

The Role of Peer Social Network Factors and Physical Activity in Adolescent Girls

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Objective: To study the relationship between peer-related physical activity (PA) social networks and the PA of adolescent girls. **Methods:** Cross-sectional, convenience sample of adolescent girls. **Mixed-model linear regression analyses to identify significant correlates of self-reported PA while accounting for correlation of girls in the same school.** **Results:** Younger girls were more active than older girls. Most ac-

tivity-related peer social network items were related to PA levels. More PA with friends was significantly related to self-reported PA in multivariate analyses. **Conclusions:** Frequency of PA with friends was an important correlate of PA among the peer network variables for adolescent girls.

Key words: Social networks, social support, physical activity, adolescents, girls

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Physical activity declines in adolescent girls, and there is a need to understand factors that are associated with this phenomenon.¹ Heaney and Israel suggest that in adults, social support together with social networks has an

important causal effect on health, exposure to stress, and the relationship between stress and health.² Almost every study that has examined the relationship between physical activity and social support has found a strong positive associa-

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tion using both cross-sectional and prospective study designs, and most have focused on adults.³⁻⁷ There is also evidence that social support may be more influential for women than for men⁵⁻⁷ and that social networks are the primary means by which individuals receive support. At the same time, the evidence for the relationship between peer support in adolescents is inconsistent. Most studies use overall measures of support with considerable variation in the measurement of physical activity.⁸

Most research on social networks or peer influence in adolescents has focused on health risk behaviors, such as the influence of peers on smoking behavior.⁹⁻¹⁴ Fewer studies have examined whether and how friends' prosocial behaviors may affect the positive health behaviors of adolescents. For instance, prosocial groups are also thought to be protective against violent behavior in youth.¹⁴

Preliminary findings from the PACE (Patient-Centered Assessment and Counseling for Exercise) study showed the relationship between overall peer support and self-reported PA was stronger for girls compared to the boys. (unpublished analyses, J Prochaska & J Sallis, July, 2002 **Not acceptable reference, please remove and adjust. Reader needs to be able to secure**). No published data currently exist on peer networks and physical activity among adolescent girls. To fill this gap in the literature, this paper provides preliminary data on the activity-related social networks of middle school girls. Social networks that include active girls or boys could positively influence girls' physical activity by providing opportunities for social support, social influence, social engagement, and access to resources and personal contact to encourage physical activity.^{15,16} Understanding which social network features are related to physical activity and the ways by which they promote physical activity will allow interventions to target those factors.

This study seeks to determine whether there is a relationship between a girl's activity level and the activity level, context, and reciprocity (who initiates physical activity) of her close friends. The data for this manuscript were collected as part of a pilot study for the Trial of Activity in Adolescent Girls (TAAG) a multicenter intervention trial designed to test whether

a school-based intervention will prevent the decline in physical activity in adolescent girls.

METHODS

Participants and Setting

Participants were recruited from 1 middle school at each of the 6 TAAG field centers in or near Baltimore, Md; Columbia, SC; Minneapolis, Minn; New Orleans, La; San Diego, Calif; and Tucson, Ariz. The University of North Carolina served as the coordinating center. Schools for the pilot study were selected as to be demographically similar to the TAAG main trial schools. Sixth-grade and eighth-grade girls were recruited from a broad range of ethnic groups, socioeconomic strata, and activity levels. Students were recruited through required classes in their respective schools, and those with completed parental consent were eligible to complete the survey. Consent forms were sent home with students and collected by teachers. A comprehensive survey of psychosocial correlates of physical activity was administered to all study participants in a classroom setting. Students were given a standardized introduction to the questionnaire by trained survey administrators at each field site. The questionnaire was designed to be completed by students in a single, 40-minute class period, and students were given a small incentive for participation. To insure confidentiality student names were removed from the survey, and only numeric identifiers remained. Data were checked for completeness, and incomplete surveys were returned to girls to complete any missing items. Data forms were transmitted to the TAAG study coordinating center for data entry and analyses. The survey instrument included a variety of other scales, but only those items and scales relevant to the present paper are reported here.

Social network. Because no previously tested instrument was identified, TAAG investigators developed an original physical activity social network questionnaire based on results of preliminary focus group work and empirical data identifying friends as an important source of support for physical activity. The questionnaire first asks the respondent (central girl) to list the initials of her 3 closest friends. Subsequent items (n=8 per friend) ask her further questions about the participants'

experiences in participating in physical activity with each of the 3 closest friends (or fewer if only 1 or 2 were identified). Prior to the administration of the survey, a draft was sent to 2 social network researchers for review and comment. Additionally, items were pretested with a small sample of girls ($n=10$) in the target age range to determine readability and ease of completion. Slight modifications were made at each phase.

Five of the 8 items used yes/no response formats (eg, "Is this friend physically active?"). These questions were scored by summing responses for all 3 friends across the individual items. Thus, each item had a possible score of 0-3 (eg, 1=answered yes for 1 friend; 3=answered yes for 3 friends). One of the 8 items identified the sex of each friend. One item asked, "How often are you physically active with this friend?" with 5 ordinal responses ranging from "never" to "5 or more times per week"; those responses were summed across the 3 friends, providing a range of 1 to 15 for that measure. For the remaining item, respondents provided a yes/no answer for each friend separately for activity at school, at home or in the neighborhood, and at other places. For this item, the yes answers were summed for all 3 friends separately for each location, providing a score with a range of 0 to 3 for each location. Two-week test-retest reliability for each of the 8 items ranged from 0.29 to 0.57.

Physical activity (PAC-Q). An adapted version of the Physical Activity Questionnaire for Older Children (PAQ-C) was used to assess overall activity patterns. The original instrument uses 9 questions to assess a child's physical activity in a variety of situations and times (eg, school, recess, after school, evening, weekend). Each of the items is scored on a 5-point Likert scale, and the average of the items is used to reflect the overall physical activity level. The version of the instrument used in this study included 5 items that assessed the girl, level of activity in specific settings, and times (ie, physical education classes, at lunch, immediately after school, in the evenings, and on the weekend). Five of the original items were excluded for various reasons. One item from the original instrument (an activity checklist) was considered too cumbersome to administer, and 2 other questions required more abstract recall than

did the 5 context-specific questions. One additional question on activity during recess was removed because it was not relevant for this particular sample. The last deleted question asked about sickness in the past week, and this question was deleted as it is not included in the overall score. Each of the 5 selected items related directly to participation in physical activity, which was defined as "sports, games, or dance that make you breathe hard, make your legs feel tired, or make you sweat."

The psychometrics of the original PAQ-C instrument have been well established in the literature. The internal reliability of the individual items has been shown to be high ($>.80$) in several different studies.^{17,18} In a sample of 84 fourth through eighth graders 1-week test-retest reliability was acceptable for males and females ($r=0.75$; $r=0.82$).¹⁷

Evidence for validity was provided in a study by Kowalski et al including 89 fourth through eighth graders. Moderate correlations were found between the PAQ-C and an activity rating score question, a teacher's rating of physical activity, and MVPA assessed by a separate inventory.¹⁹

Although the original PAQ-C has demonstrated good repeatability, reliability, and correlations with an objective measure of physical activity, the instrument for this study was reduced to 5 items (exclusion described above). Test-retest reliability of the modified PAQ-C in this sample was 0.72, with no difference observed by grade. Cronbach's alpha was 0.61 overall, 0.58 for sixth grade and 0.59 for eighth grade.

Analysis Methods

The data were derived from a cross-sectional survey of sixth and eighth graders from participating schools. Responses from girls who attend the same school are likely to be correlated, due to mutual interaction, common selection factors, and other factors.²⁰ Data were analyzed using mixed-model linear regression methods, so as to account for the correlation among girls attending the same school.^{21,22} Data were analyzed separately for sixth and eighth graders after preliminary analyses revealed a significant difference in the self-reported physical activity levels in those 2 groups of girls.

In univariate analyses, self-reported physical activity from the PAQ-C was re-

Table 1
Univariate Analysis Results

	6 th Graders			8 th Graders		
	Change in Predicted PA	95% Confidence Intervals	P-Value	Change in Predicted PA	95% Confidence Intervals	P-Value
Is this friend physically active?	0.057	-0.037, 0.150	0.235	0.150	0.067, 0.233	0.001
Are you on a sports team or ever taken a physically active class with this friend?	0.082	0.019, 0.145	0.012	0.102	0.031, 0.174	0.006
Have you ever asked this friend to be physically active with you?	0.076	0.012, 0.140	0.022	0.123	0.062, 0.183	< .001
Has this friend ever asked you to be physically active with him/her?	0.080	0.013, 0.147	0.020	0.133	0.067, 0.198	< .001
How often are you active with this friend?	0.034	0.018, 0.049	<.001	0.053	0.035, 0.071	< .001
Where do you do most of your physical activities with this friend?						
At school-linear	0.030	-0.036, 0.95	0.381	0.353	0.133, 0.573	0.002
At school- quadratic				-0.114	-0.197, -0.031	0.001
At home	- 0.023	-0.053, 0.008	0.142	0.008	-0.021, 0.038	0.578
Other places	0.038	0.010, 0.067	0.010	0.033	0.001, 0.066	0.047

Note.
PA: Physical Activity

gressed separately on each potential independent variable; school was included in each model as a random effect. For variables that were generally continuous, both linear and quadratic terms were evaluated; if the P-value for the quadratic was 0.10 or higher, the quadratic term was removed. In multivariate analysis, self-reported physical activity was regressed simultaneously on the set of potential predictor variables, carrying forward the linear and quadratic terms judged to be potentially important in univariate analyses. All models were fit using SAS 8.2 PROC MIXED.²³ A total of 488 girls were included in the analyses with 98% com-

plete data on 3 friends. The sample included white/Anglo (50.5%), African American (17.9%), and Hispanic/Latino (12.3%) girls with similar proportions recruited from sixth grade (46.7%) and eighth grade (53.3%).

RESULTS

Pac-Q physical activity scores were significantly different for sixth and eighth graders with younger girls reporting more physical activity than did older girls (sixth grade: mean 3.16 sd .77, eighth grade: mean 2.81, sd .77). Table 1 presents the results from the univariate analyses. The values in the Change in PA column are

Table 2
Multivariate Analysis Results

	6 th Graders			8 th Graders		
	Change in Predicted PA	95% Confidence Intervals	P-Value	Change in Predicted PA	95% Confidence Intervals	P-Value
Is this friend physically active?	-0.036	-0.137, 0.065	0.485	0.067	-0.019, 0.153	0.128
Are you on a sports team or ever taken a physically active class with this friend?	0.038	-0.028, 0.103	0.260	0.035	-0.037, 0.106	0.342
Have you ever asked this friend to be physically active with you?	-0.010	-0.115, 0.096	0.857	0.053	-0.028, 0.135	0.198
Has this friend ever asked you to be physically active with him/her?	0.032	-0.078, 0.143	0.570	0.000	-0.091, 0.09	1.000
How often are you active with this friend?	0.033	0.009, 0.048	0.004	0.045	0.022, 0.069	<0.001
Where do you do most of your physical activities with this friend?						
At school-linear	0.033	-0.057, 0.122	0.474	0.204	-0.029, 0.437	0.088
At school- quadratic	NA	NA	NA	-0.090	-0.171, -0.010	0.005
At home	-0.016	-0.054, 0.023	0.433	-0.011	-0.046, 0.024	0.530
Other places	0.030	-0.008, 0.068	0.124	-0.004	-0.043, 0.035	0.858

Note.

PA: Physical Activity

the change in predicted physical activity score, expressed in standard deviation units, per unit increase in the predictor variable. Potential predictors are listed, along with their linear regression coefficients and the upper and lower 95% confidence intervals for those coefficients along with P-values for the null hypothesis.

Among sixth graders, all measures were significantly related to self-reported physical activity except “friend physically active” and “friends and activities at home” questions. Most trends were positive, so that increasing values on the predictors were associated with increased self-reported physical activity. For example, a higher value of 1 unit on the friends and

sports team item was associated with 0.08 higher standard deviation units on the physical activity scale; a difference from the lowest to highest value on the friends and sports team item was associated with 0.25 higher standard deviation unit on the physical activity scale. The only exception was friends and activities at home, which had a negative but non-significant coefficient. None of the quadratic terms were significant.

Among eighth graders, all measures were significantly related to self-reported physical activity except for the question on “friends and activities at home.” Most trends were positive, so that increasing values on the predictors were associated

with higher levels of self-reported physical activity. The only exception was the quadratic term for friends and activities at school, which had an inverse association. In this case there was little relationship between a girl's report of physical activity at school and her self-reported physical activity at the lower levels of physical activity at school, and an inverse relationship for higher levels of physical activity at school. None of the other quadratic terms were significant.

Table 2 presents the results from the multivariate analysis. As for the results from univariate analyses, the values in the "Change in Predicted PA" column are the predicted change in physical activity, expressed in standard deviation units, per unit change in the predictor variable, after adjustment for the other independent predictor variables in the model. Among sixth graders, the only item significantly related to self-reported physical activity was "How often are you active with friends?" after adjusting for the other variables in the model. The relationship was positive, so that as activity with friends increased, so did self-reported physical activity. Specifically, a higher value of 1 unit on the "active with friends" item was associated with 0.028 higher standard deviation units on the physical activity scale; an increase from the lowest to the highest value on the "active with friends" item was associated with 0.085 higher standard deviation units on the physical activity scale.

Among eighth graders, after adjusting for other terms in the model, 2 variables were significantly related to self-reported physical activity. The relationship for "how often are you active with friends" was positive, so that as activity with friends increased, so did self-reported physical activity. The relationship for friends and activities at school included a positive linear component and a negative quadratic component.

DISCUSSION

This is the first study to report on the relationship between physical activity and activity-related social network variables. Social networks are thought to be particularly important for adolescents, and most studies have focused on the negative effects social networks are thought to exert (eg, on problem behavior). This study is particularly important in that it

is the first to show "protective" effects of behavior-specific social networks: adolescent girls who have more physically active friends report higher activity levels themselves. The main finding was that frequency of activity with friends was the most significant independent predictor of girls' own activity when all variables were included in the multivariate model. This finding is intuitive in that greater frequency of shared activity would be expected to yield higher physical activity scores; however, the implication is that girls who were less frequently active with friends were also less physically active overall, suggesting that in this population time spent apart from friends was generally not spent participating in physical activity. For intervention purposes, this finding would support messages encouraging girls to try doing physical activity with their friends as well as messages encouraging girls who are less social to turn some of their independent time to physically active time as part of an overall social ecological intervention such as the main trial of TAAG. In the main trial currently underway, a multicomponent approach grounded in social ecological theory is used and implemented using multiple strategies, channels, and modalities to encourage girls to be physically active. These include educational, behavioral, social, environmental, and promotional interventions. For example, one important component of the TAAG conceptual model is an emphasis on the importance of the social aspects of PA, and many of the intervention messages delivered in multiple ways (classroom settings, after school activity promotions, etc) highlight this social aspect.

Although not significant in the overall model, other factors were significant at the univariate level and may be important to consider for intervention development. The number of active friends did appear to make a difference when comparing between 0 and 3 close friends. This finding is consistent with the social network literature describing density as an important factor. Reciprocity seemed important in that respondents asking friends to be active and friends asking respondents to be active were both significantly related to self-reported activity levels as others have shown.²⁵ For the sixth grade girls, reporting shared physical activity at home or at school was not

associated with physical activity levels, but for the eighth grade girls, shared physical activities at school (but not at home) had a modest positive association with lower levels of physical activity and negative association at higher activity levels. For both sixth and eighth grade girls, the variable on friend shared activity in "other" places was significantly associated with physical activity in univariate but not in the adjusted analyses. Being on a sports team with friends was important in univariate analyses but was only borderline significant ($P=.06$) in the multivariate analyses. Some social network items had low reliability and may account for the nonsignificant results in the multivariate analyses.

Prospective studies are important, as this is a cross-sectional survey where directionality and causality cannot be ascertained. More work investigating detailed aspects of girls' activity-related social networks is needed using objectively measured physical activity. For example, it is important to understand what types of activity are preferred in group settings and whether or not group-related activity results in higher or lower intensity activity.

The idea that girls may provide a socially desirable response to the social network questions cannot be ruled out, but we believe it is unlikely to have substantially influenced our results given the variability in the girls' responses overall at the girl level. Additionally, although it is understood that friends are important to girls at this age, it does not necessarily follow that being active with friends is socially desirable.

This study provides initial support for examining the relationship between adolescent girls' social networks and their physical activity levels. The findings suggest that several aspects (location, reciprocity, frequency) of a girl's physical activity-related social network could have a positive influence on her activity behavior. These findings are consistent with the general social network literature,^{15,25,26} more recently in the Child and Adolescent Trial for Cardiovascular Health (CATCH) study²⁴ and the social ecological conceptual framework on which the TAAG intervention trial is designed.

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