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Psychosocial Determinants of Physical Activity in Children Attending Afterschool Programs: A Path Analysis

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Abstract

Background: Physical activity (PA) is important for controlling childhood obesity, but a comprehensive PA model for school-aged children is lacking.

Objectives: Guided by the youth PA promotion (YPAP) model, this study estimated the direct and indirect effects of self-efficacy, enjoyment, parental influence, and environment on self-reported PA and pedometer steps. A secondary purpose was to explore the association between self-reported PA and pedometer steps.

Methods: An observational and prospective study was conducted among 133 children, aged 8–11 years old, from 10 elementary schools with afterschool programs in a Midwestern U.S. school district from August through October 2013. PA was assessed by a 7-day recall scale and pedometers. Other variables were assessed by validated questionnaires.

Results: Approximately 65 (49%) children were overweight or obese—only 17 (13%) met national PA recommendations—and body mass index z score was negatively correlated with pedometer steps ($r = .18$, $p = .042$). A path analysis showed that self-efficacy had a direct effect on self-reported PA and pedometer steps, enjoyment had only a direct effect on self-reported PA, and parental influence had a direct effect on pedometer steps and an indirect effect on self-reported PA through self-efficacy and enjoyment. The association between self-reported PA and pedometer steps was not significant.

Discussion: Because this study only partially supports the YPAP model, studies with a larger sample size and longitudinal design are essential to further examine this model. The nonsignificant relationship of self-reported PA with pedometer steps may be due to the systematic error resulted from a common method artifact of self-report. Given the importance of parental influence, enjoyment, and self-efficacy, targeting these three determinants in future interventions to increase PA among children is recommended.

Key Words: child _ exercise _ physical activity _ structural equation model

Psychosocial Determinants of Physical Activity in Children Attending Afterschool Programs: A Path Analysis

Lack of physical activity (PA) has been reported to be a significant contributor to childhood obesity, and increasing PA has become a cornerstone of interventions aimed at reducing childhood obesity (Hills, Andersen, & Byrne, 2011). Regular PA is essential for adequate childhood growth and development, cardiorespiratory endurance, and cognitive function (Centers for Disease Control and Prevention, 2013). However, the 2009–2010 National Health and Nutrition Examination Survey showed that only 38% of U.S. children met recommendations for both PA and screenviewing time (Fakhouri, Hughes, Brody, Kit, & Ogden, 2013). For children attending afterschool programs, the percentage is even lower—with only 17% meeting the national PA recommendation (Beets, Huberty, & Beighle, 2012). In general, U.S. young people participate in lower PA levels than those in other countries, such as Canada, Norway, Switzerland, Estonia, and Australia (Hallal et al., 2012). Although many interventions have been conducted to increase children's PA, their effect on increasing the behavior among children has been minimal (about 4 minutes per day), and evidence specifying areas to target in interventions to increase PA remains inconclusive (Metcalf, Henley, & Wilkin, 2012).

Recommendations on designing PA interventions for children underscore the importance of applying a theoretical model that adequately explains the variance in PA (Riley et al., 2011), but existing theories have limitations when applied to PA interventions in children. Models of individual health behavior
(e.g., self-determination theory and theory of planned behavior) cannot inform the development of intervention strategies that target changes beyond the individual level. Social cognitive theory recognizes the influence of environment on behavior but focuses on human's potential abilities

to change and construct the environment to meet their needs (Glanz, Rimer, & Viswanath, 2008). For children who have little power to change their environment, behaviors are more passively affected by the environment. Although the socialecological model recognizes the multiple levels of influences on healthy behaviors, it does not provide testable hypotheses and specific guidelines on which variables are most important for PA in children (Elder et al., 2007). Moreover, to effectively guide research on behavior change, the model must be tailored to a specific population and behavior, but few theories or models currently used to guide research on PA have been developed specifically for children (Glanz et al., 2008). Most studies involving children apply models developed for adults, with the assumption that variables influencing PA are similar for both groups. Therefore, a critical need exists for a comprehensive PA promotion model for children. In the absence of a well-tested and empirically validated model, assisting children to attain national recommendations for PA will be difficult.

To develop or evaluate a PA model among children, reliable and valid PA measures are essential. Because of the multiple dimensions of PA, Chaumeton, Duncan, Duncan, and Strycker (2011) recommend combining subjective and objective measures of PA. Although this approach may enhance comprehensiveness of the data obtained, inconsistent associations between subjective and objective measures of PA are of concern. A systematic review including 83 studies noted low-to-moderate associations ($r = -.56$ to $.89$) between subjective and objective measures of PA—with 72% of the former overestimating the latter (Adamo, Prince, Tricco, Connor-Gorber, & Tremblay, 2009). Thus, the association between PA measured subjectively and objectively warrants further investigation.

Conceptual Framework

The youth PA promotion (YPAP) model was developed by Welk (1999) to promote youth PA based on the precede–proceed health promotion planning model. It adopts a socialecological perspective to highlight the influence of personal, social, and environmental factors on PA. The model proposes various factors that may predispose, reinforce, or enable PA. The model was adapted to include two predisposing factors (self-efficacy and enjoyment), one reinforcing factor (parental influence), and one enabling factor (environment). Selection of these factors was based on literature (Craggs, Corder, van Sluijs, & Griffin, 2011), supporting self-efficacy, enjoyment, parental influence, and environment as the most significant determinants of PA in children. The YPAP model proposes that parental influence has an indirect effect on PA through self-F1 efficacy and enjoyment (Figure 1). However, previous studies in children did not find adequate model fit for the theoretical models guided by the YPAP model (Seabra et al., 2013).

--- Figure 1 Here ---

Purpose

Guided by the YPAP model, the main purpose of this study was to estimate the direct and indirect effects of self-efficacy, enjoyment, parental influence, and environment on self-reported PA and pedometer steps. A secondary purpose was to explore the association between self-reported PA and pedometer steps.

METHODS

Design

An observational and prospective design was used to explore the psychosocial determinants of PA in children. Personal demographic information was collected. Height and weight were measured to estimate body mass index (BMI) as a means to determine each child's obesity status. Independent variables, including self-efficacy, enjoyment, parental influence, and environment, were assessed via validated psychosocial measures, and the outcome variable of PA was measured via both a self-report measure and pedometer.

Population/Sample

During August through October 2013, children were recruited from 10 elementary schools with afterschool programs in a Midwestern U.S. school district. The school district included 42,909 households with an average annual household income of $60,340, compared to $61,977 in the state and $72,579 nationally (U.S. Census Bureau, 2013). Moreover, nearly 62% of the children in this school district were eligible for free or reduced price lunch compared to 47% in the state (U.S. Census Bureau, 2013). The school district figures indicated the high percentage of children of low socioeconomic status whose families met the specified eligibility criterion for participation in U.S. government-supported child nutrition programs by having an income at or below 185% of federal poverty guidelines.

Convenience sampling was used to recruit eligible children:

(a) all elementary schools with afterschool programs in the school district were used and (b) all children aged were invited to participate in the study.

Inclusion criteria were (a) 8–11 years old and (b) able to speak and read in English. The single exclusion criterion was having a health problem that prevented participation in PA. A total of 133 children, including 59 (44.4%) girls and 74 (55.6%) boys, met the criteria and participated in the study. Suhr (2012) suggested that a 10:1 ratio for number of participants to number of parameters was a sufficient sample size for path analysis. For this study, the sample size was estimated by the number of parameters (12 in the YPAP model) and the missing data rate of 10.8%

in the pilot study. Thus, a 10:1 ratio with 12 parameters yielded a base sample size of 120 to which 13 (10.8%) additional children were added to account for estimated missing data, for a total desired sample size of 133.

Variables and Measurement

Personal Demographics A 14-item, investigator-developed demographic questionnaire was used to collect information about each child from a parent or guardian. Variables included child's age, sex, ethnicity, and race; number of children in the family; parents' marital status; annual family income; parents' employment status and education level; transportation mode from home to school; and screen-time minutes.

Obesity Status

The first author measured children's height and weight using a standardized protocol proposed by the Centers for Disease Control and Prevention to estimate BMI (weight [kg]/height [m2]). Height was measured to the nearest tenth of a centimeter using a Seca 213 Portable Stadiometer, whereas weight was assessed to the nearest tenth of a kilogram using the Tanita HD-351 Scale. The age- and sex-specific percentile for BMI was used to assess children's obesity status.

Physical Activity

To increase the accuracy of assessing PA among children, two methods—a self-report measure and pedometer—were employed. The PA Questionnaire for Older Children (PAQ-C), a self-administered 7-day recall measure for assessing general PA among children aged 8–14 years old, was used (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997). Nine items, scored on a 5-point scale, are used to calculate a mean activity score, with a higher mean score indicating a greater level of PA (Crocker et al., 1997). The PAQ-C offers a cost-effective method with high reliability, as indicated by Cronbach's alpha ranging from .79 to .89. In this study, the reliability of PAQ-C scores, estimated by Cronbach's alpha, was .88.

The Yamax SW-200 (Yamax Corp., Tokyo, Japan) is the most commonly used pedometer to assess PA among children, and pedometer steps have shown moderate to strong validity with correlation coefficients ranging from .39 to .99 with heart rate and oxygen consumption (McNamara, Hudson, & Taylor, 2010). Participants wore the pedometer for seven consecutive days and recorded the number of pedometer steps each day in a pedometer log. In this study, using 7 days of pedometer steps to assess PA in children had a high reliability of .87, estimated by intraclass correlation coefficient.

PA Self-Efficacy

The PA Self-Efficacy Scale is a self-administered, 17-item measure used to assess children's confidence in overcoming barriers to PA. It is a dichotomous scale (0 = no and 1 = yes) with a higher mean score indicating greater self-efficacy (Saunders et al., 1997). Factor analysis suggested a three factor structure: support seeking, barriers, and positive alternatives (Saunders et al., 1997). A national study in 2,257 children, aged 9–13 years old, reported a Cronbach's alpha of .68 and test–retest stability of .75 (Huhman et al., 2007). In this study, the PA Self-Efficacy Scale scores had a Cronbach's alpha of .73 and test–retest stability of .83.

PA Enjoyment

The PA Enjoyment Scale is a 16-item, self-report instrument that assesses children's positive affect associated with participation in PA. It is a 5-point Likert scale (1 = disagree a lot to 5 = agree a lot) with a higher mean score indicating higher enjoyment (Moore et al., 2009). In 2009, Moore and colleagues tested the PA Enjoyment Scale in 564 third-grade children and found that the scale had acceptable reliability and validity. In this study, the scale scores had a Cronbach's alpha of .83 and test–retest stability of .63.

Parental Influence

The Parental Influence Scale is an 18-item scale with a two-factor structure: parental support (encouragement, involvement, and facilitation) and parental role modeling (Welk, Wood, & Morss, 2003). A study involving 994 children showed that the scale had acceptable internal consistency and discriminant validity (Welk et al., 2003). Because the original bipolar statements ("Some kids have parents who get a lot of exercise" vs. "Other kids have parents who don't get a lot of exercise") in the Parental Influence Scale were found to be confusing for children, the bipolar statements were changed to unipolar statements (1 = strongly disagree to 4 = strongly agree). The modified scale scores had a Cronbach's alpha of .82 and test–retest stability of .84.

Environment

The original four-item, 5-point Likert measure (1 = disagree a lot to 5 = agree a lot) of perceived environment developed by Motl and colleagues (2005) had a two factor structure: equipment accessibility and neighborhood safety. The equipment accessibility subscale included home and community components. For children who spend most of their daytime in school, the school environment is an indispensable component that influences children's PA. Thus, Item 5, "At school, there are playgrounds, gym spaces, and enough supplies (like balls, hula hoops) to use for physical activity," was added to address the school component of equipment accessibility. In this study, the modified five-item environment scale scores had a Cronbach's alpha of .51 and test–retest stability of .61, which are adequate, considering the small number of items.

Data Collection Procedure

The university institutional review board approved the study, and permission to conduct it was obtained from the executive director of the afterschool program organization. During afterschool time, the first author screened all children attending the afterschool programs for their eligibility to participate with the help of program staff and then explained the study to 146 eligible children. Each eligible child received a recruitment folder containing (a) an introductory letter, (b) a demographic survey, and (c) an informed consent form. Children were instructed to take the folder home, ask their parents/guardians to review the information, and return the folder to the research staff the next day—regardless of their interest in participating. In the introductory letter, parents/guardians were asked to sign the consent form and complete the demographic survey if interested in having their child participate and ask their child to return the folder to the researchers the next day. To increase the likelihood that children would return the folder, all children who brought it back (regardless of parental consent) were included in a drawing for a basketball. Six eligible children (4.1%; three girls and three boys) did not have parental consent, and seven (4.8%; five girls and two boys) having parental or guardian consent refused to participate and expressed “lack of fun,” “challenge of wearing pedometers,” or “disinterest in completing the surveys” as reasons.

For each of the 133 children providing both written consent and assent, the first author measured height and weight individually in a private room after school and distributed and explained the pedometer and pedometer log to each child. Each child was instructed to attach the pedometer to the waistband of his or her clothing from Day 1 to Day 7 and record steps on pedometer log with the help from the first author or parents or guardians, as needed. The first author asked the children to return the pedometers and pedometer logs to the research staff on the next school day after they had worn the pedometer for seven consecutive days.

After receiving the pedometer and pedometer log, each child was asked to complete the surveys in a private room, with the first author reading one item at a time and allowing the child to respond to ensure understanding. Because some children had difficulty understanding some types of PA, a small card with a picture describing the type of PA was shown to the children to facilitate understanding. The first author developed and tested the card in a previously conducted feasibility study. Six (4.5%) boys did not complete the surveys at all because of injury, illness, or family relocation to a different geographical area, and all other children provided complete self-report data. For children who completed the entire study, another incentive, a playground ball, was awarded.

Data Analysis

Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to describe study variables. Independent t test and one-way ANOVA were applied to examine the influence of categorical variables on continuous variables. Bivariate Pearson correlations were employed to examine the relationships among continuous variables. Scatterplot and bivariate Pearson correlation were applied to examine the association between self-reported PA and pedometer steps.

Because of the small number of participants, a path analysis with observed variables was employed using PROC CALIS in SAS 9.4 for Windows. The analysis was conducted with a Covariance matrix as input and full information maximum likelihood estimation. A model generating approach was taken (Jöreskog, 1993). Model modification was guided by the Wald statistics and Lagrange multiplier (LM) test indices, along with the YPAP model. Specifically, new parameters were added one at a time according to the LM test index values, and nonsignificant parameters were eliminated one at a time to increase the simplicity and precision of the model based on the Wald statistics results. The goodness-of-fit indices, including non-normed fit index (NNFI) and comparative fit index (CFI), were used to evaluate the model fit. In addition, standardized root mean square residual (SRMR) and root mean square error of approximation (RMSEA) were calculated. A model with goodness-of-fit indices exceeding .95, misfit indices of SRMR less than .08, and RMSEA less than .10 has good fit (Browne & Cudeck, 1993; Hu & Bentler, 1999).

RESULTS

As shown in Tables 1 and 2, most of the children were White T1 T2 (54.4%), with the remainder being either Black (27.2%) or Hispanic (20.3%). Approximately 76 (57.1%) families were married, with three children per household. Fifty-seven (44.8%) families had annual family income of <$30,000. Twenty-four (20.2%) fathers and 20 (15%) mothers were unemployed, whereas 67 fathers (56.3%) and 57 mothers (42.9%) had a high school diploma or less.

--- TABLE 1 HERE ---

--- TABLE 2 HERE ---

Nearly half of the children were overweight or obese, but only 10 (13.5%) boys and 7 (11.9%) girls met daily PA recommendations calling for 13,000 steps/day for boys and 11,000 steps/day for girls (Tudor-Locke et al., 2011). On school days, only 25 (18.8%) children walked or bicycled to school. Parents reported that their children spent about 57.31 minutes (SD = 52.82) per day on screen (television, computers, video games), and nearly 120 (90.2%) children met the

American Academy of Pediatrics' recommendation of no more than 2 hours daily for screen-viewing time. Table 3 presents the psychometric properties and descriptive statistics for study variables.

--- TABLE 3HERE ---

Boys took more steps than girls (M= 8,441, SD = 3,685 vs. M=7,197, SD = 3,233, p = .05). Mode of transportation to school significantly affected children's pedometer steps, $F(3,122)$ = 4.16, p = .008; specifically children who walked to school took more pedometer steps (M = 10,083, SD = 3,784) than children who went to school by car (M = 7,380, SD = 3,126). Children's BMI ($r = -.27$, p = .002) and BMI z score ($r = -.18$, p = .04) were negatively correlated with pedometer steps. Overweight or obese children took fewer pedometer steps than non-overweight children (M = 7,022, SD = 3,037 vs. M = 8,741, SD = 3,798, p = .006). The length of screen-viewing time was significantly correlated with parental influence ($r = -.23$, p = .01).

--- TABLE 4 HERE ---

Table 4 demonstrates the interrelationships among the study variables. Self-reported PA was not significantly correlated with pedometer steps (r = .14, p = .12). The scatterplot F2 in Figure 2 shows the weak-positive correlation between self-reported PA and pedometer steps. As self-reported PA increased, the variation of pedometer steps tended to increase.

--- FIGURE 2 HERE ---

PA Model

The original path model, guided by the YPAP model, did not have a very good fit, $\chi2(4) = 18.44$, $p = .001$; CFI = .91, NNFI = .91, SRMR = .07, RMSEA = .17 with 90% CI [.09, .25]. The LM test suggested adding a covariance between the error of self-efficacy and the error of enjoyment. Adding this covariance improved the model fit significantly, $\Delta\chi2(1) = 10.42$, $p = .001$; CFI = .97, NNFI = .97, SRMR = .05, RMSEA = .11 with 90% CI [.01, .21]. Although the modified model had an RMSEA of greater than .10, it was selected as the final model based on the modification indices and the YPAP model.

--- FIGURE 3 HERE ---

--- TABLE 5 HERE ---

Figure 3 demonstrates the unstandardized path loadings F3 of the final PA path model. Table 5 shows the six significant T5 direct paths that occurred (a) from parental influence to self-efficacy, (b) from parental influence to enjoyment, (c) from enjoyment to self-reported PA, (d) from self-efficacy to self-reported PA, (e) from self-efficacy to pedometer steps, and (f) from parental influence to pedometer steps. The total effect of parental influence on self-reported PA was .35 (SE = .09, $p < .001$), and the indirect effect of parental influence through self-efficacy and enjoyment was significant (β^ = .18, SE = .05, $p < .001$). The total effect of parental influence on pedometer steps was .21 (SE = .10, p = .02), but the indirect effect was not significant. The final path model accounted for 30.2% and 3.5% of the variance in self-reported PA and pedometer steps, respectively.

DISCUSSION

Close to 50% of the children in this study were overweight or obese, compared to the state average of 32% and national average of 34% (Ogden, Carroll, Kit, & Flegal, 2014). The low family socioeconomic status and parental educational levels may be reasons for the high percentage of overweight or obese children in this study. Another potential factor may be the lower levels of PA (7,867 steps/day) among children in this study, compared to those in the United States (~12,500 steps/day; Tudor-Locke, Johnson, & Katzmarzyk, 2010) or Canada (~11,000 steps/day; Tudor-Locke et al., 2011). Thus, a critical need exists to target U.S. children attending afterschool programs.

Although children's pedometer steps were negatively correlated with their BMI, the strength of the relationship was low. Some evidence indicates that PA only predicts a small portion of BMI in children (Trinh, Campbell, Ukoumunne, Gerner, & Wake, 2013) and that PA may be more strongly correlated with body fat than with BMI (Duncan, Schofield, & Duncan, 2006). This information indicates that an examination of the relationship between PA and obesity status in children may require assessment of body composition and an increased need for reliable and valid measurements to accomplish the task.

PA Model

Using data from elementary school children attending afterschool programs, a path model based on the YPAP model was tested to examine the effects of self-efficacy, enjoyment, parental influence, and environment on PA. The final model, as shown in Figure 3 and Table 5, yields partial support for the YPAP model. The model demonstrates that self-efficacy had a direct effect on self-reported PA and pedometer steps, enjoyment had only a direct effect on self-reported PA, and parental influence had a direct effect on pedometer steps and an indirect effect on self-reported PA through self-efficacy and enjoyment.

Self-efficacy is the most widely reported determinant of PA in children (Craggs et al., 2011). This study provides further support on the direct effect of self-efficacy on PA, as indicated in the YPAP model. Congruent with other studies (Craggs et al., 2011) and the YPAP model (Welk, 1999), this study found that enjoyment had a significant direct effect on self-reported PA. Fun physically active video games can increase children’s energy expenditure and heart rate from rest (Biddiss & Irwin, 2010). Future researchers may want to consider video games that require both upper and lower body movement in interventions to improve children’s PA. When targeting enjoyment to improve children’s PA, researchers must be cognizant that enjoyment may be one important factor to motivate children to initiate PA. However, its motivational impact may decrease over time, especially when activities are no longer novel and children lose interest (Mellecker, Lyons, & Baranowski, 2013). Therefore, when designing PA programs, children’s own interests, self-efficacy, and their past PA experience should be considered. Building change in PA programs by offering a variety of activities and allowing children to choose among several activities at any given time is recommended.

Consistent with this study’s findings, an investigation involving 683 children showed that parental influence had an indirect effect, but not a direct effect, on children’s self-reported PA through self-efficacy and attraction to PA (Seabra et al., 2013). As proposed by the YPAP model (Welk, 1999), parental influence is an important reinforcing factor for children’s PA.

For young children whose behaviors are under less volitional control, parents are the primary providers of supportive opportunities for their children to be physically active (Beets, Cardinal, & Alderman, 2010). Parents can directly and positively influence their children’s PA by being directly involved in activities with the child, serving as a physically active role model, and providing transportation and encouragement (Edwardson & Gorely, 2010)—as indicated by the direct effect of parental influence on pedometer steps in this study. This study highlights a direct effect of parental influence on pedometer steps and an indirect effect of parental influence on self-reported PA mediated by children’s perceptions of self-efficacy and enjoyment—both of which are influenced by parents. This study’s findings are consistent with one tenet of the YPAP model (Welk, 1999). Previous studies also support a direct effect of parental influence on self-efficacy and enjoyment (Heitzler et al., 2010). All these findings emphasize the importance of parental influence in promoting children’s PA; thus, parental involvement is recommended for future PA interventions.

Although previous evidence has indicated that a favorable environment—such as one that is safe—was positively correlated with children’s PA (Franzini et al., 2009), this study found no correlation between environment and PA. Use of a self-report scale to assess the environment may have contributed to the nonsignificant correlation between environment and PA because children may (a) have difficulty identifying their living environment; (b) have limited ability to construct a favorable environment; and (c) attribute the favorable environment to their parents of providing PA facilities, transportation, and supervision. To better understand the relationship between environment and PA in children, the geographic information system may be useful for precisely assessing children’s living environment and evaluating its effect on PA.

Surprisingly, no significant direct effect of enjoyment and a very weak direct effect of self-efficacy were identified for pedometer steps, and a very small variance in pedometer steps was explained by the model. This occurrence may be due to the systematic measurement error that resulted from a common method artifact of self-report (Dishman, 1994).

Systematic error can influence all children's responses to a self-report survey systematically because of the survey environment, social desirability, and cognitive development (Dishman, 1994). As a result of measurement error, the correlations between self-reported and objectively measured variables may not be well estimated. For example, a study with 720 children, aged 10–17 years old, indicated that only peer support (^β = .15) and barriers (^β = −.12)—but not self-efficacy (^β = .01), parent support (^β = .03), and enjoyment (^β = −.07)—had significant small direct effects on accelerometer-measured PA whereas the associations among the determinants were moderate (j^βj > .20; Heitzler et al., 2010).

TABLE 5. Direct and Indirect Effects in the Physical Activity Path Model

Thus, to better understand the determinants of objectively measured PA, reliable and valid estimation of determinants is crucial. The common method of self-report may also be an explanation for the weak correlation between self-reported PA and pedometer steps and the correlation between the error of self-efficacy and the error of enjoyment. The covariance of the errors for self-efficacy and enjoyment may also indicate the existence of confounding factors that can affect both self-efficacy and enjoyment. On the basis of the health promotion model (Pender, Murdaugh, & Parsons, 2011), an individual's prior behavior and personal factors can influence his or her perceived PA self-efficacy and enjoyment. Further investigation with more reliable and valid PA measures, such as accelerometer, is needed to examine the YPAP model using structural equation modeling by adjusting for personal characteristics and experiences.

This study's findings only partially support the YPAP model, perhaps because the YPAP model emphasizes the influence of parents on children without considering the parent–child interaction. A bidirectional framework for parent–child relations has been proposed in psychology and sociology (Pettit & Arsiwalla, 2008). Differing from the unidirectional framework of parents shaping children, this bidirectional framework emphasizes both the influence of parent on child and of child on parent (De Mol & Buysse, 2008). For PA or other health behavior promotion research, the bidirectional framework implies that children's ability (self-efficacy), interest (enjoyment), and intention may have a reciprocal relationship with parents' supportive behaviors. Although plausible, longitudinal studies are needed to test this proposition.

Limitations

One limitation of this study is that the relationships between the determinants (self-efficacy, enjoyment, parental influence, and environment) and PA are not causal. Longitudinal data are

needed to examine possible causal relationships between these variables. Moreover, environment was assessed by a self-report, five-item scale completed by children and not objective observation (e.g., geographic information system). Children may have difficulty evaluating the safety of their living environment. Lastly, because the sample size is small and generalizability of the results is limited, further studies, including larger and more diverse samples, are needed to lend support for the findings.

Conclusions

The negative relationship between PA and BMI indicates that targeting children's PA is a promising strategy to help control the current epidemic of childhood obesity. This study emphasizes the importance of parental influence and children's enjoyment and self-efficacy in promoting PA among children—providing valuable information for healthcare professionals to design interventions to increase PA in elementary school children. Although this study partially supports the YPAP model, studies with a larger sample size and longitudinal design are necessary to further examine the original unidirectional model and the proposed bidirectional model. In addition, this study identified a weak correlation between self-reported PA and pedometer steps, indicating a need for more accurate measures of PA. Reliable and valid measures of PA determinants are also urgently needed.

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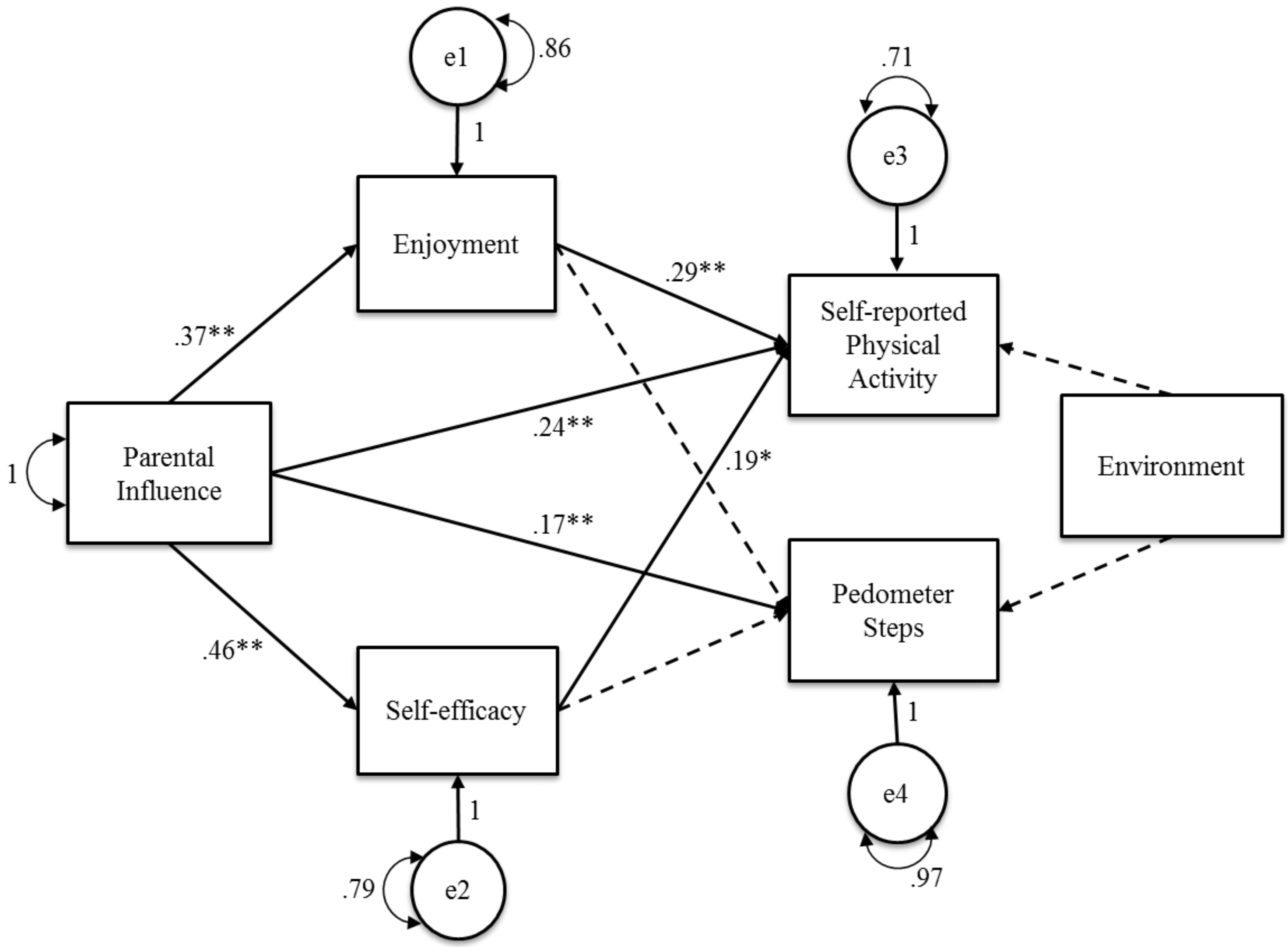
Modified Model 1



Modified Model 2

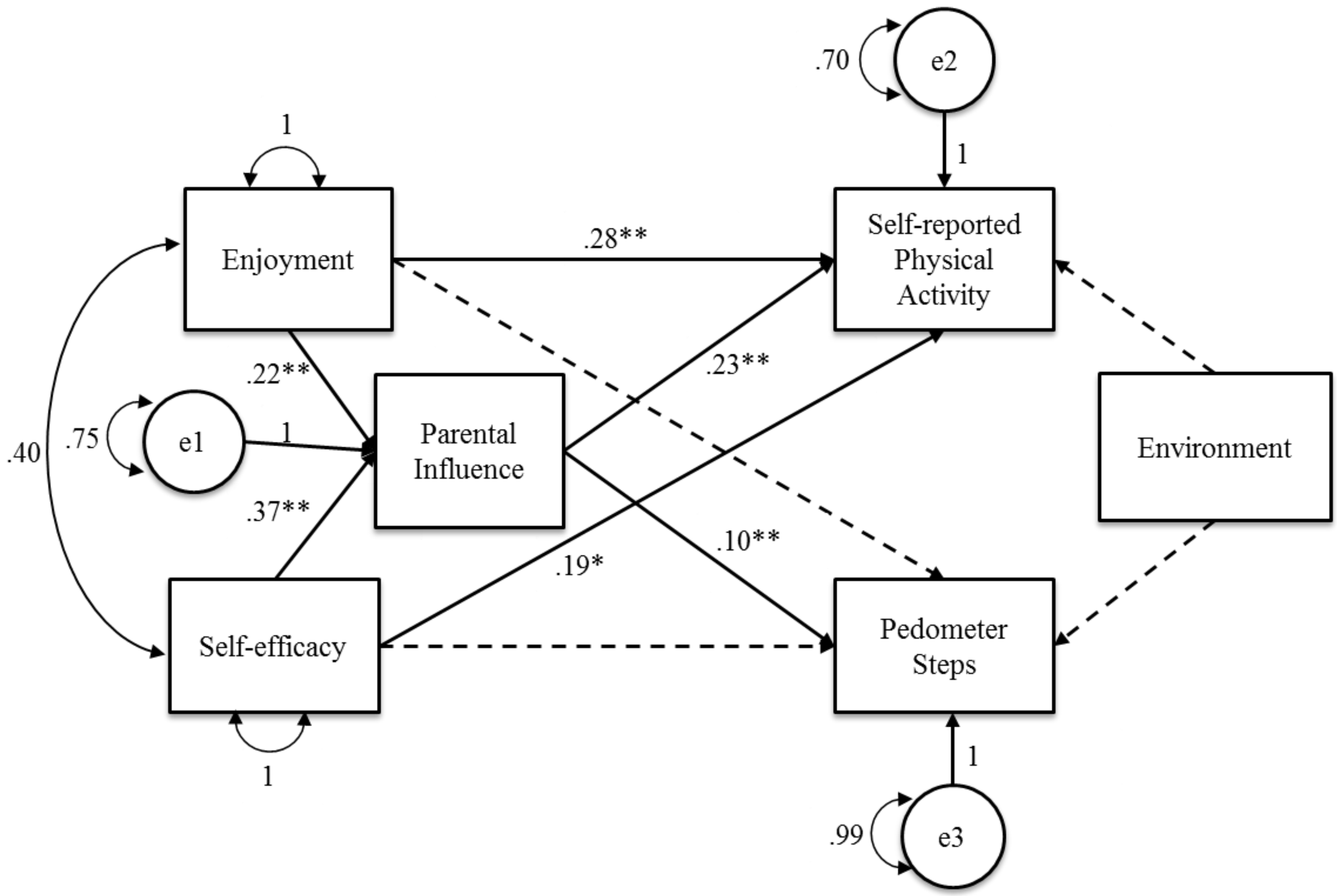


Figure 3. Physical Activity Models in Elementary School Children (*N* = 122). **p* < .05; ***p* < .01; *e* = error; ⎯→ significant path; − − → non-significant path (deleted).

Table 1

Characteristics of Participants (N = 133)

Child Variables	***M* (*SD*)**	**Parent Variables**	***M* (*SD*)**
Age	9.26 (.93)	Number of children	2.71 (1.42)
BMI	20.74 (5.12)		***N (%)***
BMI-percentile	73.97 (26.45)	Marital status	
BMI z-score	.94 (1.07)	Married/partnered	76 (57.1)
	N (%)	Separated/widowed	27 (20.3)
Sex (female)	59 (44.4)	Single	30 (22.6)
Ethnicity (Hispanic)	27 (20.3)	Annual family income	
Race		≤ $19,999	37 (29.1)
White	68 (54.4)	$20,000-$29,999	20 (15.7)
Black	34 (27.2)	$30,000-$49,999	29 (22.8)
Mixed/other	23 (18.4)	≥ $50,000	41 (32.3)
Transportation mode		Father employment status	
Walk or bike	25 (18.8)	Full time	78 (65.5)
School bus	42 (31.6)	Part time	17 (14.3)
Car	66 (49.6)	No	24 (20.2)
Screen time		Mother employment status	
Watch TV/DVDs/day	104 (78.2)	Full time	87 (65.4)
Play video games/day	83 (62.4)	Part time	26 (19.5)
Use computers/day	110 (82.7)	No	20 (15.0)
Obesity status		Father education level	
Healthy weight	68 (51.1)	≤ High school graduate	67 (56.3)
Overweight	25 (18.8)	Some/community college	37 (31.1)
Obese	40 (30.1)	≥ Bachelor's degree	15 (12.6)
		Mother education level	
		≤ High school graduate	57 (42.9)
		Some/community college	46 (34.6)
		≥ Bachelor's degree	30 (22.5)

Note. M = mean, *SD* = standard deviation.

Table 2

Psychometric Properties and Descriptive Statistics of the Major Study Variables (N = 133)

			Reliability		Range			
Scale	*M*	*SD*	Cronbach's *α*	*ICC*	Potential	Actual	Skewness	Kurtosis
Enjoyment	66.87	9.28	.83	.63	16-80	40-80	-.71	.23
Self-efficacy	13.45	2.95	.73	.83	0-17	2-17	-.91	.84
Support seeking	6.00	1.33	.61	.73	0-7	0-7	-1.43	2.32
Barriers	2.87	1.25	.64	.86	0-4	0-4	-.78	-.59
Positive alternatives	4.57	1.29	.44	.75	0-6	1-6	-.57	-.46
Parental influence	52.75	8.92	.82	.84	18-72	28-72	-.03	-.07
Parental support	36.02	6.25	.76	.74	12-48	17-48	-.32	.26
Role modeling	16.74	3.75	.68	.81	6-24	6-24	.01	-.12
Environment	18.30	3.80	.51	.61	5-25	5-25	-.37	.58
Equipment access	11.80	2.77	.66	.53	3-15	3-15	-1.06	1.01
Neighborhood safety	6.50	2.38	.49	.60	2-10	2-10	-.27	-.74
Self-reported physical activity	3.20	.70	.88	__	1-5	1.32-4.64	-.36	-.08
Pedometer steps	7868	3526	__	.87	__	1778-19932	.76	.28

Note. M = mean, *SD* = standard deviation, *ICC* = intraclass correlation coefficient.

Table 3

Interrelationships among Self-Efficacy, Enjoyment, Parental Influence, Environment, and Physical Activity (N = 122)

Variable	1	2	3	4	5	6	*M*	*SD*
1. Self-efficacy	–						13.44	2.97
2. Enjoyment	.40	–					66.92	9.36
3. Parental influence	.46	.37	–				52.71	9.02
4. Environment	.37	.37	.59	–			18.20	3.79
5. Self-reported physical activity	.41	.45	.43	.39	–		3.20	.70
6. Pedometer steps	.07	-.00	.17	.05	.14	–	7860	3438

Note. The average proportion coverage of means was 96.8%, and the average proportion coverage of covariances was 95.7%.

Table 4

Summary of Model Fit Statistics (N = 122)

Model	χ^2	***df***	***p*-value**	**GFI**	**CN**	**CFI**	**AGFI**	**RMSEA**	**AIC**	**SBC**
YPAP Model										
Full model 1	18.45	4	.001	.95	67	.91	.75	.17	5736.10	5784.98
Modified model 1	12.50	4	.014	.96	99	.92	.86	.13	5083.05	5114.68
Bidirectional Framework										
Full model 2	34.99	2	< .001	.92	22	.79	.21	.35	5756.64	5811.27
Modified model 2	2.72	3	.44	.99	376	1.00	.96	.00	5075.27	5109.78

Note. df = degree of freedom; GFI = Goodness-of-Fit Index; CN = Hoelter Critical N; CFI = Comparative Fit Index; AGFI = Adjusted Goodness-of-Fit Index; RMSEA = Root Mean Square Error of Approximation; AIC = Akaike's Information Criterion; SBC = Schwarz Bayesian Criterion.

Modified model 1 was obtained by removing the non-significant paths of 'environment → physical activity', 'environment → pedometer steps', 'enjoyment → pedometer steps', 'self-efficacy → pedometer steps' from the full model 1, shown in Figure 1.

Modified model 2 was obtained by removing the non-significant paths of 'environment → physical activity', 'environment → pedometer steps', 'enjoyment → pedometer steps', 'self-efficacy → pedometer steps' from the full model 2, shown in Figure 2.

Full model 1 was better than full model 2 (absolute $\Delta\chi^2 = 16.54$, $\Delta df = 2$, $p < .001$); Modified model 2 was better than modified model 1 (absolute $\Delta\chi^2 = 9.78$, $\Delta df = 1$, $p < .01$).