Predicting Physical Activity in 10-12 Year Old Children: A Social Ecological Approach

Tao Zhang, Katherine Thomas, and Karen Weiller
University of North Texas

The purpose of this study was to investigate the associations among predisposing (perceived competence and enjoyment), reinforcing (social environments), enabling factors (motor skills, fitness, physical environments) and physical activity among 288 children, and to identify the age and gender differences among participants. The children completed previously validated questionnaires assessing their perceived competence, enjoyment, school social and physical environments, and physical activity. Physical fitness was measured by FITNESSGRAM testing. Students’ motor skills were assessed by PE Metrics. The results indicated that perceived competence and enjoyment predicted physical activity for boys, while perceived competence was the only predictor for girls. Age effects for fitness and skill were significant, as were gender differences for skill, social environment and perceived competence. This study suggests the importance of supportive teachers who provide enjoyable physical education that builds perceived competence for children to improve fitness, motor skill development and physical activity participation. The results support associations between predisposing factors and self-reported physical activity as theorized within the social ecological model.

Keywords: motor skills, physical fitness, school children, age and gender differences

Previous research results have indicated that regular physical activity participation has a significant positive impact on an individual's health and well-being (National Association for Sport and Physical Education [NASPE], 2010; U.S. Department of Health and Human Services [USDHHS], 2010). Regular participation in physical activity is critical to achieving both short term and long term health benefits for children and adolescents. Health benefits of regular physical activity may include physical, emotional, social, and cognitive domains (USDHHS, 2010). Promoting children's regular physical activity and health has been a public health concern (Centers for Disease Control and Prevention [CDC], 1997; USDHHS, 2010). Thus, identifying factors that impact physical activity in children remains an important issue.

The authors are with the Department of Kinesiology, Health Promotion, and Recreation, University of North Texas, Denton, TX. Address author correspondence to Tao Zhang at tao.zhang@unt.edu.
Despite the widely identified health benefits of regular physical activity participation, emerging evidence indicates that nearly one third of American children are not physically active on a regular basis, and physical activity is consistently lower among girls than boys (NASPE, 2010; USDHHS, 2010). Children’s physical activity actually declines with age, and this decline is greater for girls than boys (USDHHS, 2010).

Physical inactivity and childhood overweight and obesity are continuing to increase both in the U.S. and in developed and developing countries worldwide (Sisson & Katmarzyk, 2008). The number of children who are obese has more than tripled since 1980 (USDHHS, 2010). Prevalence of obesity and overweight has increased more in Hispanic and non-Hispanic black samples than the general population (Ogden, Carroll, Kit, & Flegal, 2012). Dietz (2004) states that caloric intake and energy expenditure are the major factors in energy balance, thus to address the obesity epidemic increases in physical activity are critical. Increasing physical activity without changes in caloric intake produces negative energy balance. In addition, increases in muscle mass resulting from physical activity may increase energy demand beyond the energy expended during physical activity. Further, sedentary time is often associated with increased caloric intake.

School-based physical education programs are an important educational arena in which children can develop their motor skills, physical fitness, and accrue some of their daily physical activity (NASPE, 2010). Quality school physical activity environments may facilitate children’s motivation to be physically active and engage in regular physical activity (CDC, 2010; Daley, 2002; McKenzie, 2001; USDHHS, 2010; Wallhead & Buckworth, 2004). Thus, creating social and physical environments to foster children’s motivation toward physical activity in school settings and identifying theory-based multiple factors that influence physical activity are research priorities (USDHHS, 2010). Further, this research could facilitate the development of effective intervention strategies aimed at the prevention of physical inactivity in children. The main purpose of this study, therefore, was to investigate factors associated with physical activity in children, and how these factors vary by age and gender using the social ecological model as a framework.

Social Ecological Model

The social ecological model provides a theoretical framework to examine multiple factors influencing physical activity behavior (Stokols, 1996; Welk, 1999). Specifically, the social ecological model examines interactive relationships between the individual and multiple levels of the environment to understand when and how people initiate, adopt, and maintain physically active lifestyles (Sallis, Owen, & Fisher, 2008). The basis of the social ecological model is the assumption that the combination of individual, social environmental, and physical environmental factors will best explain physical activity (Sallis et al., 2008).

The youth physical activity promotion (YPAP) model adds specificity to the social ecological framework focusing on the correlates of physical activity behavior change in youth (Welk, 1999; Zhang, Solmon, Gao, & Kosma, 2012). The YPAP model (Gielen, McDonald, Gary, & Bone, 2008; Welk, 1999) incorporates the following correlates of physical activity in a descending order of importance: (a)
predisposing factors (e.g., perceived competence in physical activity, enjoyment of physical activity); (b) reinforcing factors (e.g., school social environments); and (c) enabling factors (e.g., motor skills, physical fitness, and school physical environments) (Gielen et al., 2008; Welk, 1999).

The YPAP model uses a social ecological approach where personal, social, and physical environmental factors may respectively predispose, reinforce, or enable youth to be physically active (Welk, 1999). Although this YPAP model provides an attractive conceptual basis for understanding the specific correlates of physical activity, there is limited empirical evidence of the application of the YPAP model for physical activity in children (Castelli & Valley, 2007; Welk, 1999). It is widely acknowledged that children’s physical activity actually declines with age, and this decline is greater for girls than boys (NASPE, 2004; USDHHS, 2008). Further, school social and physical environments can foster children’s motivation to adopt physically active lifestyles that ultimately may lead to habits of lifelong physical activity (McKenzie, 2001; Sallis et al., 2010; Zhang et al., 2012). Therefore, this study seeks to better understand the predisposing factors (perceived competency and enjoyment), the reinforcing factors (school social environments), and the enabling factors (motor skills, physical fitness, school physical environments) associated with physical activity.

**Age and Gender Differences**

Motor skill competence has been identified as an important correlate of school children’s physical activity (Barnett, van Beurden, Morgan, Brooks, & Beard, 2010; Welk, 1999). Motor skill competence can be defined as an individual’s ability to execute different fundamental motor patterns, including locomotor skills such as running or skipping, and object control skills such as striking and overhand throwing (Barnett et al., 2010; Williams et al., 2008). Further, it is noted that object control skills have more important roles in predicting school children’s physical activity than locomotor skills (Barnett et al., 2010; Stodden et al., 2008).

Two enabling factors, motor skill performance and physical fitness, have consistently produced age and gender differences. Motor skills improve during childhood as the execution of skills becomes more efficient and the outcomes more accurate and/or rapid (Barnett et al., 2010; Haywood & Getchell, 2009; Thomas & Thomas, 1988). During early childhood and the primary grades, fundamental skills improve steadily in most children. Results from a longitudinal study reported improvement in both locomotor and object control skills from age 10–16 years of age (Barnett et al., 2010). A proficiency barrier where skill does not improve is observed in children who do not practice sport specific skills during middle childhood (Clark & Metcalf, 2002).

Generally, gender differences before puberty are small and attributed to sociocultural factors (Haywood & Getchell, 2009), with the exception of overhand throwing (Thomas, Alderson, Thomas, Campbell, & Elliott, 2010). Boys typically throw better than girls. There is considerable overlap, however, in the distributions for most skills during childhood. Outcomes, in terms of distance or velocity of the throw, continue to improve even when skill efficiency plateaus (Nelson, Thomas, & Nelson, 1991). Fundamental motor skill proficiency during childhood has been
positively associated with greater physical activity, lower body fat and proficiency of those skills later in adolescence (Barnett et al., 2010).

Physical fitness variables, such as aerobic capacity and abdominal endurance, also improve during childhood and produce small gender differences before puberty (Cooper Institute for Aerobics Research, 2010; Hands, 2008). Thus, physical fitness and motor skills are expected to improve during childhood. On average, boys may perform slightly better than girls on tests of skill and fitness until puberty when boys improve rapidly (Dencker et al., 2007; Haywood & Getchell, 2009). Motor skill and physical fitness have been typically treated as distinct constructs, each contributing to the physical activity profile of a child. For instance, Haga (2008) reported a significant relationship between motor skill competence and physical fitness in 9–10 year old children. In that study, the test of motor competence covered manual dexterity, ball skills and static and dynamic balance. The fitness test included standing broad jump, throwing a tennis ball, shuttle run, speed run, climbing wall bars and the 6 min run. Thus, the focus was not on health-related physical fitness, rather the focus was on skill-related fitness, possibly exaggerating the relationship between fitness and skill.

Perceived competence was identified as a predisposing factor in the YPAP model (Welk, 1999). When actual competence was compared with perceived competence across childhood, it was evident that perceived competence becomes more accurate over time. For example, children entering school demonstrated low skill scores but had relatively positive perceptions of their competence (LeGear et al., 2012). This was attributed to the fact that children entering school have had limited opportunity to observe other children, practice motor skills and develop an accurate perception of their skill competence. As a result of exposure to other children during elementary school, perceived competence gradually and increasingly shifts toward actual competence.

Previous research demonstrated that perceived competence explained a significant portion of physical activity in girls (Davison, Downs, & Birch, 2006), but motor skill was not measured. Thus the accuracy of perceived competence could not be determined. In another study, actual motor skill abilities were measured, however the test used did not include many sport skills (Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). Significant relationships were reported among actual motor skill, perceived competence and measured physical activity. Significant gender differences existed for perceptions of competence and object control skills, favoring the boys for object control and the girls for perceived competence. Older children with lower motor skill performance had lower perceived competence, which was associated with avoiding physical activity and lower levels of physical activity. Thus, there are clear age and gender trends for perceived competence. In addition, enjoyment has also been identified as a major predisposing factor explaining youth sport and physical activity participation (Weiss, 2000; Welk, 1999). It has been reported that lower skilled children enjoyed physical activity less than higher skilled children (Barnett, van Beurden, Morgan, Brook, & Beard, 2009; Motl et al., 2001). Further, boys and girls may participate in physical activity for different reasons; boys for social connections and girls for enjoyment (Weiss, 2000).

Researchers have suggested that schools can provide physical activity environments that facilitate the adoption of physically active lifestyles (Sallis et al., 2001). School physical activity environments include both social environments (e.g.,
teacher support) and physical environments (e.g., facilities). McKenzie has found
associations between school environmental factors and students' physical activity
levels using systematic observational methods (McKenzie, 2001). Sallis and his
colleagues (2001) also reported that school environmental characteristics, includ­
ing area type (e.g., court space, indoor activity space), area size in square meters,
equipment, supervision, and organized activities, accounted for 42% of the variance
in girls who were physically active, and 59% of the variance for boys (moderate to
vigorous physical activity at school). Nevertheless, few studies have investigated
the influences of school physical activity environments on youth physical activity,
and more research is needed to investigate the age and gender differences in school
physical activity environments (Rutten, Boen, & Seghers, 2012).

Preparing children for a lifetime physical activity is crucial and begins at an
early age (Hands, 2008; Welk, 1999). Quality physical education programs afford
children the opportunity to develop motor skills, physical fitness, and increase
their overall physical activity (NASPE, 2010). Thus, examining potential age and
gender differences in physical activity and associated physical activity factors may
play a role in promoting children's physical activity. This is critical to providing
educational and instructional strategies to help develop physically active children
in school settings (NASPE, 2010).

The main purpose of this study, therefore, was to investigate the relationships
among predisposing (e.g., perceived competency and enjoyment), reinforcing (e.g.,
school social environments), enabling physical activity factors (e.g., motor skills,
physical fitness, school physical environments), and self-reported physical activity
in 10–12 year old children using a social ecological approach as a framework. A
secondary purpose was to examine age and gender differences in the study variables
(i.e., correlates of physical activity). It was hypothesized that predisposing factors
such as perceived competence would be the strongest predictors of children's
physical activity. It was also hypothesized that reinforcing factors and enabling
factors would be significant predictors of children's physical activity in this study.
In addition, it was hypothesized that younger children would have higher levels
of health-related physical fitness, but lower levels of motor skills than older chil­
dren. Finally, it was hypothesized that boys would have higher scores than girls in
perceived competence, enjoyment, social and physical environments, motor skills
and health-related physical fitness.

Method

Participants

After deleting six participants because of missing data, 288 participants remained
in grades four ($n = 145$) and five ($n = 143$), ages ten ($n = 81$), eleven ($n = 144$)
and twelve ($n = 63$) years of age with nearly equal distribution of gender at each
age or grade (boys = 149 and girls = 139). Participants self-identified as Hispanic
(33%), White (25%), African American (19%), Asian (11%), Biracial (9%), Native
American (3%), and Hawaiian (0.7%).

The participants were enrolled in three public schools from one school dis­
trict in the southern region of the United States. Each school had four classes of
4th grade and 5th grade for a total of twelve classrooms. The school district is in
a large county with diverse school and neighborhood environments. The school district follows the CATCH (Coordinated Approach To Child Health) curriculum guidelines as set out by the Texas Education Agency and as the state mandated coordinated school-based health programs designed to promote physical activity and healthy food choices. Skill development and physical fitness improvement occurs as a result of the organized CATCH curriculum. As part of the students' daily warm ups, teachers include cardiovascular, flexibility, and muscular strength and endurance movements so that students will be able to successfully participate in the fitness assessment. The schools scheduled daily 30-min physical education classes taught by certified physical education teachers with more than 15 years of teaching experience.

**Measures**

Health-related physical fitness and motor skills were measured directly while a questionnaire was used to measure the remaining variables. The remainder of the questionnaire consisted of five scales with a total of 57 items. Initial confirmatory factor analyses (Comparative Fit Index [CFI] = .86; Incremental Fit Index [IFI] = .87; Non-Normed Fit Index [NNFI] = .86; Root Mean Square Error of Approximation [RMSEA] = .078) and previous studies support the construct validity of study scales (Kowalski, Crocker, & Faulkner, 1997; Mol & et al., 2001; Robertson-Wilson, Levesque, & Holden, 2007; Williams, Freedman, & Deci, 1998). Cronbach’s alpha coefficients were calculated for each scale to establish internal consistency reliability.

The FITNESSGRAM fitness test protocols were used to assess children’s physical fitness. Students’ motor skills in basketball, overhand throwing, and striking were assessed using PE Metrics based on the previous research evidence and PE teachers’ recommendations (Castelli & Valley, 2007). Previous research has demonstrated acceptable validity and reliability of these tests and the feasibility of using them in children (Cooper Institute for Aerobics Research, 2010; NASPE, 2010).

**Demographic Variables.** Self-reported information on race, age and gender were obtained from the surveys to describe the participants.

**School Environmental Factors.** To measure school social and physical environmental factors, children rated their perceived social support on eight items and perceived physical environment on twelve items on a 4-point Likert-type scale ranging from 1 (strongly disagree) to 4 (strongly agree), as presented in questionnaires developed by Robertson-Wilson and her colleagues (Robertson-Wilson et al., 2007). The mean of the eight items and twelve items was used in analyses. Acceptable internal consistency, reliability, and validity have been reported for this instrument in school-aged students (Robertson-Wilson et al., 2007). Survey exemplars are as follows: school social environment “Other students make me feel safe when I am physically active at school” and school physical environment “The outdoor areas (e.g., playground, field) at my school are in good condition”.

**Perceived Competence.** To assess children’s perceived competence, a twelve-item Perceived Competence Scale (PCS) was used (Castelli & Valley, 2007; Williams et al., 1998). Each item was rated on a 7-point Likert-type scale where 1
was not at all true and 7 was very true. The mean of the twelve items was used as an overall indication of the magnitude of children’s perceived competence of their skills; Sample items were “I feel able to meet the challenge of doing striking with a paddle” and “I am capable of doing overhand throwing now”.

**Enjoyment of Physical activity.** Enjoyment of physical activity was assessed using a sixteen-item physical activity enjoyment scale (Moore et al., 2007; Motl et al., 2001). Children responded on a 5-point Likert-type scale anchored from 1 (disagree a lot) to 5 (agree a lot), with the stem “When I am active”. A sample answer was “When I am active, I enjoyed it”. The mean of these sixteen items was used as an overall indication of the magnitude of children’s enjoyment of physical activity.

**Self-Reported Physical Activity.** The Physical Activity Questionnaire for Older Children (PAQ-C) was used to assess level of physical activity (Kowalski et al., 1997). It is a 7-day recall questionnaire intended to assess moderate and vigorous physical activity. The PAQ-C is a reliable and valid measure of physical activity in school settings (Kowalski et al., 1997; Zhang et al., 2012).

**Health-Related Physical Fitness.** Children’s physical fitness was assessed by the FITNESSGRAM protocols developed by the Cooper Institute for Aerobics Research (2010). The testing protocols include Progressive Aerobic Cardiovascular Endurance Run (PACER), curl-ups, push-ups, height and weight (calculating BMI), and sit-and-reach tests. Following the test, FITNESSGRAM criteria were used to determine whether each participant met the Healthy Fitness Zone (HFZ) criteria. The total number of fitness tests in which the child was in or better than the HFZ were calculated and used as an overall measure of fitness.

**Motor Skills.** Three PE Metrics items (NASPE, 2010) were used to assess children’s motor skills in Overhand Throwing, Striking with a Paddle, and Basketball (Dribbling, Passing and Receiving). For overhand throwing, students were required to use an overhand throwing pattern to send a ball to a large wall target for three trials. The striking task required children to strike a ball upward five times in a row in their personal space with a short plastic paddle with 30 s. For basketball, students were asked to dribble a basketball with control while moving in a slow jog, send a catchable lead pass to a partner for at least three passes, and move to meet the ball and catch three catchable passes. All motor skills assessments were videotaped and scored by two raters. Previous work indicated that PE Metrics is a scientifically valid and useful tool for measuring students’ motor skills in physical education (Zhu et al., 2011). Each of the skill tests has specific criteria for competence, thus three measures of skill competence could be summed for a single score representing the number of skills in which a child was competent.

**Procedures**

Permission to conduct this study was obtained from the university institutional review board, the school district, the school principals, and the physical education teachers. In addition, participants and their parents or legal guardians provided child assent and written informed consent forms before the data collection. Data for this study were collected from elementary school students during their regular physical
education classes. Children completed the series of standardized questionnaires issued in English to assess their perceived competence, enjoyment, social and physical environmental factors, and self-reported physical activity in the middle of spring semester. They were encouraged to answer truthfully and assured that their responses were anonymous. All children were informed that their teachers would not have access to their responses. They spent approximately 25 minutes under the principal investigator's directions completing the questionnaires in one physical education class session.

The PE Metrics motor skill tests and FITNESSGRAM fitness tests were completed during three additional physical education class sessions. A schedule was coordinated with the physical education teachers for the data collection. Five research assistants were trained before data collection to assure they were familiar with all fitness tests and motor skill tests (See Table 1). Research assistants monitored testing and recorded all data. Students were assigned an identification number on his or her questionnaire which was used for the remaining tests.

Data Reduction and Analysis

All statistical analysis was performed using SPSS version 16. After screening the raw data to assure accuracy and determine whether the data were normally distributed, Cronbach's alpha coefficients were used to determine interrater reliability of motor skill assessments. In addition, Cronbach's alpha coefficients related to the internal consistency of the self-reported measures, analysis of variance, bivariate correlations among the study variables, and hierarchical multiple regression analyses were completed. An alpha level of .05 was used to determine statistical significance with a Bonferroni correction for multiple uses of the same data to .016. As appropriate effect sizes (ES) were calculated by using the Cohen's delta (.2 or less is a small ES, about .5 is a moderate ES, and .8 or more is a large ES); the pooled standard deviation was the denominator.

Results

Descriptive Statistics

Three tests from PE Metrics were used to represent motor skill in basketball offensive skill, overarm throwing and striking a ball with a paddle. The interrater reliability for the raters evaluating PE Metrics was acceptable. There was less than 10% discrepancy between the two raters on the final skill level assessed across the three skills. PE Metrics measures skill level using qualitative and/or quantitative components that yield a single score designated at one of four levels. The top levels are competent (level 3) and above (level 4). These scores were recoded as 1 (competent and above; levels 3 and 4) or 0 (not competent; levels 0, 1, and 2), for a possible skill scores from 0–3 based on three motor skills in basketball, overhand throwing, and striking. As shown in Table 2, boys outperformed girls on all three tests based on the percent meeting the competence criteria and means. The descriptive data revealed the expected age trends for level of skill in basketball and striking with a paddle as performance improved with age. The pattern for overarm throw was less clear with 10 year olds less competent than older children. No clear
<table>
<thead>
<tr>
<th>Table 1  PE Metrics 5th Grade Items and Scoring Criteria for Level 3 Out of 4 Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basketball Dribble, pass and receive</strong></td>
</tr>
<tr>
<td>Use basketball dribble, pass and receive with a partner.</td>
</tr>
<tr>
<td><strong>Overhand throwing Rates students on two aspects of throwing sum- ming the scores from three throws.</strong></td>
</tr>
<tr>
<td>Use an overhand throwing pattern to send a ball to a large wall target with 3 trials.</td>
</tr>
<tr>
<td><strong>Striking with a paddle Student strikes continuously with a paddle or racquet. Two trials, the best score is recorded.</strong></td>
</tr>
<tr>
<td>Strike a ball upward 5 times consecutively with short-handled paddle.</td>
</tr>
</tbody>
</table>
Table 2  Descriptive Statistics Summed by Age and Gender (N = 288)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Physical environment</th>
<th>Social environment</th>
<th>Perceived competence</th>
<th>Enjoyment</th>
<th>Motor skill</th>
<th>Physical fitness</th>
<th>Physical activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>2.96 (0.52)</td>
<td>3.04 (0.57)*</td>
<td>5.92 (0.99) *</td>
<td>4.40 (0.66)</td>
<td>2.18 (0.78) *</td>
<td>1.93 (1.00)</td>
<td>3.26 (0.52)</td>
</tr>
<tr>
<td>Girls</td>
<td>3.10 (0.48)</td>
<td>3.22 (0.52) *</td>
<td>5.47 (1.22) *</td>
<td>4.32 (0.61)</td>
<td>1.29 (0.92) *</td>
<td>2.04 (0.99)</td>
<td>3.22 (0.64)</td>
</tr>
<tr>
<td>10 year olds</td>
<td>2.98 (0.56)</td>
<td>3.10 (0.54)</td>
<td>5.68 (1.19)</td>
<td>4.42 (0.53)</td>
<td>1.42 (1.00) *</td>
<td>2.20 (0.86) *</td>
<td>2.98 (0.66)</td>
</tr>
<tr>
<td>11 Year olds</td>
<td>3.08 (0.47)</td>
<td>3.12 (0.54)</td>
<td>5.74 (1.04)</td>
<td>4.31 (0.66)</td>
<td>1.82 (0.90) *</td>
<td>2.01 (1.00) *</td>
<td>3.21 (0.65)</td>
</tr>
<tr>
<td>12 year olds</td>
<td>2.98 (0.53)</td>
<td>3.17 (0.60)</td>
<td>5.68 (1.23)</td>
<td>4.34 (0.71)</td>
<td>2.00 (0.93) *</td>
<td>1.65 (1.07) *</td>
<td>3.24 (0.65)</td>
</tr>
<tr>
<td>Overall</td>
<td>3.01 (0.51)</td>
<td>3.13 (0.55)</td>
<td>5.70 (1.13)</td>
<td>4.36 (0.64)</td>
<td>1.75 (0.96)</td>
<td>1.98 (0.99)</td>
<td>3.25 (0.66)</td>
</tr>
</tbody>
</table>

Note. Significant differences among the study variables are significant at the p < .05 level. * p < .05. Variable range: Physical environment (1-4); social environment (1-4), perceived competence (1-7); enjoyment (1-5); motor skills (0-3); physical fitness (0-3); physical activity (1-5).
pattern emerged related to the process (form) versus outcome (accuracy) data in overarm throwing.

In addition, internal consistency reliability coefficients for school social environment ($\alpha = .70$), school physical environment ($\alpha = .77$), perceived competence ($\alpha = .90$), enjoyment ($\alpha = .88$), and physical activity ($\alpha = .72$) exceeded .70, and represented acceptable levels of reliability (Nunnally, 1978).

Mean PACER scores, representing cardiovascular fitness, increased across age from nearly 25 to nearly 28 lengths. Boys performed on average almost five more laps than girls. PACER zones yielded fewer participants reaching the healthy zone as children got older (from 37–56% in ages 10–12 years) and fewer boys reaching the healthy zone than girls. When the same standard was applied to girls (e.g., the same number of lengths at each age) the percent of girls passing decreased and was slightly lower (41%) than boys passing (50%). The percent of participants in the gender groups failing to meet the healthy criteria for curl-up, and push-up were similar. Ten and eleven year olds were more likely to meet the healthy standards, while smaller percentages of twelve year olds met those standards. The minimum and maximum scores for boys, however, encompassed the girl’s distributions for PACER, push-up, curl-up and trunk lift, suggesting considerable overlap in the distributions for boys and girls. The backsaver flexibility test on the right and left side varied little by age ($M = 9.50$ left and 9.60 right) and for gender ($M = 9.10$ boys and $M = 10.10$ girls). Most children (71–86%) were in the healthy zone for trunk lift, and the mean performance varied little by age or gender ($M = 10.67$–10.83). Therefore, trunk lift and backsaver flexibility test were not included in further analyses.

### Age and Gender Differences

To determine whether there were significant age and gender differences, 3 by 2 (age 10, 11 and 12 years by gender) MANOVAs with overall motor skill (mean number of competent skill items of three), physical fitness, physical environment, social environment, perceived competence and enjoyment as dependent variables were conducted. There were significant age [$F (12,554) = 3.31, p = .0001$] and gender [$F (6, 277) = 16.83, p = .0001$] main effects. Within subjects tests produced two significant age effects [physical fitness $F (2, 282) = 5.63, p = .004$; overall skill $F (2,282) = 6.92, p = .001$], three significant gender effects [social environment $F (1, 282) = 7.46, p = .007, ES = .34$; perceived competence $F (1,282) = 10.43, p = .001, ES = .43$; motor skill $F (1,282) = 76.64, p = .0001, ES = 1.05$] and no significant interactions. Newman-Kuels tests for health-related physical fitness found 12 year old children were less fit than both 10 year old children (ES = .57) and 11 year old children (ES = .33), but 10 year old children and 11 year old children were not different from each other (ES = .21). For motor skill, 10 year old children were competent in fewer skills than 11 year old children (ES = .42) and 12 year old children (ES = .60), but 11 year old children and 12 year old children were not different from each other (ES = .21).

### Correlations and Regressions

As shown in Table 3, correlation analyses indicated that there were seven significant correlations for each gender group among the seven variables (physical activity,
Table 3  Correlations Among the Variables for Boys \((N = 149)\) Above the Diagonal and Girls \((N = 139)\) Below the Diagonal

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical activity</td>
<td></td>
<td></td>
<td>.16</td>
<td>.12</td>
<td>.28*</td>
<td>.43*</td>
<td>.01</td>
</tr>
<tr>
<td>2. Physical fitness</td>
<td>.07</td>
<td></td>
<td></td>
<td>.28*</td>
<td>.17</td>
<td>.18</td>
<td>-.01</td>
</tr>
<tr>
<td>3. Motor skill</td>
<td>.06</td>
<td>.12</td>
<td></td>
<td></td>
<td>.26*</td>
<td>.03</td>
<td>-.01</td>
</tr>
<tr>
<td>4. Perceived competence</td>
<td>.40*</td>
<td>.01</td>
<td>.13</td>
<td></td>
<td></td>
<td>.26*</td>
<td>-.02</td>
</tr>
<tr>
<td>5. Enjoyment</td>
<td>.28*</td>
<td>.12</td>
<td>.03</td>
<td>.37*</td>
<td></td>
<td></td>
<td>.16</td>
</tr>
<tr>
<td>6. Physical Environment</td>
<td>.001</td>
<td>.06</td>
<td>.03</td>
<td>.20</td>
<td>.39*</td>
<td></td>
<td>.61*</td>
</tr>
<tr>
<td>7. Social Environment</td>
<td>.16</td>
<td>-.01</td>
<td>.04</td>
<td>.45*</td>
<td>.43*</td>
<td>.64*</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Bivariate correlations among the study variables are significant at the \(p < .05\) level. * \(p < .05\).

The overall goal of this study was to investigate predisposing (perceived competence and enjoyment), reinforcing (school social environment) and enabling factors (motor skills, physical fitness and school physical environment) as these might influence self-reported physical activity in 10–12 year old elementary school students. For the boys, predisposing factors (perceived competence and enjoyment) predicted physical activity. For the girls, perceived competence was the only significant predictor. Perceived competence and enjoyment produced small and significant
correlations. Significant predictors of physical activity were all predisposing factors in this study. Thus, the first hypothesis was supported by the data.

The second hypothesis, that reinforcing and enabling factors would predict children's physical activity, was rejected. The school social environment, as a reinforcing factor, was correlated to the predisposing factor of enjoyment. The correlations were small with percent variance accounted for at 6% for boys and 18% for girls. The patterns of significant correlations might suggest that reinforcing and enabling factors influence physical activity indirectly through predisposing factors. The patterns and strength of the correlations differed, as predicted, for boys and girls. Thus, the YPAP model (Welk, 1999), where predisposing factors are the strongest predictors, were supported in this study. The school social environment was indirectly related to physical activity as it was correlated with enjoyment in boys and girls. Enabling factors tended to neither directly nor indirectly relate to physical activity. For example, skill and fitness were not important for girls, while the school physical environment was not important for boys. Clearly, more studies examining the YPAP or other models will be necessary to better understand if and how reinforcing and enabling factors might directly or indirectly influence the physical activity behavior of girls and boys (Zhang et al., 2012).

A secondary purpose of this study was to examine age and gender differences in the study variables. The hypothesized age differences were supported. However, the gender hypothesis was rejected suggesting that boys and girls in grades 4 and 5 were more alike than different based on this data. Before puberty, gender differences are attributed to sociocultural factors (Thomas & French, 1985) with the exception of overarm throwing where gender differences appear early and are consistently large. The poorest performance was in throwing for boys (46% passed) and girls (16% passed), with form rather than accuracy accounting for the greater portion of the differences between boys and girls. In this sample, basketball skill produced the largest disparity in pass rates (83% boys and 49% girls) and striking with a paddle the smallest gap (88% boys and 62% girls). Basketball offensive skills are likely a result of practice. Gender differences in perceived competence do not generally emerge during elementary school (Weiss, 2000). Perceptions of competence in younger children are based on skill mastery, enjoyment, effort and feedback from parents; beginning at age 10, the comparisons with peers become increasingly important in perceived competence. Children in this age-group gather information from their observations of coaches and teachers who are evaluating other children. Older girls may rely on internal assessments (e.g., goal mastery) and feedback from adults and peers. These represent sociocultural factors and seem to be operating in these participants. This suggests an important role for teachers in facilitating physically active lifestyles in their students.

Self-reported physical activity was not different for boys and girls, nor was physical fitness. Fitness scores were based on gender specific norms, so there should not be pass rate differences. The individual fitness test scores produced considerable overlap between boys and girls, for example 29% failed to meet or exceed the healthy zone for curl-ups with means of 30.64 (boys) and 29.22 (girls). For the push-up test, the mean difference was two push-ups favoring the boys. The PACER produced larger differences in pass rates (50% of the boys and 35% of girls failed) and larger mean performance differences (28.31 and 23.24) favoring the boys. The percent of normal weight was nearly identical for boys (56%) and girls.
(58%) in this sample. Physical activity and fitness were not significantly related in this study. While both skill and fitness have been proposed as moderators of physical activity, the current data suggest sociocultural and psycho-social variables as predictors (Stodden et al., 2008; Weiss, 2000).

Actual motor skill was relatively low in these children. Considering the context of daily physical education and certified teachers with more than 15 years of teaching experience, this finding was disappointing. This was reasonable, however, given the fact that health-related physical fitness testing was emphasized by state mandate rather than skill development. The motor skill level of girls was lower than that of the boys in this sample. Thus an area that was not emphasized in assessments, motor skill, had predicted gender differences. An area that was emphasized, health-related fitness did not produce gender differences. Physical fitness was not related to physical activity in this study. The self-reported physical activity measurement in this study could be a major reason for the lack of relationship found similar to findings from other studies (e.g., Martin et al., 2005). Taken together, these findings could suggest that programs that emphasize skill development and help children develop perceived competence and enjoyment may have a positive impact on physical activity (Barnett et al., 2009; Stodden et al., 2008). Certainly, this is consistent with Stodden and his colleagues’ conceptual model for predicting physical activity (Stodden et al., 2008). Physical fitness was not a factor in physical activity, enjoyment or competence findings in the current study. Physical fitness was related to motor skill in boys, but physical fitness and motor skill were unrelated to any variable in girls. It would seem that physical fitness had little impact on physical activity in these children. Clearly, this has serious implications for mandated fitness testing and the emphasis placed on physical fitness in schools. This is especially important when physical activity is a vital and valued goal of the program (NASPE, 2010).

Enhancing students’ enjoyment was one of important goals of the organized CATCH curriculum (Motl et al., 2001; NASPE, 2010). The school social environment, where supportive teachers are likely a critical factor, influenced enjoyment and therefore indirectly influenced physical activity. However, mandates for fitness testing, reducing obesity and significant portions of class time devoted to moderate-to-vigorous physical activity may pressure teachers to abandon their focus on the role of enjoyment (Zhang, Solmon, & Gu, 2012). Further, this suggests that developing motor skill may be important for girls because of the potential for improving perceived competence, which predicted physical activity (Barnett et al., 2010). Girls who participate in after-school programs may have higher motor skill and perceive their competency levels accurately. It is likely that girls who were more active were more involved in programs that developed motor skill, thus perceived competence and physical activity improved together. Of course, it is also possible that activity out of school was not occurring in skill development programs such as soccer or volleyball, but perceived competence predicted physical activity through another path. While the predictions were significant, it is important to note that the percent variance accounted for was small and warrants further investigation. An important consideration based on this study is that perceived competence was important to both boys and girls. Enjoyment was important only to boys. This is consistent with previous literature examining motivation for physical activity (Garn & Cothran, 2006; Weiss, 2000). The role of enjoyment or fun as it is called in the youth sport
literature is also consistent with the findings in this study (Garn & Cothran, 2006; Gould & Petlichkoff, 1988).

**Age and Gender Differences**

Motor skill should improve during childhood. Older children demonstrated greater perceived competence than younger children in this study. A mature throwing skill pattern was evident in more 11 year old children than 10 year old children. However, a smaller percentage of 12 year olds demonstrated skill competence. This could be a result of a plateau in motor skill development, which has been previously observed in girls (Nelson et al., 1991; Thomas et al., 2010), although that plateau in the previous study was in eight year olds. When the students were taught how to transfer from a closed environment to an open environment, the plateau in motor skills could be decreased (Haywood & Getchell, 2009). PE Metrics uses levels to describe skill performance, and these may not be as sensitive to developmental changes as direct measures of the components of skill. Thus, the timing of the plateau could be an artifact of the scoring used in PE Metrics. However, the use of levels is reliable and practical, easily understood by teachers and other practitioners (NASPE, 2010).

Boys had small-to-moderately greater perceived competence than girls (ES = .43). However, the difference in actual motor skill was large (ES = 1.05) favoring the boys. Girls may not have known how large the skill difference was or perhaps the actual difference did not influence their perception of competence relative to the magnitude of the skill difference. This could be interpreted as a positive, with actual motor skill having less of an impact than perceived competence. As a negative, girls may have learned to accept that their skill level is lower than boys’ skill. For example, more girls (65%) met the healthy zone criteria for the PACER than did boys (50%), but the standards to determine the healthy zone were different for boys and girls. When the boy’s standard was applied, only 41% of the girls would meet the standard. The remaining fitness items produced similar pass/fail rates using the different standards. The means for each of those subtests were similar for boys and girls. The facts that pass rates varied between the genders when separate standards were used to determine success is particularly troubling. What remains unknown is whether having a higher standard might improve performance of girls by challenging them, or whether a higher standard would discourage girls. A key issue is whether there is a logical, biological or defensible reason to have separate standards for 10 year old boys and girls and at what age separate standards should be introduced.

PE Metrics uses the same criteria for skill competence for boys and girls (NASPE, 2010). Boys were more likely to meet the criteria for basketball (34% more boys met the criteria), throwing (30% more boys met the criteria) and striking with a paddle (26% more boys met the criteria). Gender differences in motor skill are typically small before puberty except in overarm throwing (Thomas & French, 1985). Overarm throwing has been studied because of unique age and gender outcomes with some speculation about underlying evolutionary explanations for the gender differences (Thomas et al., 2010). Thus, gender differences would be expected to be large favoring boys in throwing in this study. The competency rate for overarm throwing favored the boys, but was not as large as might be expected based on the literature. The largest difference between the genders was for basketball, a test that
did not include overarm throwing. Boys and girls were most similar in competence for striking, a skill that is individual (no partner or team) and that may be used (practiced) less in children of this age. Basketball produced the largest gender difference in competence, which was the most complex skill because it combined three skills while moving and demanded working with a partner.

Given the gender differences in three motor skills in this study, more practice opportunities in physical education classes are necessary for girls to increase their motor skill performance in the school setting (Haywood & Getchell, 2009). Skill practice is often deliberate practice that may not contribute to moderate-to-vigorous physical activity or health-related physical fitness (Barnett et al., 2010). Thus, whether it is more important to develop skill or fitness is a critical question teachers need to face. PE Metrics would be useful to use for teachers and in research, but further research studies are needed to explore the plateau effect in some motor skills when using PE Metrics (NASPE, 2010).

Although race differences were not a primary objective in this study, over half of the participants self-identified as non-White. White children were more likely to be successful in both physical fitness and motor skill than African American or Hispanic children. The variable that might be most influenced by obesity and overweight, the PACER, yielded a 60% healthy zone for Hispanic children with fewer White and African American children passing the PACER. Hispanic children performed more poorly on the remaining fitness tests for curl-ups and push-ups and their overall fitness profile was poorer than other racial groups.

Testing the interactions among predisposing factors, reinforcing factors, enabling factors predicting physical activity is a good strategy when conducting research grounded in social ecological model. Although we cannot find additional contributions based on these interactions in the current study, it would be better to pay attention to these interactions in future research studies because this approach may create greater integrity between theory and analysis grounded in social ecological model.

The results of this study need to be considered in the context of its limitations. Specifically, one of the major limitations was that the measure of physical activity was self-reported. Future research should include objective physical activity assessment techniques such as accelerometers, pedometers, and heart rate monitors to increase the validity and reliability of the scores produced in the physical activity measurement. Further, the cross-sectional sample used in this study does not support a causal inference. A longitudinal or experimental research design is needed in future studies to determine if improvements in the constructs of interest were related to children’s physical activity behavior changes. Third, the participants were recruited from three schools in the current study. To increase the variability of school physical and social environments and to increase the generalizability of the findings, future studies are needed to obtain a stratified random sample from multiple schools.

In summary, predicting physical activity during childhood is a complex issue. Physical education programs must be concerned about perceived competence and student enjoyment, especially for boys, in addition to teaching skill and maintaining or improving physical fitness (NASPE, 2010; Welk, 1999). Separate standards for boys and girls did not produce equivalent pass rates for the PACER, although
considerable overlap existed when comparing boys and girls on most fitness items. Therefore a question to be addressed is whether separate standards might inhibit performance by setting low expectations for the girls and their teachers. Girls perceived their competence as lower, and their measured motor skill was generally lower than boys. While it may be counterproductive to have separate standards for boys and girls for skill and fitness tests, care should be taken to address issues that impact racial groups differentially. Culturally sensitive curriculum and tests should be considered to assure that groups most at health risk based on BMI or fitness, have the support structures necessary to be physically active in and out of school.

To our knowledge, this is the first study to use PE Metrics to examine elementary school children’s motor skills. The study was conducted in a naturalistic setting where physical fitness was emphasized by state mandate. The study used variables representing each factor in the YPAP model (predisposing, reinforcing and enabling) to predict physical activity in 10–12 year old children. The study identified age, gender and race issues that warrant further examination. Further, the study provided partial support for the YPAP model, specifically demonstrating different predisposing factors for boys and girls. Finally, the results and previous research evidence suggested best practices for school physical education programs as follows: boys and girls in grades 4 and 5 are more alike than different; perceived competence was important for boys and girls and predicted physical activity; the school social environment, where teachers can be supportive and encourage students to support peers, influenced physical activity; skill level likely influences perceived competence and skill level was generally low in these students, suggesting that more practice and feedback on skill is important.

Notes

We test the interactive relationships between individual and environmental factors in this study based on the following steps:

1. Center the independent variables (IV) around their respective means (i.e., new IV1 = IV1—mean [IV1]);
2. Using these centered values, compute the interaction term (e.g., new Environmental Variable * new Individual Variable = Interaction Term between Environmental and Individual Variable);
3. Enter these Interaction Variables into the hierarchical regression model (block three), to test if these Interaction Variables can make significant contribute to self-reported physical activity beyond the influences of individual factors and environmental factors in this study.

References


