Change in Parent and Peer Support across Ages 9 to 15 yr and Adolescent Girls' Physical Activity

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ABSTRACT

DAVISON, K. K., and R. JAGO. Change in Parent and Peer Support across Ages 9 to 15 yr and Adolescent Girls' Physical Activity. *Med. Sci. Sports Exerc.*, Vol. 41, No. 9, pp. 1816–1825, 2009. **Purpose**: To examine change in parent and peer support for girls' physical activity (PA) across ages 9 to 15 yr and assess if girls who remain active during adolescence are differentially exposed to support when compared with girls who do not remain active. **Methods**: Participants included 174 non-Hispanic white girls assessed at ages 9, 11, 13, and 15 yr. Parental modeling and logistic support for PA were assessed at all ages; peer support was assessed at ages 9, 11, and 13 yr. Minutes per day of moderate-to-vigorous PA (MVPA) was measured at ages 13 and 15 yr using 7-d accelerometry. Girls' body mass index and self-reported PA were measured at ages 9, 11, and 13 yr. Girls were classified as maintaining PA during adolescence if they recorded $\geq$30 min$\cdot$d^{-1} of MVPA at ages 13 and 15 yr. Patterns of change in parent/peer support and differences in exposure to support for girls who maintained PA and those who did not maintain PA were assessed using individual growth curve modeling. **Results**: A linear decline was observed in parental modeling. A curvilinear pattern of change was observed for parental logistic support and peer support. Although the rate of change varied by age, logistic support generally decreased, and peer support increased across time. Girls who maintained PA had parents who reported higher modeling of PA across time and stable levels of logistic support. In contrast, girls who did not maintain PA had parents who reported lower modeling and declines in logistic support. **Conclusions**: Parental modeling of PA before adolescence and logistic support during adolescence could help girls establish early patterns of PA and social networks that facilitate maintained PA during adolescence. **Key Words:** SOCIAL SUPPORT, FAMILY, ENVIRONMENT, OBESITY, YOUTH, ENCOURAGEMENT

Physical activity (PA) has been associated with positive physical (13,16,21) and mental health outcomes (26) among youth. Despite the well-publicized benefits of PA, many children and adolescents do not meet PA recommendations, and the percentage of youth meeting recommendations declines precipitously with age. Recent data from the United States assessing objectively measured PA indicate that the percentage of youth who attain 60 min of moderate-to-vigorous PA (MVPA) per day declines from 42% at ages 6–11 yr to 8% at ages 12–15 yr (30). Although there is conflicting evidence on gender differences in rates of decline in PA, there is overwhelming evidence that girls are less active than boys at all ages (20,30). Hence, any declines in PA may have a disproportionate impact on girls given their low baseline levels of PA. To effectively promote and maintain active lifestyles among youth, and in particular girls, we need to identify the factors that influence girls' PA between childhood and adolescence and find strategies to change those factors.

Decreases in girls' PA may be explained by a variety of personal, interpersonal, and community-based factors such as the timing of pubertal maturation (1), the onset of romantic relations (3), and the lack of community-based opportunities for sports and PA that are of interest to girls (9). Changes in PA during the transition to adolescence may also reflect changes in activity support provided by parents and peers. Social cognitive theory (2) suggests that social support is likely to be a key determinant of youth PA. Early research by Lau et al. (15) showed that parental influence on health behaviors (PA, diet, alcohol, and seatbelt use) is maintained as children leave home and progress onto university. This was explained by parental influence on the establishment of beliefs during childhood, which influence adult beliefs and, in turn, adult behavior. The

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same study also reported that peer influence on the health behaviors of university students was roughly equivalent to parental behavior, suggesting that parental influence remains strong as children age and peer influence increases. When combined with social cognitive theory, these findings suggest that parent and peer support for PA are likely to be key influences on youth PA.

The anticipated benefits of social support are substantiated by research that has repeatedly shown that parent and peer support are associated with higher PA among youth (10,12,24). The role of social support is also demonstrated in results from longitudinal research indicating that lower family support for PA among adolescent girls in 8th grade was associated with a steeper decline in PA between the 8th and 12th grades (7). Further evidence of the prospective association between family support and children's MVPA is illustrated in research examining the effect of more general forms of family support, including family cohesion, parental engagement, and parent–child communication, on children's MVPA 1 year later (22). Although there is a growing body of research on the prospective association between parental support and child PA, much less is known about the prospective effect of peer support. Furthermore, to the authors' knowledge, no research has examined patterns of change in parent and peer support between middle childhood and adolescence and their predictive effect on change in PA during adolescence or the likelihood of maintaining levels of PA at a time when declining PA is the norm. The current study addresses these neglected areas of inquiry.

In this longitudinal study of girls and their families, parent and peer support of girls' PA were assessed when girls were 9, 11, 13, and 15 yr old. In addition, girls' PA was objectively measured when they were 13 and 15 yr old. These data provide a unique opportunity to examine patterns of change in social support specific to PA and its impact on adolescent girls' PA. Thus, the aims of this study were to examine 1) change in parental and peer support for girls' PA across ages 9 to 15 yr and 2) differences in patterns of change in support for girls who remain active across ages 13 to 15 yr and girls who do not show sustained levels of PA. To make full use of the data available, these objectives were addressed using multilevel modeling.

METHODS

Participants

Families were part of a longitudinal study examining girls' health and development across ages 5 to 15 yr. Participants in the current study include 183 non-Hispanic white girls and their mothers and fathers who were assessed when girls were 9 yr old (mean ± SD age = 9.34 ± 0.3) and invited to complete follow-up assessments when girls were 11, 13, and 15 yr old. The number of families who completed each follow-up assessment includes 172 families at age 11 (mean ± SD age = 11.34 ± 0.3 yr), 166 families at age 13 (mean ± SD age = 13.33 ± 0.3 yr), and 165 families at age 15 (mean ± SD age = 15.34 ± 0.3 yr). Girls and their families who did not participate in the study beyond age 9 yr (N = 9) were not included in the analyses, resulting in a final sample size of 174 families. The final sample size differs from the number of families that participated at age 11 yr (N = 172) because families that missed a specific time of assessment were not excluded from future participation in the study. Differences in family demographics (family income, parent education, and parent and child body mass index (BMI)) and parental support were examined for families who dropped out of the study and families with continued participation. No significant group differences in family demographics were identified. In addition, only one of the four parental support scores differed by family drop out. Fathers from families that dropped out of the study reported significantly higher levels of modeling PA when girls were 9 yr old than fathers who remained in the study. Thus, family drop out did not introduce notable and consistent bias into the data.

The sampling frame included intact families with age-eligible daughters residing in a five-county region around the town in which the host institution was located. This region included a small college town (higher socioeconomic status) and the surrounding rural areas (lower socioeconomic status). The ethnic/racial makeup of families residing in this region is predominantly non-Hispanic white. Families were recruited for participation in the longitudinal study using flyers and newspaper advertisements. In addition, families with age-eligible female children received mailings and follow-up phone calls. Although intact families were initially recruited into the study, family members were not excluded from future participation as a result of separation or divorce. In this instance, parents had the option of participating together (i.e., attending together) or separately. With respect to participant compensation, girls and their parents were jointly compensated for their participation at all times of assessment; the amount compensated differed by assessment occasion. In addition to the family-based compensation, at ages 13 and 15 yr, girls were individually compensated $50 for their participation in the accelerometer protocol. The Institutional Review Board at The Pennsylvania State University approved all study procedures. Written consent from parents (for their daughters) and written assent from girls was obtained before girls' completion of the study protocol.

Procedures

During summer of the years the girls turned 9, 11, 13, and 15 yr old, parents and girls visited the General Clinical Research Center at Pennsylvania State University to complete self-report questionnaires and had their height and weight measured. Parents completed the questionnaires independently. Girls were individually administered the questionnaires by trained assistants at age 9 yr and completed the questionnaires independently at ages 11, 13, and 15 yr with guidance from research assistants. In addition, when girls

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were 13 and 15 yr old, research personnel visited girls during early fall (i.e., September and October) at their homes or at their schools to explain the accelerometer protocol and distribute the monitors. Monitors were returned by registered mail. All accelerometer data were collected between September and mid November to ensure that cold weather did not prevent girls from being active outdoors.

Measures: Independent and Dependent Variables

Activity support. Parents' support of girls' PA was measured using the Activity Support Scale (ACTS) (6). The ACTS is a seven-item scale that measures two domains of parental support including logistic support (e.g., taking girls to places where they can be active, enrolling them in activities) and modeling (e.g., being active with girls, using own behavior to show girls how to be active). Mothers and fathers completed the ACTS when girls were 9, 11, 13, and 15 yr old. Previous research supports the factorial structure, predictive validity, and internal consistency of this scale (6). Preliminary results showed that there were few differences in the results when mothers' and fathers' reports on the ACTS were examined separately. Therefore, to simplify the presentation of the results and reduce the number of analyses performed, scores for mothers and fathers were combined to create a parental modeling and parental logistic support score at each age. For single-parent families, data for the participating parent only was used to create parental support scores. The internal consistency coefficients for the ACTS in this sample ranged between $\alpha = 0.70$ and $\alpha = 0.77$ across all times of assessment.

Peer support of girls' PA was measured using three of the five questions from the peer support subscale of the adolescent-report version of the ACTS (5). Two questions specific to peers' admiration of people who are active were excluded because we found that preadolescent children had difficulty understanding these questions. Prior research supports the factor structure, the internal consistency, and the predictive validity of the adolescent-report version of the ACTS. The internal consistency coefficients for peer support in this sample were $\alpha = 0.53$ (age 9 yr), $\alpha = 0.64$ (age 11 yr), and $\alpha = 0.81$ (age 13 yr). Peer support was one of several measures that was not administered at age 15 to reduce participant burden and facilitate family retention. Only measures central to the original project were retained at age 15 yr.

PA: objective monitoring. An objective assessment of girls' PA was obtained when girls were 13 and 15 yr old using the ActiGraph 7164 accelerometer (Shalimar, FL), which has been shown to be a valid and reliable tool for assessing PA in children and adolescents (33). After receiving detailed instructions regarding the care and use of the accelerometers, girls were instructed to wear the ActiGraph at all times, except when bathing and swimming, for seven consecutive days. Consistent with previous studies (31–33), the ActiGraph was worn on the right hip. Accelerometer data, which are outputted as "counts," were compiled during 30-s intervals. Nonwearing time for each monitoring day was calculated by counting the number of zero counts accumulated in strings of 20 min or longer. Girls were included in the analyses if they had 4 d or more with 10 h or more of wearing time (19,31). Of the 148 girls who completed the accelerometer protocol at age 13 yr, 140 girls had valid data on the basis of the criteria above. Of the 113 girls who completed the accelerometer protocol at age 15 yr, 96 girls had valid data. Raw accelerometer counts were converted to minutes per day spent in MVPA using age-specific count thresholds developed by Freedson et al. (8,32).

Measures: Covariates

PA: before age 13 yr. Because an objective measure of girls' PA was not available before age 13 yr, data from surrogate measures of PA that were obtained at ages 9, 11, and 13 yr were combined and used in analyses to control for preexisting differences in PA. The following three measures of PA were obtained at each age: 1) general inclination toward activity, 2) participation in organized sports, and 3) physical fitness. The children's Physical Activity Scale (CPA) was used to assess girls' general inclination toward activity (e.g., "I would rather watch TV or play in the house than play outside") (34). The scale includes 15 items and uses a 4-point response scale ranging from 1 = completely true to 4 = completely false. In prior research, scores on the CPA were found to be associated with a 1-mile run/walk time, body fat percentage, and BMI (34), thus supporting the validity of the scale. In the current study, the internal consistency coefficients for the CPA were $\alpha = 0.67$ (age 9 yr), $\alpha = 0.73$ (age 11 yr), and $\alpha = 0.77$ (age 13 yr). Participation in team sports and organized activities was assessed using an activity checklist. Girls were presented with a list of 24 activities (e.g., rollerblading, soccer, cheerleading) and asked to indicate if they participated in each activity at an organized level (i.e., took lessons or played on a team). The total number of activities selected was summed to reflect the total number of sports and organized activities in which girls participated. Although there are no validity data available for the activity checklist, activities included on the checklist are consistent with preferred activities reported by youth living in rural areas (25). Finally, girls' physical fitness, an indirect measure of PA, was measured using the Progressive Aerobic Cardiovascular Endurance Run (PACER) (17). Previous research illustrates the test–retest reliability of the PACER and has shown that the number of laps completed is significantly and positively correlated with measured $\dot{V}O_{2max}$ (18).

The three measures of PA were combined to produce a composite measure of PA at ages 9, 11, and 13 yr. This was achieved using principal component analysis and specifying the retention of a single component. The component score was created by assigning weights (or factor loadings) to the three measures that reflected their intercorrelations. The resulting component score (a *z*-score with a mean of 0 and

SD of 1) was significantly correlated with each individual measure of PA with correlations ranging between $r = 0.57$ and $r = 0.79$, $P < 0.0001$. In addition, at age 13 yr, the composite PA score was significantly correlated with girls' objectively measured MVPA ($r = 0.47$, $P < 0.0001$). The composite scores for PA (at ages 9, 11, and 13 yr) were included in the analyses to account for the lagged effect of PA on parent and peer support.

Family income and maternal education. Mothers' years of education and combined family income were assessed using a brief background questionnaire. When girls were 9 yr old, mothers were asked to indicate their highest level of formal education from a list of nine options. Responses were converted to reflect the number of years of schooling. Mothers also reported their combined family income using the following options: 0 = <\$20,000; 1 = \$20,000–\$35,000; 2 = \$36,000–\$50,000; 3 = \$51,000–\$75,000; 4 = \$76,000–\$100,000; 5 = \$100,000+.

BMI. Girls' height and weight were measured in triplicate at all ages. The mean of the three values was used to calculate their BMI at each age (weight (kg)/height (m)^2). Age- and sex-specific BMI percentiles were calculated using the 2000 growth charts from the Centers for Disease Control and Prevention (CDC) (14).

Perceived athletic competence. Girls completed the Self-perception Profile (SPP) for children at ages 9, 11, 13, and 15 yr. The SPP is a 36-item scale assessing six dimensions of perceived competence (S. Harter, unpublished manuscript, 1985); only perceived athletic competence was relevant to the current study (e.g., I think I could do well at just about any new athletic activity). The SPP adopts a 4-point response scale from 1 = really disagree to 4 = really agree. Scores were averaged for each subscale to create a score ranging from 1 (low perceived competence) to 4 (high perceived competence). Previous research with the SPP in a large biracial sample of 11- and 12-yr-old girls from the National Heart Lung and Blood Institute Growth and Health Study supports the reliability and validity of the scale with white girls (27). In the current sample, the internal consistency coefficient was $\alpha = 0.80$ or higher at each time of assessment.

Statistical Analyses

The goals of this study were assessed using individual growth models (28) with PROC MIXED (SAS, Cary, NY). This analytic method makes full use of the data available at each time of assessment (i.e., cases with missing data are included in the analyses), accounts for the within person correlation across time, reduces the number of analyses performed, and increases the number of data points and, consequently, the statistical power (28). PROC MIXED produces valid parameter estimates in the presence of missing data provided that the data are "missing at random." On the basis of criteria outlined by Singer and Willet (28), the assumption of missing at random was met in the current study as was the assumption of normality. As recommended by Cohen et al. (4), parent and peer support scores were converted to POMP scores, or percentage of maximum possible scores (i.e., actual score/highest possible score), before conducting analyses. The use of POMP scores (a) facilitates meaningful comparisons within and across samples because they are not sample dependent, (b) allows comparisons across different measures of the same construct, and (c) provides a meaningful metric for interpreting parameter estimates (4).

Goal 1: Change in parent and peer support across ages 9 to 15 yr. Goal 1 was assessed using the full data set ($N = 177$). Unconditional models (i.e., with no covariates) were initially fit for parental modeling, logistic support, and peer support to ensure that there was sufficient variation in the data to warrant the inclusion of predictor variables. After determining that there was sufficient variation in the data, the pattern of change (i.e., linear vs quadratic) in each form of support was assessed by regressing time and time^2 onto each outcome in turn. The intercept and slope (i.e., time) were modeled as random effects. In cases where the quadratic effect was not significant, it was dropped from the model, and the model was rerun including only the linear effect. A follow-up set of analyses examined covariation between parent and peer support. For these analyses, the models for logistic support and modeling were rerun including peer support as a time-varying covariate. Likewise, the model for peer support was rerun including logistic support, followed by modeling, as time-varying covariates. As all analyses were considered exploratory and initial analyses indicated that associations were different between time points, an unstructured error covariance matrix was used for all models.

Goal 2: Parent and peer support across ages 9 to 15 yr and girls' PA during adolescence. Analyses to assess goal 2 were limited to girls with accelerometer data at ages 13 and 15 yr ($N = 96$). The primary objective of these analyses was to determine whether girls who maintained PA during adolescence were differentially exposed to parent and peer support across ages 9 to 15 yr than girls who did not maintain PA. Girls who maintained PA during adolescence were a particular focus of these analyses because rapid declines in PA during this age period are normative (20). Consequently, identifying strategies to foster maintained PA during adolescence is a priority. Girls were divided into two groups on the basis of their MVPA. Girls were considered to have "maintained PA" if they recorded ≥30 min of MVPA at ages 13 and 15 yr ($N = 24$). If girls did not meet this criterion, they were classified as "did not maintain PA" ($N = 72$). This cut point is consistent with prior CDC/American College of Sports Medicine recommendations for children and adults and therefore can be compared with previously published data (23). It was not possible to use current recommendations of 60 min MVPA per day (36) to define the groups because fewer than 5% of girls met this criterion. The small

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percentage of girls who met current recommendations for PA in this study is consistent with data from a large national longitudinal sample of youth (20). For descriptive purposes, one-way ANOVA tests were performed to examine if there were differences at each age in MVPA, VPA, prior PA, BMI, and parent and peer support for girls who did and did not maintain PA. Differences in change in MVPA and VPA for girls who did and did not maintain PA were examined in individual growth models with time, maintain PA, and time × maintain PA regressed onto MVPA and VPA.

Differences in exposure to parent and peer support across ages 9 to 15 yr for girls who did and did not maintain PA were examined using individual growth modeling. The models differed slightly for each form of support because of linear versus curvilinear patterns of change in support that were identified when addressing goal 1. When parental modeling was the outcome variable, the model was comprised of time, maintained PA (1 = yes; 0 = no), and the interaction between time and maintained PA. When logistic support and peer support were the outcome variables, the models were comprised of time, time × time, maintained PA (1 = yes; 0 = no), the interaction between time and maintained PA, and the interaction between time × time and maintained PA. The intercept and slope were specified as random effects in all models.

Potential covariates were examined and included in the models as necessary. To account for prior levels of PA and the lagged effect of PA on support, the composite PA score (at ages 9, 11, and 13 yr) was entered into all models as a time-varying covariate. BMI, perceived athletic competence, family income, and maternal education were also examined for possible inclusion as covariates. With one exception, none of these variables was associated with the independent and dependent variable. As a result, they were not included in the analyses. The one exception was maternal education, which was identified as a covariate for logistic support; mothers with a college degree reported higher logistic support and were more likely to have daughters who maintained PA. Therefore, maternal education was included as a covariate in the model predicting logistic support. Finally, parent support and peer support were included as time-varying covariates as necessary in the respective models on the basis of results from the analyses examining their covariation (from goal 1).

Several strategies were used to aid the interpretation of the data. First, all covariates were centered around the mean. Consequently, the parameter estimates refer to the participants' predicted mean score on the outcome variable when the covariates are set at the sample mean. Second, in instances where there was a significant effect for maintain or maintain × time, the effect size (Cohen's *d*) was calculated using the method outlined by Tymms (35). Finally, the within- and between-subject variances for the unconditional growth model (i.e., the model before the inclusion of covariates beyond the effects of time) and the full model are presented. The inclusion of such information allows the calculation of the pseudo R^2 for the intercept and slope, which correspond to the between-subject variance in the outcome variable at age 9 yr (intercept) and change in the outcome across ages 9 to 15 yr (slope) that is explained by the covariates (28).

RESULTS

Goal 1. Results for goal 1 are illustrated in Figure 1. Parental modeling showed a linear decline between ages 9 and 15 yr ($b = -2.3$, $t = -8.25$, $P < 0.0001$), decreasing 2.3 percentage points between each time of measurement. The quadratic effect of time was not significant. In contrast, linear ($b = 2.9$, $t = 2.60$, $P < 0.01$) and quadratic ($b = -1.6$, $t = -4.76$, $P < 0.0001$) effects of time were observed for parental logistic support. Logistic support increased approximately 1.3 percentage points between ages 9 and 11 yr and then decreased between ages 11 and 15 yr at a rate of 2 (11–13 yr) and 5.3 points (13–15 yr). Similarly, linear ($b = 5.8$, $t = 5.05$, $P < 0.001$) and quadratic ($b = -1.5$, $t = -4.40$, $P < 0.0001$) effects of time were identified for peer support. Although peer support increased across ages 9 to 13 yr, more

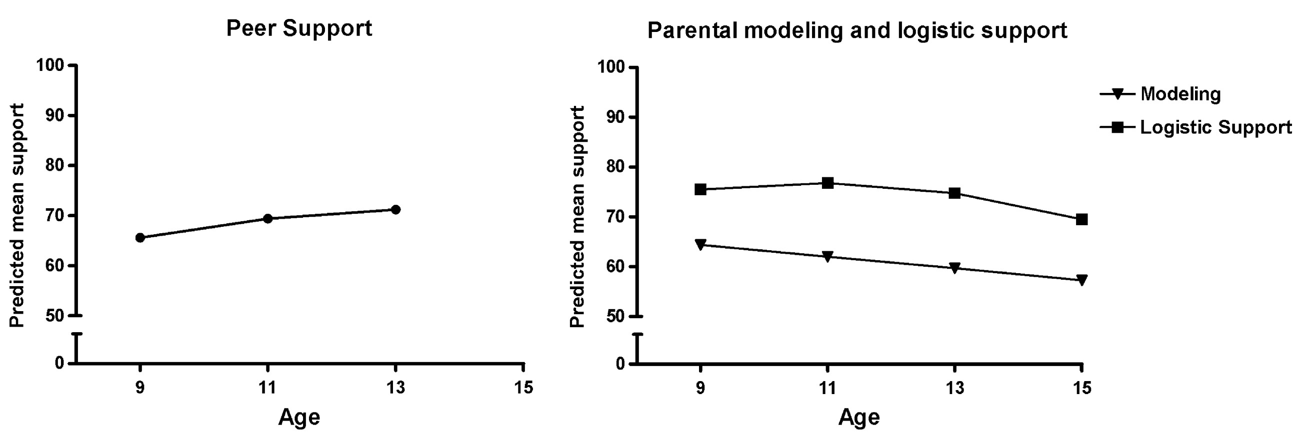

FIGURE 1—Changes in predicted mean† parent and peer support across ages 9 to 15 yr.
†Percentage of maximum possible (POMP) scores presented (possible range = 1–100).

TABLE 1. Mean (SD) PA, BMI, and parent/peer support scores for girls who did and did not maintain PA.

	Recorded at Least 30 min·d^{-1} of MVPA at Ages 13 and 15 yr			
	Yes (N = 24) (Maintained PA)	No (N = 72) (Did Not Maintain PA)	F	P
Average min/day MVPA (age 13 yr)	45.7 (13.0)	32.2 (12.9)	21.05	<0.0001
Average min/day MVPA (age 15 yr)	44.1 (12.9)	20.3 (10.5)	81.85	<0.0001
Average min/day VPA (age 13 yr)	5.9 (3.7)	3.6 (3.6)	7.07	<0.01
Average min/day VPA (age 15 yr)	5.0 (4.3)	1.5 (1.9)	31.29	<0.0001
Composite PA score[a] (age 9 yr)	0.34 (1.42)	−0.28 (1.05)	4.98	0.02
Composite PA score (age 11 yr)	0.14 (1.17)	−0.15 (1.16)	1.14	0.29
Composite PA score (age 13 yr)	0.11 (1.17)	−0.20 (1.13)	1.45	0.23
BMI (age 9 yr)	18.0 (3.1)	18.8 (3.2)	1.25	0.21
BMI (age 11 yr)	19.6 (3.8)	20.4 (3.6)	0.97	0.25
BMI (age 13 yr)	21.2 (4.9)	21.5 (3.9)	0.06	0.62
BMI (age 15 yr)	22.3 (4.9)	22.3 (3.9)	0.00	0.72
Parental modeling[b] (age 9 yr)	69.0 (11.7)	61.3 (10.9)	9.54	<0.01
Parental modeling (age 11 yr)	65.6 (12.6)	59.6 (14.0)	3.20	0.07
Parental modeling (age 13 yr)	62.1 (15.1)	59.1 (13.8)	0.81	0.37
Parental modeling (age 15 yr)	60.1 (13.3)	56.5 (13.4)	1.22	0.27
Logistic support[b] (age 9 yr)	76.7 (11.8)	74.0 (15.8)	0.48	0.49
Logistic support (age 11 yr)	79.8 (10.3)	76.1 (15.4)	1.26	0.26
Logistic Support (age 13 yr)	76.2 (13.3)	72.1 (14.9)	1.42	0.23
Logistic support (age 15 yr)	78.0 (14.4)	67.1 (13.3)	8.20	<0.01
Peer support[b] (age 9 yr)	67.2 (14.1)	62.3 (14.4)	2.07	0.15
Peer support (age 11 yr)	75.3 (13.0)	70.3 (.15)	2.09	0.15
Peer support (age 13 yr)	72.4 (13.9)	69.2 (14.7)	0.86	0.35

[a] Composite (standardized) PA scores were calculated at ages 9, 11, and 13 yr using thee measures of PA.
[b] Parent and peer support scores were converted to POMP scores to facilitate interpretation. Therefore, the possible range is 1–100.

pronounced increases were observed between ages 9 and 11 yr (3.8 points) compared with ages 11 to 13 yr (1.8 points).

When peer support was included as a time-varying covariate in analyses predicting change in parental support, there was evidence of covariation between peer support and logistic support (b = 8.1, t = 2.14, P = 0.03) but not between peer support and parental modeling (b = 1.5, t = 0.54, P = 0.59). Likewise, logistic support (b = 7.7, t = 2.05, P = 0.04) was a significant covariate in analyses predicting peer support. Therefore, in analyses for goal 2, peer support was included as a time-varying covariate when predicting parental logistic support and logistic support was included as a time-varying covariate when predicting peer support.

Goal 2. Table 1 reports mean scores for MVPA, VPA, prior PA, BMI, and parent and peer support at each age for girls who did and did not maintain PA across ages 13 to 15 yr. As expected, girls who maintained PA had significantly higher minutes of MVPA and VPA at ages 13 and 15 yr. Compared with girls who did not maintain PA, girls who maintained PA accumulated on average 13 extra min of MVPA per day at age 13 yr and 24 extra min of MVPA per day at age 15 yr. Furthermore, MVPA declined significantly between ages 13 and 15 yr for girls who did not maintain PA (b = −11.85, t = −6.37, P < 0.0001) but did not change for girls who maintained PA (b = −1.56, t = −0.48, P = 0.63). No differences in rate of change in VPA were observed. Girls who maintained PA also had significantly higher composite PA scores at age 9 yr but not at ages 11 and 13 yr. Finally, an inconsistent pattern of differences in parent and peer support was observed for girls who maintained and did not maintain PA. Girls who maintained PA reported significantly higher parental modeling at age 9 yr and higher logistic support at age 15 yr than girls who did not maintain PA. No other differences in parental support were identified, and no differences in peer support were observed at any age.

Results from the individual growth models are reported in Table 2. For parental logistic support, a significant interaction between time and maintained PA was identified, indicating that the predicted rate of change in parents'

TABLE 2. Results from the individual growth models examining differences in parent and peer support across ages 9 to 15 yr for girls who did and did not maintain PA.

	Parental Logistic Support	Parental Modeling	Peer Support
Intercept (age 9 yr)	75.22 (1.72)***	61.54 (1.39)***	63.59 (1.50)***
Time	1.46 (1.49)	−1.65 (0.45)***	8.11 (1.76)***
Time × time	−1.34 (.44)**		−1.99 (0.53)***
Maintain PA	−0.09 (3.35)	7.55 (2.81)**	3.66 (2.85)
Time × maintain PA	2.87 (1.42)*	−1.53 (91)	−0.88 (1.55)
Prior PA	2.46 (0.71)***	0.41 (65)	1.78 (0.75)*
Maternal education	0.34 (0.51)		
Peer support	0.05 (0.04)		
Parental logistic support			0.08 (0.05)
Variance components for unconditional growth model			
Level 1 (within-person)	67.13 (6.94)	44.69 (4.61)	101.92 (10.54)
Level 2 (intercept)	149.31 (28.90)	117.36 (21.81)	76.56 (22.93)
Level 2 (slope)	23.61 (5.59)	5.59 (2.33)	23.28 (6.80)
Variance components for full model			
Level 1 (within-person)	70.94 (7.58)	44.77 (4.63)	104.62 (11.16)
Level 2 (intercept)	139.52 (28.81)	106.54 (20.51)	64.95 (21.05)
Level 2 (slope)	20.96 (7.587)	5.43 (2.33)	21.06 (7.18)
Pseudo R^2 (intercept)[a]	0.065	0.092	0.152
Pseudo R^2 (slope)[b]	0.112	0.028	0.095

* P < 0.05.
** P < 0.01.
*** P < 0.001.
Pseudo R^2 = between-subject variance in the intercept ([a]) and slope ([b]) that is explained by the level 2 covariates.

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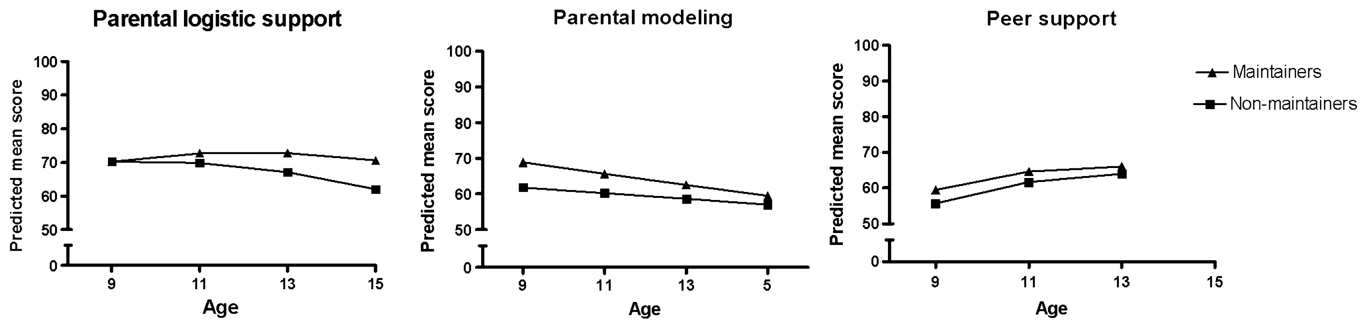

FIGURE 2—Predicted mean† parent and peer support scores at each age for girls who did and did not maintain PA (controlling for covariates). †Percentage of maximum possible (POMP) scores presented (possible range = 1–100).

logistic support across ages 9 to 15 yr differed significantly for girls who did and did not maintain PA. This interaction was observed in the absence of a main effect for maintain PA. These effects are illustrated in Figure 2. Although parents' logistic support was similar across groups at age 9 yr, logistic support declined across ages 9 to 15 yr for girls who did not maintain PA. In contrast, no change in logistic support was observed for girls who maintained PA. Consequently, group differences in logistic support increased with age. Cohen's d for the time × maintained PA effect was 0.44, indicating a moderate effect size. The inclusion of level 2 covariates (i.e., between-subject covariates) explained approximately 6.5% of the between-subject variance in the logistic support at age 9 yr and 11% of the variance in change in logistic support across ages 9 to 15 yr.

For parental modeling, a significant main effect for maintaining PA and a trend for the interaction between time and maintaining PA were detected (Table 2). As shown in Figure 2, girls who maintained PA had parents who reported higher levels of modeling across all ages. Furthermore, whereas a decline in parental modeling was observed across ages 9 to 15 yr for both groups, the rate of decline was marginally steeper for girls who maintained PA. As a result, by age 15 yr, similar rates of parental modeling were reported across groups. The effect size for the main effect of maintained PA was $d = 0.96$, indicating a large effect size. In contrast, a small-to-medium effect size was observed for the time × maintained PA interaction ($d = 0.29$). The inclusion of level 2 covariates explained approximately 9% of the between-subject variance in parental modeling at age 9 yr (i.e., the intercept) and 3% of the variance in change in parental modeling across ages 9 to 15 yr.

When examining group differences in exposure to peer support, there was neither a main effect of maintaining PA nor was there an interaction between maintaining PA and time. That is, no differences in exposure to peer support at age 9 yr or across ages 9 to 13 yr were observed for girls who did and did not maintain PA. Although the level 2 covariates explained 15% of the between-subject variance in peer support at age 9 yr and 9.5% of the variance in change in peer support, most of the variances explained are likely due to the effect of logistic support that was included in the analysis to control for covariation between logistic support and peer support.

DISCUSSION

In the context of notable declines in girls' PA during adolescence, the identification of factors that can be used to foster the maintenance of appropriate levels of PA during this developmental period is a research priority. This study examined changes in parent and peer support for girls' PA across ages 9 to 15 yr and differences in exposure to support for girls who did and did not maintain PA during adolescence. Results from the individual growth models showed that parental support for PA declined between childhood and adolescence. In particular, a linear decline was observed in parental modeling, and a curvilinear pattern of change was observed for logistic support with logistic support increasing slightly between ages 9 and 11 yr and decreasing thereafter. In contrast, peer support increased in a curvilinear manner between ages 9 and 13 yr, with a greater rate of increase observed between ages 9 and 11 yr compared with ages 11 and 13 yr. Differences in patterns of change in support were examined for girls who maintained PA during adolescence or who recorded at least 30 min of MVPA at ages 13 and 15 yr and for girls who did not achieve this criterion. Group differences in exposure to parental support but not peer support were identified. Compared with girls who did not maintain PA, girls who maintained PA had parents who reported higher modeling of PA across all ages, although the difference between groups decreased with time in the context of declining levels of parental modeling. In addition, although parents' reports of logistic support were similar for both groups at age 9 yr, girls who maintained PA had parents who reported sustained levels of logistic support across ages 9 to 15 yr. In contrast, notable declines in logistic support were observed for girls who did not maintain PA. All results were independent of prior PA and other potential confounding factors such as maternal education and peer support. These findings extend prior research on the concurrent link between parents' logistic support and modeling and youth PA (5,6,10) and suggest that both forms of parental support could play an important role in the development and maintenance of an active lifestyle among children and, in particular, girls.

Positive effects of parental support were observed for parental modeling and logistic support, although the pattern of effects differed by form of support. Results suggest that parental modeling was particularly important during preadolescence but was less influential with increasing age, possibly as a result of overall declines in parental modeling. In contrast, logistic support played less of a role at younger ages but increased as girls approached adolescence. Declining levels of parental modeling between childhood and adolescence and, consequently, the impact of parental modeling on girls' future PA likely reflect developmental declines in the time that children spend with their parents and in opportunities for joint leisure (38). Parents' logistic support for girls' PA also declined between ages 9 and 15 yr for girls who did not maintain PA but remained stable for girls who maintained PA. This pattern highlights the importance of logistic support for maintaining children's levels of PA during the developmental transition from childhood to adolescence.

Parental logistic support is likely to be an important factor in helping girls maintain PA for several reasons. Firstly, parental logistic support for PA may help to facilitate the initiation of new PA behaviors. Secondly, continued parental logistical support is likely to assist with the maintenance of PA. For example, it seems plausible that girls will be more likely to continue to attend sport practice if their parents continue to provide transportation to the activity venue; the withdrawal of transport could be the trigger to stop attending. Thirdly, participating in organized activities, as a result of parental logistic support, introduces girls to a potential network of peers who encourage and support PA. This would suggest that early parental logistic support is a precursor for peer support. Indeed, in this study, parental logistic support and peer support covaried across time. Links between logistic support and the maintenance of PA, however, persisted after taking peer support into consideration. In contrast, effects of peer support on the maintenance of PA were not independent of parents' logistic support. The suggested mechanisms linking logistic support and girls' PA are purely speculative, however, and require additional research.

In contrast to parental support, peer support increased between childhood and adolescence, with the greatest rate of increase observed between ages 9 and 11 yr. The end of elementary school is a period when traditionally children gain greater license to spend time without adult supervision. This is also an age when children's cognitive abilities to make decisions about their own behavior increase (29). The age-related changes in parental and peer PA support for PA likely reflect the assertion of girls' independence. Girls who are afforded more parental license are likely to attend more sport clubs or other organized activities, which will require parental logistic support but not parental modeling. This is consistent with the observation that peer support and parental logistic support were correlated across time but peer support and parental modeling were not. Although we previously argued that the lack of an effect of peer support on girls' maintained PA may reflect its codependence with parents' logistic support, the absence of an effect could also be explained by the low internal consistency coefficients observed for peer support at ages 9 and 11 yr. Thus, additional measurement work with the peer support scale is necessary to increase confidence in any conclusions about the role of peer support in fostering maintained PA.

Results from this study are consistent with previous research on changes in generalized social support during adolescence and its association with health outcomes among youth. Research outside the domain of PA indicates that parents' social support declines, whereas support from peers increases from early to mid adolescence (11,37). Prior research also supports positive associations between change in parental support and change in adolescents' physical health status. For example, Wickrama et al. (37) found that change in parents' supportive behavior (i.e., observational ratings of parents' warmth and hostility toward their adolescents) across grades 7 to 11 were positively associated with change in adolescents' perceived health status. Finally, the influence of peers is found to complement but not override the effect of parental support during adolescence. When Helsen et al. (11) simultaneously examined parent and peer support as predictors of adolescents' emotional well-being, higher support from parents, but not peers, was associated with more positive well-being, particularly among girls. Peer support interacted with parental support such that peer support predicted adolescents' emotional health in the absence of parental support. Thus, contrary to popular belief, parental support seems to be an important determinant of adolescents' health behaviors and health outcomes, although peer relations are increasingly important at this time.

Strengths and limitations. The greatest strengths of this study include its longitudinal design and the use of validated measures of PA and parental support for PA. To our knowledge, this is the first study to model developmental changes in parent and peer support for PA from childhood to adolescence and examine patterns of change as explanatory factors for maintained PA during adolescence, a time of high risk for declines in PA (20,30). This goal was achieved by individual growth modeling, which made full use of the data available. In addition to its analytic strengths, the use of individual growth modeling in this study facilitated the conceptual interpretation of the data. For example, findings from the ANOVA models identified an inconsistent pattern of effects for parental support across time, suggesting a weak relationship between parental support and girls' PA. The exact nature of these effects, however, was readily identified in the individual growth models. This pattern would have been missed had we relied exclusively on the ANOVA models. Additional strengths of the study include the use of an objective measure of PA, which rules out the potential for subjective bias in recall, and the use of a multidimensional measure of parental support, which allowed us to separate the effects of parental modeling from more tangible forms of support such as enrolling girls in organized activities.

A key limitation of this study is the lack of data for boys and the predominately white, middle-class nature of the sample, which limit the generalizability of the results. Very little is known about the impact of parent and peer support on PA among minority youth and youth from lower socioeconomic groups. The ability to examine similar relationships in more diverse samples is constrained by the absence of validated measures of support for PA in these populations. Research by the authors is currently in progress to develop and validate such measures and to expand the applicability of this research. A second limitation is the small sample size, which precluded the use of the current recommendations for PA to classify the maintenance of PA. As a result, the older, lower recommendations for PA were used. Although this allows comparison with previously published data, girls in the maintained PA group were still relatively inactive. Consequently, additional research with a larger sample and using the current recommendations of 60-min MVPA is necessary to determine whether similar results are evident. Another limitation is the absence of accelerometer data at ages 9 and 11 yr, which prevented the ability to model change in the PA across the measurement periods. The use of a composite, self-report measure of PA to control for PA at the earlier assessments, however, minimized the impact of this limitation on the internal validity of the results. Finally, as previously noted, the measure of peer support had low internal reliability at the younger ages indicating that the scale requires additional measurement work to improve its psychometric properties with younger children.

CONCLUSIONS

Research shows that girls become increasingly inactive during adolescence. Identifying girls who maintain PA during this period of heightened risk and profiling their early experiences in the context of PA may lead to the identification of intervention strategies to increase the number of adolescent girls who maintain sufficient PA. Results from this longitudinal study showed that girls who maintained PA during adolescence had parents who reported higher modeling of PA across all ages, but particularly at age 9 yr, and sustained levels of logistic support for PA across ages 9 to 15 yr. This is in contrast to consistently lower parental modeling and declining levels of logistic support for girls who did not maintain PA. These findings suggest that whereas parental modeling is linked with higher PA among girls across time, parents' logistic support for PA may be particularly important for promoting maintained levels of PA into adolescence. Given that the parents' ability to provide a high level of logistic support is likely to be affected by lifestyle issues such as their work patterns, there is a need to understand the factors that influence the provision of logistic support and develop innovative approaches to facilitate the provision of support when maintenance becomes difficult. Potential approaches could include schemes that adopt a communal approach to logistical support such as car-pooling to and from activity locations or incorporating opportunities for parents to socialize, and network, while their children participate in activities. Future research should also examine the applicability of logistic support as a strategy to promote youth PA in more diverse samples, particularly ethnic/racial groups that generally report low participation in organized activities and greater participation in unstructured activities that require less direct parental involvement.

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