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Parent Modeling: Perceptions of Parents' Physical Activity Predict Girls' Activity throughout Adolescence

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Abstract

Objectives—To determine if parent modeling of physical activity has a differential impact on girls' physical activity (PA) by race, if the association declines over time, and to assess the contribution of parent modeling to girls' activity relative to other potential predictors.

Study design—Longitudinal examination of parent modeling's impact on future log transformed metabolic equivalents (log METs) of leisure-time PA among 1213 African-American and 1166 Caucasian girls in the NHLBI Growth and Health Study, from age 9-10 through 18-19 years, using linear regression. Race interaction terms and time trends were examined.

Results—Girls' perceptions of parent modeling significantly predicted future log METs in each study year; associations remained stable over time and were similar by race. Girls' perception of parent PA better predicted girl log METs than did parent self-report. On average, girls reporting that their parents exercised ≥ 3 x/week were about 50% more active than girls with sedentary parents.

Conclusions—Girls' perception of parent activity predicts PA for girls throughout adolescence, despite age-associated decreases in PA. We did not find differences in this association by race. Interventions designed to increase parental activity may improve parent health, positively influence daughters' activity, and begin to address disparities in cardiovascular health.

Keywords

pediatric obesity; physical activity; minority health

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*Given the 0.8 SD for mother's activity in each year, a 2-unit increase (from "never" to " ≥ 3 times/week") in mother's activity is a change of 2.5 SDs. In Year 7, e.g., the β for mother's activity of 0.16 implies that a 2.5 SD increase in mother's activity is a 0.4 (0.16*2.5) SD increase in log METs. The SD for log METs was 1.4 in Year 7; thus, a 0.4 log MET SD increase is equivalent to a 0.56 (1.4*0.4) increase in log METs. Using logarithmic properties: $\log(\text{METs}_{\geq 3\text{x/wk}}) - \log(\text{METs}_{\text{never}}) = \log(\text{METs}_{\geq 3\text{x/wk}}/\text{METs}_{\text{never}}) = 0.56$. Exponentiating both sides of the equation: $(\text{METs}_{\geq 3\text{x/wk}}/\text{METs}_{\text{never}}) = e^{0.56} = 1.75$. Therefore, girls who reported frequently-exercising parents in Year 5 are estimated to have 75% greater METs in Year 7 than girls who reported sedentary parents in Year 5.

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African-American women have the highest rates of death from cardiovascular disease.¹ Despite the known importance of physical activity in preventing cardiovascular disease,² African-American women have the lowest levels of physical activity.³ Even though youth overall are far from meeting the Institute of Medicine's activity goals,⁴ African-American girls have lower levels of activity and steeper rates of activity decline than their Caucasian counterparts,⁵ and are the subgroup least likely to meet recommended physical activity goals.^{6, 7} Disparities in cardiovascular health are likely to increase in magnitude unless interventions are found that successfully reduce cardiovascular risk among African-American girls. Identifying predictors of activity that are amenable to change will be key in formulating effective interventions.

Parent behavior is particularly interesting as a potential focus for intervention. The family is the child's most proximal environment and is expected to have the greatest influence on behavior in early life.⁸ Although parent physical activity behaviors (parent modeling) appear to positively influence physical activity among largely European-descent youth,⁹⁻¹¹ almost all studies over the last 2 decades examining this relationship in African-American girls have found no association. This apparent differential effect might indicate an interaction between race and the effect of parent modeling on physical activity. Alternatively, it may reflect the use of less-than-optimal measures of parental activity, the fact that associations have been examined among subjects of different ages, or the fact that no large-scale studies focusing on African-American girls have been conducted to date.

Our objectives in this analysis were to determine whether parent modeling predicted girls' activity, to determine if the association declined over time, and to identify variations in this association by race. In order to understand the importance of parent modeling in the context of other potential influences on activity, we examined the predictive ability of parent modeling relative to behavioral, social, and environmental factors associated with physical activity.¹³

Methods

The NGHS was a multi-center prospective study following 1213 African-American and 1166 Caucasian girls from 1987 to 1997. Girls were enrolled at 9 or 10 years of age from the Washington DC, Cincinnati, and San Francisco metropolitan areas. Over the 10 years of follow-up, data were available on 91% of African-American girls and 88% of Caucasian girls. The study design and baseline characteristics have previously been reported.¹⁴

Child Physical Activity

Girls' out-of-school physical activity was assessed using the longitudinally validated Habitual Activity Questionnaire (HAQ), administered as a structured interview in years 1, 3, and 5 and self-administered in years 7-10.¹⁵ The HAQ provides metabolic equivalents (METs) for all leisure-time physical activity, including sports, recreational activities, and lesson-related activities. METs provide an estimate of energy expenditure relative to the resting state, at which children consume 1 kcal/minute, on average;¹⁶ e.g., an activity at which girls are expected to burn 4 kcals/min (e.g., volleyball) would have a MET of 4.¹⁷ The HAQ score, described previously,¹⁵ is derived from estimated METs¹⁷ for each recorded activity multiplied by the weekly frequency of the activity, times the fraction of the year during which the activity was performed. After summing the METs of all activities, an overall average weekly score (MET-times per week) was calculated. An HAQ score of 8.0 MET-times per week could represent bicycling (4 METs) two times per week for 52 weeks per year or playing basketball (6 METs) two times per week for 35 weeks per year, e.g.. Hereafter, MET-times per week are referred to as METs.

In addition to parent modeling, potential predictors of child activity from previously published research were selected from the NGHS dataset and organized using the ecological approach suggested by Social Cognitive Theory.¹⁸ We assessed the ability of each explanatory variable to predict girl's future physical activity (METs) with a 2-year time lag (e.g., mother's physical activity as measured in Year 1 was used to predict girls' activity in Year 3). Race and baseline parental education were not time-lagged.

Parent Physical Activity

In years 1, 3, 5, and 7, parents responded to 4 questions directly related to their leisure-time physical activity, with one 3-point item (*Do you make an effort to get a lot of exercise, some exercise or little or no exercise in recreational activities?* Coded 0=None/Little, 1=Some or 2=A lot) and 3 Yes-No items (*Do you usually exercise 3 or more times per week? Do you play sports or active games often? Do you run, play ball, exercise or take long walks at least 3x/wk?* Coded 0=No or 1=Yes). An aggregate of the items provided more information about a parent's overall activity than any single item, therefore the leisure activity index was created as a sum of the parent-report variables. Reliability analyses demonstrated good internal consistency for this index in each year (Cronbach's alpha 0.72 to 0.80).

Demographic information

A parent/guardian provided information on race, household income, and their maximal education attained.

Perception of Parent Activities

Girls' perception of parent/guardian activity was assessed in years 1, 3, 5, 7 and 8 with separate questions for mother/female guardian (*How often does your mother or female guardian exercise, like jogging, running, playing sports, or taking long walks?*) and father/male guardian. In each year, all questions related to a parent were phrased "parent or guardian"; we use "mother," "father" or "parent" alone here for parsimony. Girls were also asked how often they exercised with one or both of their parents. Possible responses for each question were: never or hardly ever; once or twice a week; and three or more times a week.

Attitudes and Behaviors

Girls responded to yes/no questions asking if they agreed with statements related to athletic competence (*I feel I am good at sports*), preference for sedentary activities (*I would rather play board games or video games than do outdoor activities*), preference for other things than exercise (*Most of the time I would rather do other things than exercise*), enjoyment of activity (*I enjoy activities such as walking, playing ball, bike riding or skating*, Years 1, 3, and 5 only), believing boys were better at physical activity than girls, and outcome beliefs related to health (*I believe that exercising keeps me healthy*, Years 1, 3, and 5, only) and weight (*I believe that exercising helps me control my weight*). Weekly television and video exposure was assessed to the nearest half-hour with a comprehensive checklist. In Years 7 and 8, girls were asked how often they exercised with friends.

During yearly medical examinations, trained healthcare professionals assessed body mass index (BMI) in kg/m² and pubertal stage (available as a score from 1-6 through Year 6).

METs were non-normally distributed with clustering at lower values of METs; we therefore log-transformed girl-reported METs (log METs). We used bootstrapping techniques to estimate confidence intervals for all measures of association.

Dichotomous and ordinal responses were recoded as necessary so lower values were negative ("no" or "never") and higher values were positive ("yes" or "usually/always"). Model checks

including quadratic terms for girls' perceptions of parent activities suggested that treating the ordinal variables as continuous was reasonable in both univariate and multivariate analyses.

Univariate linear regression models explored time-lagged associations between girl- or parent-reported predictor variables in Years 1, 3, 5, 7, and 8 and log METS in Years 3, 5, 7, 9, and 10, respectively. Predictor variables included in multivariate models were the same in each year, selected based on associations from univariate analyses. Race interaction terms were considered for all models.

To determine if associations changed over time, we calculated a linear trend statistic across time for the standardized beta coefficients (β s) of each time-lagged predictor. Bootstrapping was used to generate a confidence interval for the estimated time trends.

Results

Study subjects were from diverse socioeconomic backgrounds (Table I; available at www.jpeds.com). As reported previously,⁵ by year 7, approximately one-third of girls reported no leisure-time physical activity. Table II (available at www.jpeds.com) shows the range of METs reported in each year, by tertile of the METs index (the distribution of METs in each year has been previously reported⁵).

Girls' perception of parent activity and parent self-reported activity were correlated in each year, (β s .27 to .64, $p < 0.001$); associations were generally smaller for African-American than Caucasian girls, after adjusting for parental education (Table III; available at www.jpeds.com). Girls' perception of parent activity better predicted girls' activity (log METs) than parent self-report (Table IV). Given that associations were stronger by girl report and that parent response rate decreased in Years 3 and 5, we did not include parent-reported variables in the models. Across all years, the SD for girls' report of mothers' activity was 0.8; fathers' activity SD was 0.8; and the SD for exercising with parent ranged from 0.6 to 0.8.

Time-lagged girls' perceptions of parents' activity significantly predicted log METs throughout the study (Table V and Figure); the impact of exercising with a parent declined over time. β s presented express the change in standardized log METS (number of SDs of log METS) associated with a change of 1 SD in the predictor. β s are independent of variable scales; thus, magnitudes can be directly compared. The impact of parent modeling on girl METs did not vary by race, except that mothers' activity as assessed in Years 7 and 8 had less impact on log METS for African-American girls in Years 9 and 10, respectively (p for interaction < 0.05). Nonetheless, time-lagged mother's activity significantly predicted greater activity for girls of both races in Years 9 and 10 (data not shown).

Girls' enjoyment of activity and believing exercise made one healthy were weak positive predictors in univariate analyses and were not significant in multivariate models. Pubertal stage, assessed in Years 1-6, significantly predicted log METS in Years 5 and 7 but not in multivariate models. Exercising with a friend in Years 7 and 8 (when this factor was assessed) significantly predicted girls' activity in Years 9 and 10.

At least one parent modeling variable significantly predicted girls' activity in each year (Table V). Parents' activity was a stable predictor over time, and β s for exercising with a parent declined. No interactions were found by race except in Year 9, when both mothers' activity and exercising with a parent showed less impact for African-American than Caucasian girls. Models including only the three parent modeling variables explained from 3% to 6% of the variance in log METs in each year.

Similar to other predictors, multivariate β s for parent modeling variables were generally of smaller magnitude than univariate β s. In all but Year 3, only 30-40% of the decrease in magnitude was attributable to the other 2 parent modeling variables. Race and parent education explained 25-75% of the decrease in magnitude for mother's and father's activity, but none of the decrease for exercising with parent (although African-American girls reported significantly lower levels of parental physical activity than Caucasian girls in Years 3-8, they reported higher rates of exercising with a parent in Years 7 and 8 – data not shown). Preference for exercise explained an additional 10%-40% of the decrease in the magnitude of parent modeling variables and perceived athletic competence explained an additional 30-40% of the decrease in the magnitude of parent exercising with child.

Girls who reported that their parents exercised ≥ 3 times/week had log METS 0.3 to 0.6 units higher than girls reporting that their parents never exercised. Thus, girls who reported frequently-exercising parents had from 20% (in Year 3) to over 100% (in Year 10) greater METS than girls reporting sedentary parents. Using correlations from multivariate models, the increase in METS going from never- to frequently-exercising parents ranged from about 10% in Year 3 to about 30% in Year 10 for mother's and father's activity.

Multivariate models explained 5% to 28% of the variance in log METs (Table V). Models shown in Table IV do not include report of exercising with friends (only available in Years 7 and 8); including exercising with friends did not increase the variance explained.

Discussion

In 2000, based on a thorough review of 108 studies, Sallis et al reported that parent physical activity had been “frequently studied with considerable lack of consistency” as to its ability to predict child activity.¹³ Since then, 6 studies have demonstrated an association between parent modeling and physical activity among largely Caucasian adolescents,^{9-11, 19-21} and 3 studies examining the relationship found no association for African-American girls,²²⁻²⁴ the group at greatest risk of physical inactivity. In contrast, using a large, longitudinal dataset, we demonstrate the impact of perceived parent modeling on girls' activity for both African-American and Caucasian girls. Girls who perceived that their parents exercised 3 or more times weekly were, on average, about 50% more active than girls with perceived sedentary parents. Our findings likely differ from prior studies in part because we used girls' *perception* of parental activity, while 2 of the 3 recent studies focusing on African-American youth relied on parents' self-report of activity. In the present study, girls' activity levels were more strongly influenced by girls' perception of parental activity than by parent-reported activity. Because the correlation between girl- and parent-report of parent activity was slightly lower for African-American than for Caucasian girls, using girls' perception of parent activity may be especially important for African-American youth.

Although parent-report might seem a more reliable indicator of parent activity than child-report, parents may over-report their physical activity levels, as is commonly seen with self-reported physical activity assessments.²⁵ A child could, therefore, provide a more accurate report of a parents' actual behaviors. Alternatively, girls may not observe their parents sufficiently to assess their parents' activity. This is particularly likely to be problematic in studies including parents' workday physical activity. Including workday activity may better capture total parental activity (Polley et al found that almost all activity reported by mothers occurred during their workday²³), but workday activity is less likely to influence children's activity levels and less likely to represent parents' values for physical activity. These results may provide potent incentive for parents to exercise, as health care providers can illustrate the link between a child's perception of his or her parents' activity and the child's own health and well-being. Further, these findings have public health implications, suggesting interventions

focused on parents' activity might indirectly but significantly benefit the cardiovascular health of their children. The impact of parent modeling of activity (and dietary) behaviors might explain why involving the family in clinical interventions to reduce obesity in children leads to greater success.²⁶ However, public health interventions to date have largely been aimed at increasing activity at the level of the child.

Developmental theory might suggest that parental influence decreases with time, but we found a stable relationship between parent and girl activity throughout adolescence, despite the increasing influence of psychosocial variables. This extends findings from Sallis' early study among Latino and Anglo youth, suggesting that the impact of parent modeling on child activity did not decline over the 2-year period from 5th to 6th grade.²⁷ We demonstrate the stability of the relationship over an 8-year period. Trost found that mothers' activity in 5th grade significantly predicted African-American girls' vigorous physical activity in 6th grade, but fathers' activity did not.²⁸ Our results would suggest that both parents' activity levels play important roles and that the impact of father's modeling increases over time. The decline in the association between girls' activity and exercising with a parent over time may reflect the fact that the prevalence of exercising with parents decreased from 70% at age 9-10 to 32% at age 16-17 (data not shown). It is unrealistic to expect that girls will wish to exercise with their parents as they establish their independence and spend more time with peers. Thus, there may be a critical window for exercising with parents earlier, and parents' habitual activity remains an important target for intervention throughout adolescence.

We found that the three parent modeling variables taken together explained approximately 5% of the variance in girls' activity in any given year and overall, the models explained up to 28% of the variance in girls' future activity. Parent education greatly attenuated the impact of parent modeling on girl's physical activity in multivariate models, which is consistent with previous research reporting the negative influence of low socioeconomic status and potentially stressful home environment factors on physical activity.^{9, 22, 29} Families with fewer resources are less likely to access to facilities and time for physical activity. This underscores the critical need to address social disparities that potentiate health disparities, and the importance of creating environmental changes (through policy and urban planning, e.g.) that support families' efforts to be active.³⁰

Several limitations merit comment. Although girls with more active parents were, on average, 50% more active than girls with sedentary parents, the overall decline in activity overshadows this finding in later years and parent modeling explained a small percent of variance in girl's activity in multivariate models. Data were self-reported, although using time-lagged predictor variables minimizes bias from girls' current activity, potential confounding, and the effects of temporal trends. The influence of friends, an important contributor to girl activity, was not measured until Year 7 of the study. The model does not include logistical support, parental encouragement, or self-efficacy, all of which have been shown to relate to activity^{9, 10, 31-34} and to mediate the impact of parents' activity on child physical activity.³⁵ Their absence likely reduces our ability to explain more variance in girls' activity. Nonetheless, previous research¹⁹ supports collapsing parental logistic support for physical activity with parent activity, likely because active parents appear to provide greater logistical support.³⁶

The rapid decline in physical activity by age demonstrated among this diverse group of adolescent girls is of great concern. Our findings would suggest that it is not what parents say, but what children observe their parents doing. Culturally appropriate interventions to increase African-American parents' activity, as part of a concerted public health effort, could address cardiovascular risk factors among both adults and children, potentially minimizing the growing disparities in cardiovascular health.

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Figure.

Girls' physical activity (mean METs) by girl-reported level of parent activity

Table I

Sociodemographics at baseline

	Caucasian	African-American
N	1165	1213
Household income at baseline (1987)		
% <\$20 000	17%	47%
% \$20 000-49 999	49%	38%
% ≥\$50 000	34%	15%
Highest education obtained by parent		
High school or less	20%	32%
Some college	30%	47%
College or graduate degree	50%	21%
% Single parent households	19%	44%

Table 2

Tertiles of MET-times/week in each Year.

	Year 3	Year 5	Year 7	Year 9	Year 10
Tertile	Range	Range	Range	Range	Range
1	0 – 15	0 – 11	0	0	0
2	15 – 28	12 – 23	0 – 11	0 – 13	0 – 13
3	28 – 115	23 – 100	11 – 123	13 – 106	13 – 121
METs - Mean (SD)	24.3 (15.8)	19.9 (15.0)	9.8 (12.9)	11.1 (14.5)	12.4 (17.4)
log METs - Mean (SD)	3.0 (0.7)	2.8 (0.8)	1.6 (1.4)	1.6 (1.4)	1.6 (1.5)

(Numbers are rounded to nearest whole number; tertiles do not overlap.)

Table 3

Standardized beta coefficients for girls' perception of parent activity predicting parent self-reported activity, adjusted for parent education

	Year 1	Year 3	Year 5	Year 7
For Mother's activity (all girls)	.29 **	.27 **	.49 **	.43 **
African-American girls	.20 **	.21 *	.40 **	.38 **
Caucasian girls	.38 **	.38 **	.56 **	.47 **
Difference by race	-.18 †	-.17	-.16 †	-.09
For Father's activity (all girls)	.34 *	.37 **	.64 **	.47 **
African-American girls	.31 **	.32 *	.66 **	.41 **
Caucasian girls	.35 **	.40 **	.63 **	.51 **
Difference by race	-.04	-.12	.03	-.10

* Correlation significant at $p < 0.05$;

** correlation significant at $p < 0.001$

† Interaction term for race significant at $p < 0.05$

Table 4

Correlations (Pearson's R) between log METs and time-lagged parent activity: Girl vs. Parent report

	Year 3	Year 5	Year 7	Year 9
Correlation between log METs and Mother's activity by:				
Girl Report ^I	.13 [*]	.12	.18 [*]	.16 [*]
Mother Report	.06 [*]	.01	.06	.12 [*]
Difference [95% CI]	.07 [.01, .12]	.11 [-.08, .29]	.12 [.03, .22]	.04 [-.03, .09]
Correlation between log METs and Father's activity by:				
Girl Report ^I	.13 [*]	.08	.13 [*]	.18 [*]
Father Report	.04	.12	.02	.03
Difference [95% CI]	.09 [-.02, .18]	-.04 [-.26, .20]	.11 [-.01, .24]	.15 [.06, .24]

^I For subgroup of girls with parent reporting.* Association with log METs significant at $p < 0.05$

Table 5

Univariate (UV) and Multivariate (MV) time-lagged associations with Girl METs

	Year 3 (Age 11-12)		Year 5 (Age 13-14)		Year 7 (Age 15-16)		Year 9 (Age 17-18)		Year 10 (Age 18-19)		Time Trends	
	UV	MV n=1589	UV	MV n=1359	UV	MV n=1187	UV	MV n=1322	UV	MV n=1318	UV	MV
Parent Modeling Variables												
Mom exercises regularly	.12 [†]	.06 [*]	.14 [†]	.09 [†]	.16 [†]	.05	.16 [†]	.03	.17 [†]	.06 [*]	.01	.00
Dad exercises regularly	.11 [†]	.04	.09 [†]	.01	.15 [†]	.06 [*]	.21 [†]	.07 [†]	.22 [†]	.08 [†]	.02 [†]	.01
Exercise w/ parent	.14 [†]	.10 [†]	.11 [†]	.08 [†]	.10 [†]	.03	.10 [†]	.04	.02	-.01	-.01 [†]	-.01 [*]
Girl Attitudes & Behaviors												
Athletic competence	.11 [†]	.03	.11 [†]	.05	.22 [†]	.16 [†]	.21 [†]	.14 [†]	.17 [†]	.09 [†]	.01 [†]	.01 [*]
Prefer sedentary activities	-.09 [†]	-.05 [*]	-.13 [†]	-.09 [†]	-.26 [†]	-.11 [†]	-.22 [†]	-.04	-.21 [†]	-.04	-.02 [†]	.00
Rather do other things	-.09 [†]	.00	-.17 [†]	-.09 [†]	-.29 [†]	-.12 [†]	-.34 [†]	-.19 [†]	-.29 [†]	-.16 [†]	-.03 [†]	-.02 [†]
Boys better at activity	-.09 [†]	-.07 [†]	-.05 [*]	-.01	-.12 [†]	-.01	-.15 [†]	-.05 [*]	-.11 [†]	-.02	-.01	.00
Exercise controls weight	.03	.03	.00	.01	.14 [†]	.02	.19 [†]	.05	.18 [†]	.08 [†]	.03 [†]	.01
Screen time	-.02	.06 [*]	-.07 [†]	.03	-.22 [†]	.02	-.30 [†]	-.06 [*]	-.30 [†]	-.10 [†]	-.05 [†]	-.02 [†]
Demographic/Physiologic Girl Variables												
African American race	-.11 [†]	-.09 [†]	-.21 [†]	-.14 [†]	-.34 [†]	-.20 [†]	-.34 [†]	-.19 [†]	-.35 [†]	-.21 [†]	-.03 [†]	-.02 [†]
Parent Education	.07 [†]	.04	.16 [†]	.11 [†]	.32 [†]	.19 [†]	.32 [†]	.17 [†]	.35 [†]	.18 [†]	.04 [†]	.02 [†]
BMI	-.06 [†]	-.05	-.13 [†]	-.05	-.16 [†]	-.07 [†]	-.15 [†]	-.04	-.14 [†]	.00	-.01 [*]	.00
Adjusted R2 for model		.05		.11		.26		.28		.28		

* p<0.05
[†] p<0.01

Values shown are standardized β coefficients. Time trends represent change in coefficients per year. Multivariate models do not include interaction terms for race.