomic status were obtained. The highest education level of either parent as reported by the girls was dichotomized into high school or less and greater than a high school education. The second measure of socioeconomic status used was based on the geocoded address and 2000 US Census [22] data for the block group median household income.

Perceived Environment

The perceived environment was measured using two items with responses of 1=disagree a lot to 5=agree a lot. Perceived equipment accessibility and perception of access to facilities to be active were assessed using the following: (1) At home, there are enough supplies and pieces of sports equipment to use for physical activity, and (2) there are playgrounds, parks, or gyms close to my home or that I can get to easily. These two items were used separately in analyses.

Perceived Social Support

Twenty-four items were included on the questionnaire to measure social support. The items were rated on a five-point Likert-type scale that ranged from 1 (disagree a lot) to 5 (agree a lot) and corresponded to six four-item subscales: reliable alliance, attachment, guidance, nurturance, social integration, and reassurance of worth [23]. For the present analysis, only guidance, nurturance, and reassurance of worth subscales (12 items) were used to measure perceived social support, which were common between black and white girls [23]. These three subscales provided a measure of perceived social support that was significantly related to physical activity in adolescent girls [24]. In the present group of girls, Cronbach's alpha was 0.75 for guidance, 0.73 for nurturance, 0.65 for reassurance of worth, and 0.80 for the total scale.

Self-Efficacy for Overcoming Barriers

Perceived self-efficacy for overcoming barriers to physical activity was measured using eight items with responses of 1=disagree a lot to 5=agree a lot [25]. Cronbach's alpha was 0.78.

Statistical Analysis

Descriptive Statistics

Means (standard deviations) and frequencies were calculated for the study variables. Independent *t* tests were calculated for reported number of blocks of VPA by the categorical variables.

Structural Equation Model

Using AMOS (version 5.0), two structural equation models (SEM) were tested; one model used the 0.75-mile buffer

and the second used the 2.0-mile buffer for the number of PA commercial facilities. The structural model included three correlated exogenous latent variables: perceived access to home sports equipment (one indicator), perceived access to physical activity facilities (i.e., playgrounds, parks, or gyms) near the home (one indicator), and perceived social support (three indicators) and two endogenous latent variables: perceived barriers self-efficacy (eight indicators) and self-reported VPA (three indicators). PA commercial facilities were modeled as three exogenous observed scores. The model also included race, median household income, BMI, and sport team membership as exogenous covariates. Correlations were estimated among all exogenous latent variables. The structural model included direct paths from (1) perceived access to home sports equipment, perceived access to physical activity facilities, social support, 3 PA commercial facility variables, race, median household income, BMI, and sport team membership to endogenous variables of barriers self-efficacy and VPA and (2) from barriers self-efficacy to VPA. The indirect effects were tested for significance using bias-corrected bootstrap (1,000 samples) 95% confidence intervals [26]. Models with group (control, intervention) as an exogenous covariate were also examined.

Model fit was assessed according to multiple fit indices using decision rules described by Hoyle [27] and others. A χ^2 value that is non-significant is an indicator of optimal fit, but it is too sensitive to a large sample, so other indices are commonly used. The root mean square error of approximation (RMSEA) represents closeness of fit. Values of ≤0.06 represent a close fit, while 0 represents an exact fit [28]. The comparative fit index (CFI) tests the proportionate improvement in fit of the target model with the null model. CFI values approximating 0.90 indicate a minimally acceptable fit [29].

Results

Descriptive Statistics

After deletions for missing data for one or more days of physical activity (n=55), BMI (n=32), median household income (n=6), family support (n=19), social provisions (n=3), parent education (n=6), and race/ethnicity and other races (n=64), 1,126 girls were included in the analyses. Fifty-five percent of the girls were black (Table 1), their mean age was 17.7 (SD=0.6) years, 65% of the girls had at least one parent with greater than a high school education, and 52% were sport team members. White girls (white=0.98±1.1; black=0.55±0.3, p<0.001) and girls with a least one parent with greater than a high school education (>high school 0.81±1.2; ≤high school 0.62±1.2, p<0.001) and sport team members (sport tem=1.08±1.4; non-member=0.37±0.8) reported greater number of 30-min blocks of VPA than their counterparts. There were no differences between girls in the control and intervention schools for the number of 30-min blocks of VPA (control=0.79±1.3; intervention=0.70±1.2, p=0.20).

Table 1 Characteristics of 1,126 girls

Characteristic	Mean (SD) percent
Black (%)	55.1
Age (years)	17.7 (0.6)
BMI	25.0 (6.4)
Median household income	$40,689 (15,280)
Parent >High School education (%)	64.5
Sport team member (%)	52.3
Control group (%)	44.1
Perceived barriers self-efficacy	3.7 (0.7)
Perceived social support	3.5 (0.7)
Perceived equipment accessibility	3.7 (1.4)
Perceived access to gyms and parks	3.8 (1.4)
Number of 30-min blocks of VPA	0.7 (1.2)
≥2 blocks of MVPA (%)	74.5
≥1 block of VPA (%)	34.9

BMI body mass index, *MVPA* moderate-to-vigorous physical activity, *VPA* vigorous physical activity

Approximately 25% of the girls had one or more commercial PA facilities within the 0.75-mile street network of their homes and 65% had one or more PA facilities within the 2.0-mile buffer. More of the girls had a PA facility that provided individual activities such as dance classes or martial arts studios (Table 2) than the other two types of PA commercial facilities.

Pearson bivariate correlations among the variables are displayed in Table 3. Number of multipurpose and individual PA commercial facilities, median household income, sport team membership, perceived equipment accessibility, perceived social support, and barriers self-efficacy had significant positive associations with VPA. BMI had a significant negative association with VPA.

Structural Equation Model

The SEM model (Fig. 1) provided an acceptable fit [χ^2=643.1, df=173, p<0.001, RMSEA=0.049 (95% CI, 0.045, 0.053) and CFI=0.909]. Solid lines in the figure show significant relations, while dashed lines represent non-significant relations. Perceived access to physical activity facilities was negatively related to self-reported VPA, while social support, multipurpose commercial PA facilities, and barriers self-efficacy were positively associated with self-reported VPA. Social support had a significant positive

Table 2 Commercial physical activity facilities

Type of facility	0.75-mile street network buffer				2.0-mile street network buffer			
	Mean	(SD)	Range	Percent[a]	Mean	(SD)	Range	Percent[a]
Team facilities	0.02	0.16	0–2	2.3	0.17	0.49	0–4	13.1
Athletic organizations								
Baseball/softball clubs								
Basketball clubs								
Cheerleading								
Golf								
Gymnastics								
Hockey								
Paintball								
Soccer clubs								
Swimming pool								
Individual	0.36	0.87	0–7	20.7	2.6	3.8	0–18	55.6
Bowling								
Dance								
Diving								
Health club								
Martial arts								
Racquetball courts								
Rock climbing								
Sailing								
Scuba diving								
Self-defense instruction								
Skating rinks								
Sky diving instruction								
Stables								
Tennis								
Yoga								
Multipurpose	0.08	0.32	0–3	6.5	1.1	2.7	0–15	36.3
Recreation center								
Youth organizations and clubs								
Total	0.46	1.06	0–9	24.7	3.9	5.6	0–33	65.2

[a] Percent of girls with 1 or more commercial PA facilities

relationship with perceived barriers self-efficacy. Significant ($p<0.05$) direct relationships (standardized regression weight β) with VPA were observed for multipurpose commercial PA facilities ($\beta=0.07$), perceived access to facilities ($\beta=-0.07$), race ($\beta=-0.08$), median household income ($\beta=0.07$), sport team membership ($\beta=0.16$), perceived social support ($\beta=0.24$), and barriers self-efficacy ($\beta=0.13$). Small but significant ($p<0.05$) indirect relationships (i.e., mediated by self-efficacy) with VPA were observed for perceived social support ($\beta=0.07$) and perceived access to physical activity facilities ($\beta=0.01$). The model accounted for 40% (95% CI, 32–47%) of the variance in self-efficacy and 22% (95% CI, 15–27%) of the variance in VPA. The results for the 2.0-mile street network buffer substantively gave the same results (Fig. 2). Also, analyses with group (control, intervention) as an exogenous covariate did not alter the results.

The inverse relation of VPA with perceived access to facilities, but positive relation with self-efficacy, indicated suppression (i.e., inconsistent mediation) of the relation between perceived access and VPA [30]. This was explained by a discordant interaction between perceived social support and high levels of barriers self-efficacy. Based on median splits of each variable, there was a small, positive bivariate correlation ($r=0.064$) between VPA and perceived access among girls having high self-efficacy and high social support ($n=433$) but a small inverse correlation ($r=-0.11$) among girls having high self-efficacy and low social support ($n=198$). When the SEM was tested separately in these two groups, the relation between multipurpose facilities and VPA remained significant ($p<0.05$) in each group ($\beta=0.11$ to 0.16). When the SEM was re-specified without self-efficacy and social support, the relation between VPA and perceived access to facilities was zero, but the positive relations of

Table 3 Bivariate Pearson correlations among variables computed (n=1,126) from 0.75-mile street network buffer

	Barriers self-efficacy	Perceived social support	Perceived facility access	Perceived equipment availability	Sport team member	BMI	Median household income	Race	Multipurpose facilities	Individual-use facilities	Team facilities
VPA	0.312***	0.383***	0.04	0.122***	0.326***	−0.123***	0.142***	−0.177***	0.109***	0.089**	0.011
Barriers self-efficacy	1.00	0.603***	0.235***	0.266***	0.318***	−0.094**	0.037	−0.207***	0.056	−0.016	−0.007
Perceived social support		1.00	0.301***	0.402***	0.459***	−0.190***	0.146***	−0.168***	0.083**	0.029	−0.041
Perceived facility access			1.00	0.297***	0.063*	−0.051	0.071*	−0.005	0.081**	0.076**	0.065*
Perceived equipment availability				1.00	0.179***	−0.10***	0.126***	−0.189***	0.021	0.005	−0.045
Sport team member					1.00	−0.196***	0.095***	−0.166***	0.032	0.014	−0.010
BMI						1.00	−0.190***	0.236***	−0.002	−0.005	−0.008
Median household income							1.00	−0.335***	−0.012	0.001	−0.008
Black or white race								1.00	0.014	−0.012	−0.013
Multipurpose facilities									1.00	0.285**	0.101***
Individual-use facilities										1.00	0.112***

Coefficients transformed from t ratios for associations with binary variables of sport team member (Yes=1, No=0) and race (black=1, white=0). Factor scores from confirmatory factor analysis were used for physical activity, barriers self-efficacy, and perceived social support

BMI body mass index

*p<0.05, **p<0.01, ***p<0.001

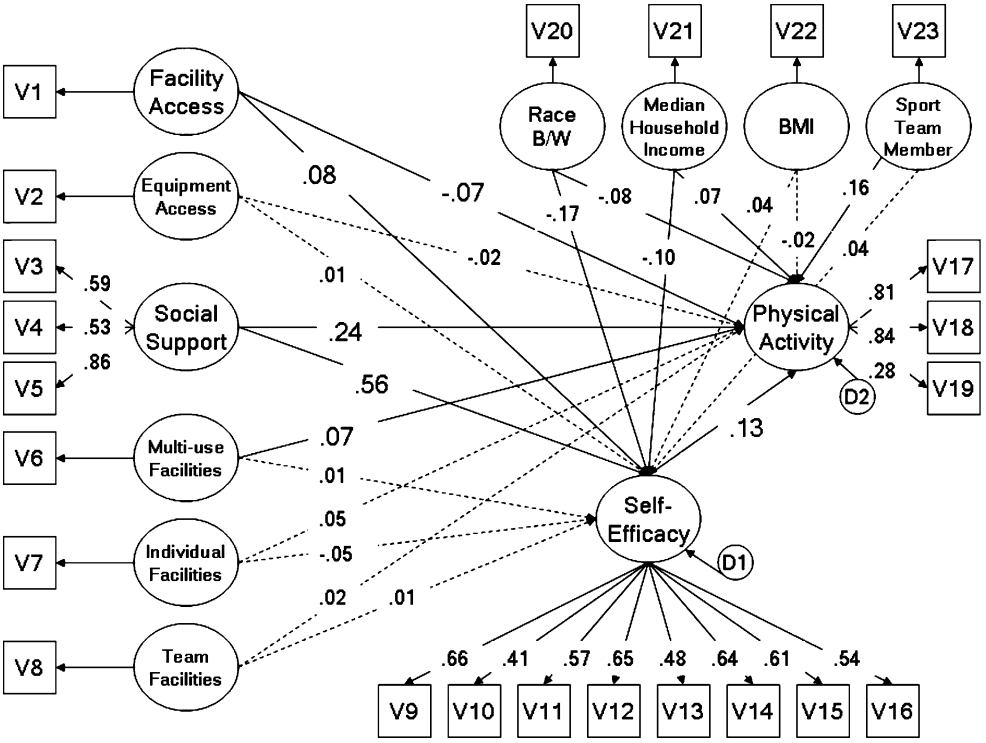

Fig. 1 The model illustrating the relationship among objectively measured commercial PA facilities within 0.75-mile street network buffer, perceptions of physical and social environment, barriers self-efficacy, and VPA tested using structural equation modeling (*SEM*). *D1–D2* represent disturbance terms for the self-efficacy and VPA variables, and *V1–V23* are the items for the latent variables. *Solid lines* represent significant relationships and *dashed lines* represent non-significant relationships. The RMSEA of the model was 0.049 (95% CI, 0.045–0.053); CFI= 0.909

multipurpose commercial facilities with VPA (β=0.09) remained significant (p<0.01).

Correlations among the exogenous variables in the SEM are displayed in Table 4. There were significant correlations among social support, perceived equipment availability, sport team membership, BMI, median household income, and race (0=white, 1=black). There were significant correlations between perceived facility access and social support, perceived equipment availability, and median household income. There were significant correlations

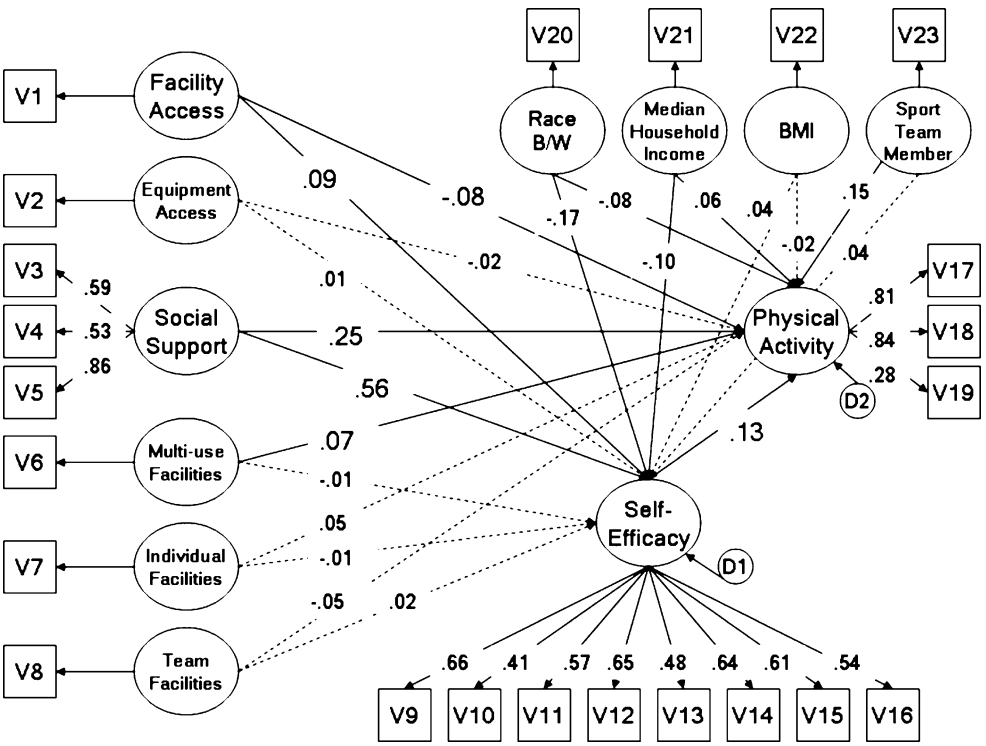

Fig. 2 The model illustrating the relationship among objectively measured Commercial PA facilities within 2.0-mile street network buffer, perceptions of physical and social environment, barriers self-efficacy, and VPA tested using structural equation modeling (*SEM*). *D1–D2* represent disturbance terms for the self-efficacy and VPA variables, and *V1–V23* are the items. *Solid lines* represent significant relationships and *dashed lines* represent non-significant relationships. The RMSEA of the model was 0.049 (95% CI, 0.045–0.053); CFI=0.914

Table 4 Correlations (SEM model) among exogenous demographic, social cognitive variables, and PA commercial for 0.75-mile street network buffer

	Perceived facility access	Perceived equipment availability	Sport team member	BMI	Median household income	Race (black=1, white=0)	Multipurpose facilities	Individual facilities	Team facilities
Perceived social support	0.286***	0.381***	0.477***	−0.193***	0.154***	−0.144***	0.082	0.035	−0.043
Perceived facility access	1.00	0.297***	0.063*	−0.051	0.071*	−0.005	0.081**	0.076*	0.065*
Perceived equipment availability		1.00	0.180***	−0.100***	0.126***	−0.189***	0.021	0.005	−0.045
Sport team member			1.00	−0.196***	0.095**	−0.166***	0.032	0.014	−0.010
BMI				1.00	−0.190***	0.236***	−0.002	−0.005	−0.008
Median household income					1.00	−0.335***	−0.012	0.011	−0.008
Black or white Race						1.00	0.014	−0.012	−0.013
Multipurpose facility							1.00	0.285***	0.101**
Individual facility								1.00	0.112***

BMI body mass index
*$p<0.05$, **$p<0.01$, ***$p<0.001$

among multipurpose, team, individual PA commercial, and perceived facility access. The correlations for the 2.0-mile street network buffer were substantively the same as for the 0.75-mile street network buffer (see Appendix).

Discussion

This study is unique because it used structural equation modeling to explore direct and indirect relationships between VPA and both perceived influences of the social and physical environment and objectively measured proximity to commercial PA facilities within a social-cognitive model. Over 24% of the girls within the 0.75-mile and 65% of the girls in the 2.0-mile street network buffer of their homes had at least one PA commercial facility. When the relationships of perceived environmental factors (access to facilities and equipment availability), objectively measured environmental factors (access to multipurpose, team, and individual PA facilities), perceived social support, and perceived barriers self-efficacy with VPA were examined, results indicated that perceived barriers self efficacy, perceived social support, and access to multipurpose commercial PA facilities were directly related to VPA. The relation between perceived social support and VPA was also indirect, meditated by perceived barriers self-efficacy.

Perceived social support had the strongest direct relationship with VPA in the SEM model. The social support measure used in the present study encompasses support from non-specific significant others, which likely includes family members and friends [23, 24]. Family members may provide transportation, and offer encouragement, as well as participate in PA with the girls [31, 32]. Girls may go with or meet friends at places to be physically active (e.g., multipurpose PA facilities). In the present study, there is a positive significant correlation between perceived facility access and multipurpose PA facilities (Table 4) in the SEM model. In adults [33, 34] and sixth grade girls [35], access to objectively measured facilities was significantly related to PA even after controlling for selected personal and social variables.

Sport team membership had the second strongest direct relationship to VPA. Other studies have also found the importance of sport participation for acquiring physical activity in girls [12]. Correlations in the SEM model suggest that sport team membership is related to higher perceived social support, perceived access to facilities, and perceived availability of equipment. Unfortunately, during

adolescence, there is a decline in sport team participation [1], but previous sport team members may be more inclined to find other ways to be physically active.

There is also a significant indirect path from social support to VPA mediated by perceived barriers self-efficacy. Girls with higher social support may be better able overcome barriers to VPA. But just because a facility is within the buffer does not mean that she will go there. She may not want to participate in activities that are offered at the facility due to social factors (i.e., friends are not physically active) [36]. Other barriers to participation might include cost of the activity [36, 37], that the hours of operation do not correspond to free time [36], or that the girl is not aware of the facility [38].

Proximity to multipurpose commercial PA facilities was also related to VPA in high school girls. Findings from the present investigation are consistent with several recent studies [13, 35, 39, 40] that used GIS methods to examine the relationship between PA facilities and adolescents' PA. For example, Gorden-Larsen et al. [39] reported that the relative odds of achieving five or more bouts of MVPA per week were increased when adolescents had one or more commercial PA facilities within a 8.07-km buffer around their residence as compared to adolescents with zero facilities. Powell et al. [40] reported that number of commercial physical activity-related facilities increased frequent VPA by 9.0% in 12th girls.

Significant positive Pearson correlations occurred between both multipurpose and individual commercial PA facilities with VPA. Pate et al. [17], using data from the 12th grade LEAP girls, found significant relationships with both number of individual and multipurpose commercial PA facilities and VPA. However, using SEM, with the three types of commercial PA facilities simultaneously entered, only multipurpose commercial PA facilities were significantly related to VPA. The types of physical activities that girls participate in are often performed in these facilities (i.e., dance, martial arts, tennis, and basketball) and she may go to these facilities with her friends [41–44].

Consistent with results from another sample of this cohort [16], the SEM revealed an inverse relation of VPA with perceived access to facilities despite a positive, non-significant bivariate correlation between the two variables. The positive relation of perceived access with barriers self-efficacy, which was positively related to VPA, indicated a suppression effect (i.e., inconsistent mediation) by self-efficacy [30]. Subsequent analysis revealed that girls who had high self-efficacy for overcoming barriers but who perceived low social support were less active despite perceiving greater access to physical activity facilities. This interaction of self-efficacy and social support might be explained by features of the girls not measured in this study, but it is consistent with our prospective cohort results that girls who perceive a reduction in social support during high school have greater declines in physical activity despite maintaining high barriers self-efficacy [45]. Because the objective measure of access to multipurpose facilities was positively related to VPA independently of its positive relation with perceived access, our results support the importance of using both objective and subjective measures in studies of access to physical activity facilities.

The results of this study illustrate the importance of simultaneously considering multiple levels and types of influences to understand VPA. After adjusting for demographic variables and sport team membership, elements of the objectively measured physical environment (proximity of multipurpose commercial PA facilities), social environment (perceived social support), and barriers self-efficacy were independently associated with VPA in the sample.

The present study has several strengths, which include the objective measurement of commercial PA facilities and the use of GIS methods to determine the number of commercial PA facilities within 0.75- and 2.0-mile street network buffers around the girls' homes. Another strength is that the social environment, as well as individual influences on PA, was considered. Limitations to the study include that it is not certain if all commercial PA facilities were identified and if a girl actually went to a commercial PA facility near her home. Also, a self-report measure of PA was used. However, the 3DPAR has been validated with accelerometry [18, 46]. Only 12th grade South Carolina girls were measured in the present study, and the percentage of black girls in the study sample was higher than in the school population. Therefore, the findings of this study may not be generalizable to other populations. Future studies should include both males and females and different age groups of children.

Girls in the 12th grade are involved in many after school activities, including volunteer work and working for pay [47, 48]. After deletion of work-related PA, 30% of the girls reported an average of one or more blocks of VPA per day over the 3 days of recall. Having a multipurpose commercial PA facility within a 0.75- or 2.0-mile street network buffer around their homes was related to VPA, independent of barriers self-efficacy, social support, perceived environment, demographic variables, and sports team membership within the past year. The physical activity that youth accumulate at these commercial PA facilities adds to the 60 min of MVPA that youth should acquire each day [49].

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Appendix

Correlations (SEM) among demographic, social cognitive variables, and PA commercial for 2.0-mile street network buffer

	Perceived facility access	Perceived equipment availability	Sport team member	BMI	Median household income	Race (black=1, white=0)	Multipurpose facilities	Individual facilities	Team facilities
Perceived social support	0.287***	0.380***	0.478***	−0.193***	0.154***	−0.145***	−0.018	0.029	0.000
Perceived facility access	1.00	0.297***	0.062*	−0.052	0.072*	−0.004	0.166***	0.193***	0.103***
Perceived equipment availability		1.00	0.180***	−0.099***	0.126***	−0.189***	−0.061*	0.000	−0.012
Sport team member			1.00	−0.197***	0.096**	−0.166***	−0.051	0.026	−0.038
BMI				1.00	−0.190***	0.237***	0.028	−0.040	−0.034
Median household income					1.00	−0.335***	−0.001	0.136***	0.027
Black or white Race						1.00	0.121***	−0.055	0.006
Multipurpose facility							1.00	0.351***	0.323***
Individual facility								1.00	0.422***

BMI body mass index
*$p<0.05$, **$p<0.01$, ***$p<0.001$

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