

ONLINE FIRST

Parental and Environmental Correlates of Physical Activity of Children Attending Preschool

Marsha Dowda, DrPH; Karin A. Pfeiffer, PhD; William H. Brown, PhD; Jonathan A. Mitchell, MS; Wonwoo Byun, MS; Russell R. Pate, PhD

Objective: To determine, using a social-cognitive framework and structural equation modeling, if parent-reported family physical activity (PA) variables are related to PA of young children.

Design: Cross-sectional study.

Setting: Children attending 23 preschools in and around Columbia, South Carolina.

Participants: Three hundred sixty-nine children (48.0% male and 50.4% black) and their parents.

Main Exposures: Family variables were reported by parents and included parent PA, parent enjoyment of PA, importance to adults of child playing sports and being active, and family support.

Main Outcome Measures: Moderate to vigorous physical activity (MVPA) of children was modeled as a latent variable using PA from direct observation, accelerometers, and parent's perception of the child's athletic coordination.

Results: A model of direct and indirect relations of family variables, preschool quality, home PA equipment, and child's enjoyment of PA had acceptable fit (root mean square error of approximation, 0.053; comparative fit index, 0.90). Parent PA, parent enjoyment of PA, and importance of child's PA were significantly related to family support. Family support, quality of preschool attended, home PA equipment, and child's enjoyment of PA were positively related to child's PA. However, there was no direct relationship between parent PA and the child's PA.

Conclusion: Although parent PA was not directly related to children's MVPA, results showed that parent PA indirectly affects preschool children's MVPA via its influence on family support for children's PA.

Arch Pediatr Adolesc Med. 2011;165(10):939-944.

Published online June 6, 2011.

doi:10.1001/archpediatrics.2011.84

Author Affiliations:

Department of Exercise Science, Arnold School of Public Health (Drs Dowda and Pate and Messrs Mitchell and Byun), and Department of Educational Studies (Dr Brown), University of South Carolina, Columbia; and Department of Kinesiology, Michigan State University, Lansing (Dr Pfeiffer).

IN PRESCHOOL CHILDREN (AGE, 2-5 years), the prevalence of overweight and obesity has doubled in recent decades.^{1,2} The causes of the increase have not been fully identified. However, it seems probable that reduced physical activity (PA) and increased sedentary activity are important contributing factors.³⁻⁵ According to the PA guidelines for preschool children developed by the National Association for Sport and Physical Education,⁶ preschool children (age, 3-5 years) should accumulate at least 120 minutes of PA (60 minutes of structured PA and 60 minutes of free-play activity) during a typical day. However, there is evidence that children attending preschool are not accumulating this level of PA.^{7,8}

Parents play a significant role in the health of their children and contribute to the physical and social environments in

which their children develop.⁹ Of particular interest, given the rise in overweight and obesity, is the extent to which parents influence television viewing, dietary intake, and PA patterns of young children.¹⁰ The home environment may be an appropriate setting in which to conduct health behavior interventions, particularly school- or community-linked home interventions.^{9,11} However, a better understanding of how families contribute to the PA of young children is needed to design effective family-based PA interventions for preschool children.

Several models have been used to study correlates of PA, including social cognitive theory and the Youth Physical Activity Promotion Model.^{12,13} These models incorporate factors at different levels and propose that PA is affected by social and physical environmental influences (eg, social support, preschool a child attends,

equipment for PA in the home) and personal factors (eg, sex of the child, enjoyment of PA).^{12,13} Parental PA and parental support have been accepted as correlates of PA in children and youth.¹⁴ Recently, Loprinzi and Trost¹⁵ used path analysis to assess parental influences on PA behavior of young children both at home and while in preschool. The purpose of the present study was to use parental variables from the Loprinzi and Trost model¹⁵ and variables from other models^{12,13} to test a model of parental influence and physical environment variables in preschool children's PA over the entire day. Child's PA was measured by 3 methods, and the analysis was performed using structural equation modeling.

METHODS

STUDY DESIGN AND PARTICIPANTS

Participants in this study were enrolled in the Children's Activity and Movement in Preschool Study (CHAMPS).^{16,17} All 3- to 5-year-old children from 23 preschools enrolled in the study (2003-2005) were asked to participate. Accelerometer data and parent questionnaires were collected from 411 children (47.5% male, 51.6% black, and 40.4% white). Complete data (accelerometers, direct observation, and parent questionnaires) were available for 369 children. Data were collected over a 2-week period. Children from whom data were available and were not available did not differ by age, body mass index (BMI), moderate to vigorous PA (MVPA) from accelerometer, or race. Written informed consent was obtained from children's parents or guardians prior to collection of data. The study was approved by the University of South Carolina institutional review board.

ACCELEROMETRY

Children wore ActiGraph accelerometers (Model 7164; ActiGraph LLC, Pensacola, Florida) over a 2-week period including 1 weekend, both while in preschool and at home. The monitors were initialized to save data in 15-second intervals to detect the short bursts of activity that are characteristic of 3- to 5-year-old children. Participants wore the accelerometers on an elastic belt on the right hip. Parents were instructed to remove the accelerometer only during water activities (bathing or swimming) and when the child went to bed at night.

Accelerometer data were reduced using cut points developed specifically for 3- to 5-year-old children to identify intervals of MVPA (>420 counts/15 s).¹⁸ Sixty minutes of consecutive zeros were considered as nonwear time. Minutes per hour of MVPA were then calculated, using each child's wear time as the divisor. Days on which total wear time was less than 5 hours or the child was absent from preschool were deleted from the analyses.

DIRECT OBSERVATION OF PA

The Observational System for Recording Physical Activity in Children-Preschool Version (OSRAC-P)¹⁹ was used to measure PA while the children were in the preschool. The OSRAC-P is a focal child, momentary time sampling observation system with a 5-second observe interval, followed by a 25-second record interval for each 30-second observation interval. Physical activity codes used in the OSRAC-P were modified from the Children's Activity Rating Scale.²⁰ Activity intensities were scored on a scale of 1 to 5, with 1 indicating stationary or motionless and 5 indicating fast movement. Percentage of time in inter-

vals coded as levels 4 or 5 was reported as MVPA. Data were collected in 30-minute sessions, and each child was observed for 10 to 12 randomly chosen sessions during the 2-week data collection period. Interobserver agreement was 91% for all reliability observation sessions.

PARENT SURVEY

A parent or guardian completed a survey that included questions about the child's date of birth, sex and race, and the level of education of adults in the household. In addition, the parent or guardian also reported his or her child's athletic coordination and enjoyment of PA and completed a checklist of PA equipment at home used by the child (**Table 1**). The parent's perception of the child's athletic coordination was used in the present study as a parent-reported proxy of PA because of its previously established relationship as a predictor of PA.²⁴

The survey also asked about parent enjoyment of PA, family support for PA (5 items), and importance of the child participating in sports and PA (1 item), which are presented in Table 1. Family support items inquired about support from all family members. Three items assessed parent PA (Table 1), including moderate PA (MPA) during the previous 7 days, vigorous PA (VPA) during the previous 7 days, and a self-rating (0 to 10) of parent's PA level.

BODY MASS INDEX

Children's height was measured to the nearest 0.1 cm using a portable stadiometer (Shorr Productions, Olney, Maryland). Weight was measured to the nearest 0.1 kg using an electronic scale (Model 770; Seca, Hamburg, Germany). The average of 2 measurements was used for both height and weight, and body mass index (BMI) was calculated from the averages (calculated as weight in kilograms divided by height in meters squared).

PRESCHOOL QUALITY

The Early Childhood Environment Rating Scale-Revised Edition (ECERS-R)²⁵ was administered in a randomly selected classroom at each preschool by a trained researcher. The ECERS-R provides an estimate of the level of preschool quality based on current understanding of best practices in early childhood education. The ECERS-R evaluates 7 dimensions, and the scale includes 43 items. The items are rated from 1 to 7 on a Likert-type scale, with a score of 1 for inadequate and 7 for excellent. In this study, scores from each subscale were added and divided by the number of items. The psychometric properties of the ECERS-R have been reported elsewhere.²⁵ The mean (range) score for the 23 preschools was 4.9 (3.5-5.9).

STATISTICAL ANALYSES

Structural equation modeling (SEM) using full-information maximum likelihood estimation was performed using Mplus 5.1²⁶ to test the hypothesized relationships (**Figure**). Approximately 6% of the participants had 1 or more missing values. The model tested is presented in the Figure. The measurement model included latent variables for parent PA (3 indicators), parent enjoyment of PA (1 indicator), importance of child participating in sports/PA (1 indicator), family support of PA (5 indicators), and child's PA (3 indicators: accelerometer, direct observation, and parent report). The model also included preschool quality, sex, PA equipment in the home, and child's enjoyment of PA. Correlations were estimated among all exogenous variables. The structural model included the following: (1) direct paths from parent PA, fam-

Table 1. Description of Parent-Reported Variables

Variable	Items	Response	Test-Retest
Child's coordination	Compared with other children the same age and sex, how would you describe your child's level of athletic coordination?	1 = Much less 5 = Much more	ICC, R = 0.81 ²¹
Child enjoys PA	How much does your child enjoy PA?	1 = PA is not enjoyable 5 = PA is very enjoyable	ICC, R = 0.87 ²¹
PA equipment at home (No. of items)	Number of items (ie, basketball hoop, big yard, swings tricycle)	Sum of 18 items plus a write-in item	NA
Family support (all family members, including siblings)	During a typical week how often does a member of your household 1. Encourage your child to do PA or play outside? 2. Play outside or do PA with your child? 3. Provide transportation to a place where he or she can do PA or play? 4. Watch your child participate in physical activities or outdoor games? 5. Tell your child that PA is good for his or her health?	1 = Never 5 = Daily	ICC, R = 0.81 ²¹
Importance of child's participation (all adults)	How important is it to the adults in your household that your child participates in sports and physical activities?	1 = Very unimportant 5 = Very important	ICC, R = 0.67 ²³
Parent enjoys PA (all adults)	How much do the adults in your household enjoy participating in sports or exercise?	1 = Not enjoyable 5 = Very enjoyable	ICC, R = 0.76 ²³
Parent PA (respondent only)	1. How many of the past 7 days did you exercise or participate in sport activities for at least 20 minutes that made you sweat and breathe hard, such as basketball, soccer, running, swimming laps, fast bicycling, fast dancing or similar aerobic activities? 2. On how many of the past 7 days did you participate in PA for at least 30 minutes that did not make you sweat or breathe hard, such as fast walking, slow bicycling, skating, pushing a lawn mower, or mopping floors? 3. Please rate your own PA using a scale of 0 to 10. A 10 means "You hardly get off the couch."	1. 0-7 d 2. 0-7 d 3. 0-10	1. ICC, R = 0.67 ²³ 2. ICC, R = 0.71 ²³ 3. Not reported

Abbreviations: ICC, intraclass correlation; NA, not applicable; PA, physical activity; R, reliability.

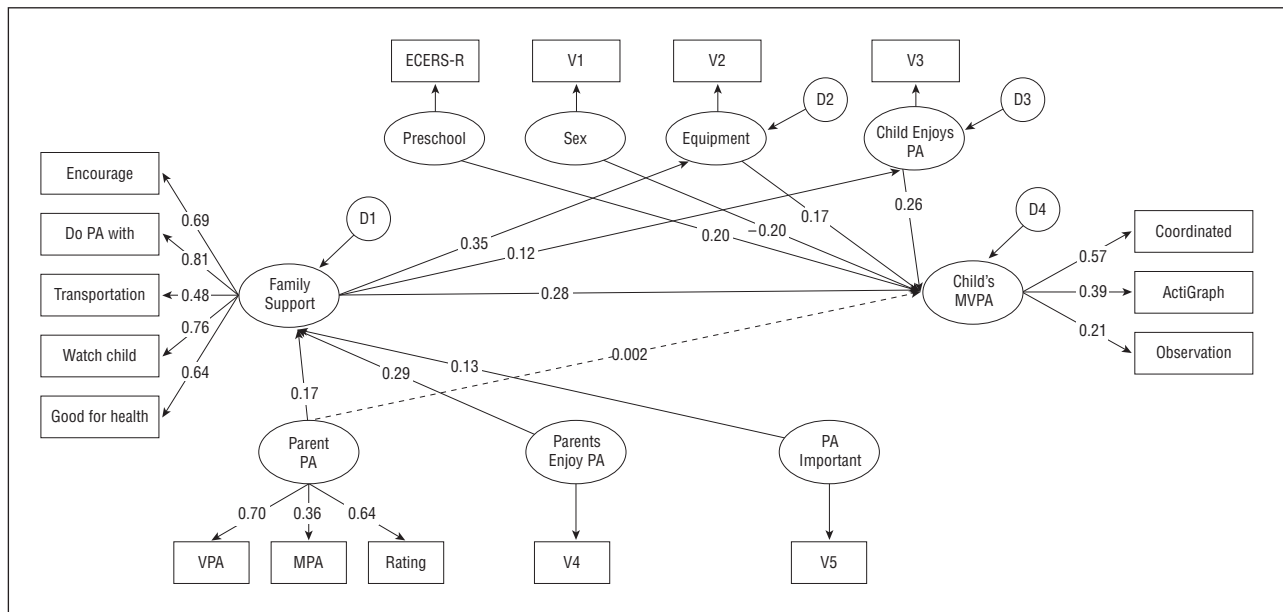


Figure. Model illustrating the relationship among child's MVPA and family influences, adjusting for sex, preschool quality, and home equipment using structural equation modeling with standardized regression coefficients (β). D1 through D4 represent disturbance terms for the latent variables. Solid lines represent significant relationships and dashed lines represent nonsignificant relationships. V1 through V5 are single indicators for latent variables. The root mean square error of approximation of the model was 0.053 (95% confidence interval, 0.043-0.063); comparative fit index=0.90; $\chi^2_{104}=211.9$; $P<.001$. ActiGraph refers to ActiGraph accelerometers (Model 7164; ActiGraph LLC, Pensacola, Florida). ECERS-R indicates Early Childhood Environment Rating Scale-Revised Edition; MPA, moderate physical activity; MVPA, moderate to vigorous physical activity; PA, physical activity; VPA, vigorous physical activity.

ily support, preschool quality, sex, home equipment, and child's enjoyment of PA to child's PA; (2) direct paths from importance of child participating in PA, parent enjoyment of PA, and parent PA to family support; and (3) direct effects

from family support to home equipment and child's enjoyment of PA. The strength of the relationships was determined by the standardized regression coefficients (β) of the model. The β coefficients are correlations but are adjusted for other

Table 2. Descriptive Characteristics of 369 Children

Characteristic	Value
Age, mean (SD), y	4.2 (0.7)
BMI, mean (SD)	16.6 (2.8)
Male sex, %	48.0
Race, %	
Black	50.4
White	41.2
Other	8.4
Parents with >high school education, %	53.9
Adult completing questionnaire, %	
Mother	91.6
Father	4.9
Other/unknown	3.5

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).

correlations (paths) in the model. A higher β value indicates a stronger relationship.

Indirect effects and 95% confidence intervals (CIs) were estimated with PRODCLIN.²⁷ This program produces unstandardized beta (*b*) coefficients for the indirect effect and is significant if the 95% CI does not contain 0.

Model fit was assessed according to multiple fit indexes using decision rules described by Hoyle²⁸ and others. A χ^2 value that is nonsignificant is an indicator of optimal fit, but it is too sensitive in a large sample, so other fit indexes also were used to test model fit. The root mean square error of approximation is a standardized estimation that is used to represent closeness of fit. Values of 0.06 or lower represent a close fit, while 0 represents an exact fit.²⁹ The comparative fit index (CFI) tests the proportionate improvement in fit of the target model with the null model; CFI values approximating 0.90 indicate minimally acceptable fit.³⁰ $P < .05$ was considered statistically significant.

RESULTS

The mean (SD) age of the children was 4.2 (0.7) years, 48.0% were male, and 92% of the questionnaires were completed by the child's mother (**Table 2**). On average, children wore the accelerometer for a mean (SD) of 12.7 (1.5) hours per day for 6.9 (2.5) days. The only significant sex difference ($P < .05$) for the study variables was for MVPA as measured by accelerometry (**Table 3**).

The SEM model (Figure) provided an acceptable fit. Family support, preschool quality, access to home equipment, and child's enjoyment of PA were positively related to child's MVPA. Significant direct relationships (standardized regression weight [β]) with child's MVPA were observed for family support ($\beta = 0.28$), preschool quality ($\beta = 0.20$), sex ($\beta = -0.20$), home equipment ($\beta = 0.17$), and child's enjoyment of PA ($\beta = 0.26$). Parent PA, parent enjoyment of PA, and importance of child's participation in sports and PA were positively related to family support. Family support was positively related to child's access to home equipment and child's enjoyment of PA. The model accounted for 20.7% of the variance in family support, 12.0% of the variance in home equipment, 1.5% of the variance in child's enjoyment of PA, and 31.5% of variance in child's MVPA.

Five indirect effects were tested using the PRODCLIN program.²⁷ The indirect effect (unstandardized beta [*b*] and 95% CI) between parent PA and child's MVPA (mediated by family support) was significant ($b = 0.015$; 95% CI, 0.001 to 0.036). Other significant indirect effects were found between parent enjoyment of PA and child's MVPA, mediated by family support ($b = 0.031$; 95% CI, 0.005 to 0.065); between importance of child participation in PA and child's MVPA, mediated by family support ($b = 0.014$; 95% CI, 0.001 to 0.034); and between family support and child's MVPA, mediated by child's enjoyment of PA ($b = 0.021$; 95% CI, 0.0003 to 0.054). However, the indirect effect between family support and child's MVPA, mediated by home equipment, was not significant ($b = 0.040$; 95% CI, -0.0001 to 0.0826).

Correlations among the exogenous variables in the SEM are displayed in **Table 4**. Significant correlations were observed between importance of child's participation in PA and parent enjoyment of PA, and between parent PA and parent enjoyment of PA.

COMMENT

This study is the first, to our knowledge, to use SEM in identifying factors that directly and indirectly associate with MVPA in preschool children. Three types of factors were related to child MVPA, including parent/family factors (eg, family support), school/environment factors (eg, preschool quality), and individual factors (eg, enjoyment of PA). The findings that MVPA behavior in young children is influenced by a complex set of social environmental and personal factors are consistent with social cognitive theory, the Youth PA Promotion Model, and social ecological framework.^{12,13,31}

The β coefficients presented for the SEM were standardized and therefore have a common metric that is uniform across all the measures in the model. This makes it possible to assess the relative importance of the predictors. For the direct effects in the Figure (arrows pointing directly to child's MVPA), the strongest predictor of child's MVPA was family support ($\beta = 0.28$), and the second was child's enjoyment of PA ($\beta = 0.26$). Parent PA was the weakest predictor of child's MVPA ($\beta = 0.002$).

The influence of parents' PA levels on their children's PA is not clear, with studies reporting conflicting results. In this study, the SEM analyses revealed that parent PA was related to child MVPA indirectly, through its influence on family support. A recent meta analysis found that parental modeling has a weak influence on child and adolescent PA.³² However, the influence of parent PA may be more important for preschool children. For example, Moore et al³³ reported that preschool children of active mothers were more likely to be active than children of inactive mothers. In another study, however, mothers' PA was not related to PA of young children.²² In a longitudinal study of preschool children, father's activity was a significant predictor of child's PA after adjustments for potential confounders.³⁴ Similar to the present study, Loprinzi and Trost¹⁵ found no direct effect of parent PA on child PA, but did find an indirect effect that was mediated by parental support. Similar findings have been reported in older children using path analy-

Table 3. Means (SDs) for Study Variables by Total Group and by Sex^a

Variable	Total		Mean (SD)		P Value
	No.	Mean (SD)	Male (n=177)	Female (n=192)	
Family encourages PA	364	3.6 (0.9)	3.7 (0.9)	3.6 (0.9)	.10
Family did PA with child	363	3.4 (0.7)	0.7 (0.1)	0.7 (0.1)	.23
Family provided transportation	362	2.8 (0.9)	2.9 (1.0)	2.8 (0.8)	.51
Family watches child do PA	362	3.4 (0.9)	3.5 (0.8)	3.4 (0.9)	.15
Family told PA is good for health	364	3.4 (1.2)	3.5 (1.1)	3.2 (1.1)	.05
Parent VPA	366	2.3 (1.9)	2.1 (1.9)	2.4 (1.9)	.19
Parent MPA	362	2.8 (2.1)	2.7 (2.1)	2.8 (2.1)	.82
Parent rate	365	4.4 (2.0)	4.5 (2.0)	4.3 (1.9)	.34
Parent enjoyment of PA	366	4.2 (1.1)	4.2 (1.1)	4.1 (1.1)	.28
Importance of child's participation	366	4.6 (1.1)	4.7 (1.1)	4.6 (1.1)	.47
Child's coordination	366	3.4 (0.7)	3.4 (0.8)	3.3 (0.7)	.48
ActiGraph ^b MVPA, min/h	369	7.5 (2.0)	8.1 (2.1)	7.0 (2.0)	<.001
Direct observation, % MVPA	369	2.6 (1.9)	2.4 (2.8)	2.2 (2.4)	.12
Child's enjoyment of PA	367	4.8 (0.5)	4.8 (0.5)	4.8 (0.5)	.66
PA equipment	369	5.7 (2.5)	5.8 (2.4)	5.6 (2.6)	.58
ECERS-R	369	5.0 (0.5)	5.1 (0.5)	5.0 (0.5)	.19

Abbreviations: ECERS-R, Early Childhood Environment Rating Scale—Revised Edition; MPA, moderated physical activity; MVPA, moderated to vigorous physical activity; PA, physical activity; VPA, vigorous physical activity.

^aTable 1 provides the response range for each of the scale items.

^bActiGraph accelerometer (Model 7164; ActiGraph LLC, Pensacola, Florida).

Table 4. Correlations (Structural Equation Model) Among Exogenous Variables

Variable	Sex of Child	Parent Enjoyment of PA	Child's PA Important	Preschool Quality	Parent PA
Sex of child	1.00
Parent enjoyment of PA	-0.06	1.00
Child's PA important	-0.07	0.34 ^a	1.00
Preschool quality	-0.07	-0.01	-0.03	1.00	...
Parent PA	0.02	0.42 ^a	0.11	-0.01	1.00

Abbreviation: PA, physical activity.

^a $P < .001$.

sis over the total day.²³ Although it seems clear that parent PA behavior influences children's PA, longitudinal studies are needed to clarify the mechanisms of this influence.

Two additional parent/family factors—parent enjoyment of PA and the importance parents placed on their child participating in sports and PA—were significantly related to family support of PA, which in turn was significantly related to child MVPA. Similar findings in preschool children and older children have been reported by others.^{15,23,35} For example, in a study of fourth- to sixth-grade children,³⁵ those who reported greater parent enjoyment of PA and parental encouragement of PA participated in PA at higher levels. As in the present study, parental role modeling of PA was not directly related to child's MVPA. Although parental modeling may not affect child PA directly, parents who are active may be more likely to participate in PA with their child and to support his or her PA. Interventions to increase PA levels of children should consider focusing some resources on increasing parent enjoyment of PA and support for their child's sports and PA.

This study used a novel approach to creating the MVPA variable that functioned as the dependent variable in the SEM. The variable was created from 2 objective mea-

asures of PA (accelerometry and direct observation) and 1 subjective measure (parent-reported child's athletic coordination). This approach is based on the assumption that MVPA is a latent variable for which there is no single ideal measure. Taken together, multiple data sources can provide a better overall picture of children's PA than any of the sources alone.³⁶

Strengths of the present study include triangulating child's MVPA from 3 measures of PA. Although parent's perception of athletic coordination is not a direct measure of PA, it has been shown to be correlated with PA in preschool children and older youth.^{11,24,33} Limitations include the cross-sectional nature of the data, self-reported parent PA, and the use of parent report of child's enjoyment of PA. However, there is some evidence that parents can reliably report psychosocial variables of their children.³⁷

In conclusion, similar to other studies in preschool and older children, family influences were strongly associated with preschool children's PA.^{15,23,35} Because a majority of children aged up to 5 years are enrolled in some form of preschool,³⁸ preschools are a logical setting for intervening to increase PA in young children. The findings of the present study suggest that a family component to interventions may help young children accumu-

late the recommended 60 minutes or more of structured MVPA each day.^{6,39,40} Preschools can help families learn about places to be active, promote community PA programs, and sponsor activities that help parents and children be active together.⁴¹ Preschools should provide teacher training, focus resources and modify policies and practices in ways that promote structured activity, active free play, and active learning.^{17,42}

Accepted for Publication: March 21, 2011.

Published Online: June 6, 2011. doi:10.1001/archpediatrics.2011.84

Correspondence: Marsha Dowda, DrPH, Department of Exercise Science, Arnold School of Public Health, University of South Carolina, 921 Assembly St, Columbia, SC 29208 (mdowda@mailbox.sc.edu).

Author Contributions: Dr Dowda had full access to all of the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis. *Study concept and design:* Dowda, Pfeiffer, Brown, and Pate. *Analysis and interpretation of data:* Dowda, Pfeiffer, Mitchell, and Byun. *Drafting of the manuscript:* Dowda, Brown, Byun, and Pate. *Critical revision of the manuscript for important intellectual content:* Pfeiffer, Brown, and Mitchell. *Statistical analysis:* Dowda. *Obtained funding:* Pfeiffer, Brown, and Pate. *Administrative, technical, and material support:* Brown and Pate. *Study supervision:* Pfeiffer and Pate.

Financial Disclosure: None reported.

Funding/Support: This study was funded by National Institute of Child Health and Human Development grant R01HD043125.

Additional Contributions: Gaye G. Christmus, MPH, edited the manuscript, and Kristen Swaney, MPH, managed the project.

REFERENCES

- Ogden CL, Troiano RP, Briefel RR, Kuczmarski RJ, Flegal KM, Johnson CL. Prevalence of overweight among preschool children in the United States, 1971 through 1994. *Pediatrics*. 1997;99(4):E1.
- Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA*. 2006;295(13):1549-1555.
- Dennison BA, Erb TA, Jenkins PL. Television viewing and television in bedroom associated with overweight risk among low-income preschool children. *Pediatrics*. 2002;109(6):1028-1035.
- Epstein LH, Paluch RA, Gordy CC, Dorn J. Decreasing sedentary behaviors in treating pediatric obesity. *Arch Pediatr Adolesc Med*. 2000;154(3):220-226.
- Gortmaker SL, Peterson K, Wiecha J, et al. Reducing obesity via a school-based interdisciplinary intervention among youth: Planet Health. *Arch Pediatr Adolesc Med*. 1999;153(4):409-418.
- National Association for Sport and Physical Education. *Active Start: A Statement of Physical Activity Guidelines for Children Birth to Five Years*. Reston, VA: NASPE Publications; 2002.
- Pate RR, Pfeiffer KA, Trost SG, Ziegler P, Dowda M. Physical activity among children attending preschools. *Pediatrics*. 2004;114(5):1258-1263.
- Oliver M, Schofield GM, Kolt GS. Physical activity in preschoolers: understanding prevalence and measurement issues. *Sports Med*. 2007;37(12):1045-1070.
- Novilla ML, Barnes MD, De La Cruz NG, Williams PN, Rogers J. Public health perspectives on the family: an ecological approach to promoting health in the family and community. *Fam Community Health*. 2006;29(1):28-42.
- Pocock M, Trivedi D, Wills W, Bunn F, Magnusson J. Parental perceptions regarding healthy behaviours for preventing overweight and obesity in young children: a systematic review of qualitative studies. *Obes Rev*. 2010;11(5):338-353.
- Edmundson E, Parcel GS, Perry CL, et al. The effects of the child and adolescent trial for cardiovascular health intervention on psychosocial determinants of cardiovascular disease risk behavior among third-grade students. *Am J Health Promot*. 1996;10(3):217-225.
- Bandura A. *Social Learning Theory*. Englewood Cliffs, NJ: Prentice Hall; 1977.
- Welk GJ. The youth physical activity promotion model: a conceptual bridge between theory and practice. *Quest*. 1999;51(1):5-23.
- Van Der Horst K, Paw MJ, Twisk JW, Van Mechelen W. A brief review on correlates of physical activity and sedentariness in youth. *Med Sci Sports Exerc*. 2007;39(8):1241-1250.
- Loprinzi PD, Trost SG. Parental influences on physical activity behavior in preschool children. *Prev Med*. 2010;50(3):129-133.
- Pate RR, McIver KL, Dowda M, Brown WH, Addy C. Directly observed physical activity levels in preschool children. *J Sch Health*. 2008;78(8):438-444.
- Dowda M, Brown WH, McIver KL, et al. Policies and characteristics of the preschool environment and physical activity of young children. *Pediatrics*. 2009;123(2):e261-e266.
- Pate RR, Almeida MJ, McIver KL, Pfeiffer KA, Dowda M. Validation and calibration of an accelerometer in preschool children. *Obesity (Silver Spring)*. 2006;14(11):2000-2006.
- Brown WH, Pfeiffer KA, McIver KL, Dowda M, Almeida MJ, Pate RR. Assessing preschool children's physical activity: the Observational System for Recording Physical Activity in children-preschool version. *Res Q Exerc Sport*. 2006;77(2):167-176.
- Puhl J, Greaves K, Hoyt M, Baranowski T. Children's Activity Rating Scale (CARS): description and calibration. *Res Q Exerc Sport*. 1990;61(1):26-36.
- Sallis JF, Taylor WC, Dowda M, Freedson PS, Pate RR. Correlates of vigorous physical activity for children grades 1 through 12: comparing parent-reported and objectively measured physical activity. *Pediatr Exerc Sci*. 2002;14(1):30-44.
- Sallis JF, Nader PR, Broyles SL, et al. Correlates of physical activity at home in Mexican-American and Anglo-American preschool children. *Health Psychol*. 1993;12(5):390-398.
- Trost SG, Sallis JF, Pate RR, Freedson PS, Taylor WC, Dowda M. Evaluating a model of parental influence on youth physical activity. *Am J Prev Med*. 2003;25(4):277-282.
- Pfeiffer KA, Dowda M, McIver KL, Pate RR. Factors related to objectively measured physical activity in preschool children. *Pediatr Exerc Sci*. 2009;21(2):196-208.
- Harms T, Clifford RM, Cryer D. *Early Childhood Environment Rating Scale—Revised (ECERS-R)*. New York, NY: Teachers College Press; 1998.
- Muthen LK, Muthen BO. *Mplus: Statistical Analysis With Latent Variables (Edition 5.1)*. Los Angeles, CA: Muthen & Muthen; 2007.
- MacKinnon DP, Fritz MS, Williams J, Lockwood CM. Distribution of the product confidence limits for the indirect effect: program PRODCLIN. *Behav Res Methods*. 2007;39(3):384-389.
- Hoyle RH. The structural equation modeling approach: basic concepts and fundamental issues. In: Hoyle RH, ed. *Structural Equation Modeling Concepts, Issues and Applications*. Thousand Oaks, CA: Sage; 1995: 1-15.
- Carmine EG, McIver JP. Analyzing models unobserved variables. In: Bohrnstedt GW, Birgatte EF, eds. *Social Measurement: Current Issues*. Beverly Hills, CA: Sage; 1981.
- Bentler PM. Comparative fit indexes in structural models. *Psychol Bull*. 1990;107(2):238-246.
- Stokols D. Translating social ecological theory into guidelines for community health promotion. *Am J Health Promot*. 1996;10(4):282-298.
- Pugliese J, Tinsley B. Parental socialization of child and adolescent physical activity: a meta-analysis. *J Fam Psychol*. 2007;21(3):331-343.
- Moore LL, Lombardi DA, White MJ, Campbell JL, Oliveria SA, Ellison RC. Influence of parents' physical activity levels on activity levels of young children. *J Pediatr*. 1991;118(2):215-219.
- Taylor RW, Murdoch L, Carter P, Gerrard DF, Williams SM, Taylor BJ. Longitudinal study of physical activity and inactivity in preschoolers: the FLAME study. *Med Sci Sports Exerc*. 2009;41(1):96-102.
- Brustad RJ. Attraction to physical activity in urban schoolchildren: parental socialization and gender influences. *Res Q Exerc Sport*. 1996;67(3):316-323.
- Welk GJ, Corbin CB, Dale D. Measurement issues in the assessment of physical activity in children. *Res Q Exerc Sport*. 2000;71(2)(Suppl):S59-S73.
- Dowda M, Pate RR, Sallis JF, et al. Agreement between student-reported and proxy-reported physical activity questionnaires. *Pediatr Exerc Sci*. 2007;19(3):310-318.
- Federal Interagency Forum on Child and Family Statistics. *America's Children in Brief: Key National Indicators of Well-being, 2008*. Washington, DC: US Government Printing Office; 2008.
- Strong WB, Malina RM, Blimkie CJ, et al. Evidence based physical activity for school-age youth. *J Pediatr*. 2005;146(6):732-737.
- US Department of Health and Human Services. *2008 Physical Activity Guidelines for Americans*. Washington, DC: US Department of Health and Human Services; 2008.
- O'Connor TM, Jago R, Baranowski T. Engaging parents to increase youth physical activity: a systematic review. *Am J Prev Med*. 2009;37(2):141-149.
- Bower JK, Hales DP, Tate DF, Rubin DA, Benjamin SE, Ward DS. The childcare environment and children's physical activity. *Am J Prev Med*. 2008;34(1):23-29.