

# Pedometer-Based Physical Activity Level and Body Composition among Minority Children in a Physical Activity Setting

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## Abstract

*Most studies focusing on the relationship between physical activity and obesity have been conducted in middle class Caucasian adults and children and few such studies are available concerning minority children in physical activity settings (Johnson, Kulinna, Tudor-Locke, Darst, & Pangrazi, 2007; Rowlands et al., 1999; Tudor-Locke, Lee, Morgan, Beighle, & Pangrazi, 2006; Tudor-Locke, Pangrazi, & Corbin, 2004). To address this issue, the current study examined the relationship between pedometer-based physical activity level (i.e., step counts) and body composition (i.e. Body Mass Index [BMI]) among low socio-economic minority children in an after-school physical activity program. Participants included 131 students in grades 3-6 (64 boys and 67 girls) from one public elementary school. To assess each gender's BMI and physical activity level, they were instructed to carry the pedometers for the entire after-school physical activity class time for six consecutive lessons. Pearson correlation and regression analysis indicates that there was an inverse and significant relationship between both genders' pedometer-based physical activity level and their BMI. One-way ANOVA tests identified statistically significant differences between step counts and BMI mean scores. Results provided empirical evidence that such a relationship existed among this group of minority children. This study also confirms previous findings that boys are more active than girls ( $p < .01$ ) and girls have higher BMI than boys ( $p < .01$ ). Therefore, this study suggests that more attention should be provided related to intervention studies in girls.*

It is well documented that childhood and adult obesity has become an epidemic (U.S. Department of Health and Human Services [USDHHS], 1996; Veugelers & Fitzgerald, 2005). This consequently leads to an increase in chronic diseases including coronary heart disease, certain cancers, Type II diabetes, high blood pressure, social, and emotional depressions (USDHHS, 1996). Besides the disease burden, overweight and obesity and their associated health problems have a significant economic impact on health care systems (USDHHS, 2001). Although the benefits of participation in regular physical activity to health is unquestionable, physical inactivity in the population remains a persistent problem (Pate et al., 1995). Because the measurement of children's physical activity has become a significant factor of understanding disease prevention (Baranowski et al., 2003), children's physical activity level is needed to examine for public health purposes (Cavill, Biddle, & Sallis, 2001).

Inactivity rates are especially higher among at-risk children, persons of low socio-economic levels, and persons with less education (Crespo et al., 2000; King et al., 2000). Some researchers describe at-risk children as individuals who come from economically disadvantaged backgrounds, are often members of minority groups, and are often from single-parent families (Levin, 1989; Preeceisen, 1988; Strother, 1986). Data from Youth Risk Behavior Surveillance in the United States indicate participation in sufficient vigorous physical activity was higher among Caucasian (65.2%) than African-American (54.8%) and Hispanic-American (59.3%) children (Centers for Disease Control and Prevention [CDC], 2004).

African-American children are also reported to watch the most television of any ethnic group, and children who spend large amounts of time watching television are likely to be sedentary (Sallis, Prochaska, & Taylor, 2000). Therefore, African-American children appear more likely to experience some of the obesity-related health problems including diabetes, hypertension, cancer and heart disease. As a result, the role of research in physical activity is especially crucial to decrease at-risk minority children's health problems.

Significantly, girls are generally less physically active than boys (Cavill et al., 2001; Rowlands, Eston, & Ingledew, 1999; Sallis, Prochaska, & Taylor, 2000; Tudor-Locke & Myers, 2001). By reviewing 32 empirical studies, Tudor-Locke and Myers (2001), for example, indicated that 8–10-year-old girls took fewer steps than 8–10-year-old boys. Self-report methods, however, were generally used to assess children's physical activity primarily due to their practicality and ease of administration (Tudor-Locke et al., 2004). Self-report methods in measuring physical activity, however, can be inaccurate (Mackay, Schofield, & Schluter, 2007). Therefore, there was a need for researchers to use objective and more accurate measures to understand health consequences and determinants of physical activity, evaluate the efficiency of interventions, and guide health policy (Booth, 2000). As a result, a variety of techniques have been developed to measure physical activity accurately, including accelerometers, heart rate monitors, and pedometers (Ainsworth, 2000; Bassett, 2000; Behrens et al., 2005; Mitre, Lanningham-Foster, Foster, & Levine, 2009; Pangrazi et al., 2003; Tudor-Locke et al., 2004). Among these techniques, pedometers are relatively inexpensive, have been widely used in field studies, and have been found to be a valid and reliable way of measuring total daily activity (Bassett et al., 1996; Strycker, Duncan, Chaumeton, Duncan, & Toobert, 2007; Tudor-Locke and Myers, 2001; Tudor-Locke et al., 2002; Tudor-Locke et al.,

2004). Moreover, Pedometers have been used successfully in a variety of ways to promote activity among youth (Lubans, Morgan, & Tudor-Locke, 2009). Therefore, pedometers were chosen to measure children's physical activity level in this study.

Physical activity has been associated with body composition. Body composition can be determined by such methods as body mass index (BMI), underwater weighing, and skinfold test. Although BMI has several limitations (the degree of error may vary with gender, ethnicity, and fat-free mass), it is the most common method used to determine if an individual's weight is in a healthy range. BMI is safe, simple to calculate, inexpensive to obtain, and widely used to characterize childhood fatness in large-scale studies (Raustorp, Pangrazi, & Stahle, 2004; Tudor-Locke et al., 2004).

A great deal of research has been conducted to examine relationships between pedometer-based physical activity level (i.e., step counts) and BMI (Bar-Or, 2000; Cuddihy, Michaud-Tomson, Jones, & Johnston, 2006; Raustorp et al., 2004; Raustorp, Mattsson, Svensson, & Stashle, 2006; Rowlands, Eston, & Ingledew, 1999; Scott, Grant, & Elizabeth, 2006; Tudor-Locke et al., 2001; Tudor-Locke et al., 2004). Cuddihy et al. (2006), for example, revealed that a significant inverse relationship between mean daily steps and BMI ( $r = -0.251, p < .0001$ ). Tudor-Locke et al. (2001) also examined the relationship between pedometer-based physical activity (steps/day) and body composition variables (BMI and percentage body fat) among 109 healthy adults. The finding of Tudor-Locke et al. (2001) study indicated that there was a distinct inverse relationship between pedometer-based ambulatory activity (e.g., walking, running) and body composition. One of the limitations of Tudor-Locke et al. (2001) was that non-ambulatory activities (e.g., swimming, bicycling, weight training) would be missed or underestimated because pedometers do not capture amount of these activities. Rowlands et al. (1999) also assessed the relationship among regular daily

activity, levels of body composition and aerobic fitness in 8- to 10-yr-old 34 children. Findings of Rowlands et al. (1999) study also indicated that there was a distinct inverse relationship between pedometer-based physical activity and body composition variables. These studies specified that researchers did have limited control over participants who could actually do physical activities, use pedometers correctly, or fool some pedometers into recording steps by shaking them.

A controlled physical activity setting, however, can be used to improve the reliability and validity of pedometers because children can be easily monitored by teachers or researchers. Under a controlled environment, for example, Tudor-Locke et al. (2006) examined 81 sixth-grade children's (28 boys and 53 girls) pedometer-based physical activity during the segmented school day (i.e., before school, during physical education, recess, lunchtime, and after school). Tudor-Locke et al. (2006) reported that children took approximately 1,500 steps during a 30-minute physical education class period. Flohr and Todd (2003) compared two consecutive weeks of daily pedometer counts between young adolescents participating in organized after school activity programs to those not participating in after school programs. Their data indicate that young adolescents involved in after school activity programs are more physically active than those who are not. They also indicate that young adolescents took approximately 2,000 steps during a physical activity class period.

Moreover, most studies focusing on the relationship between physical activity and obesity have been conducted in middle class Caucasian adults and children and few such studies are available concerning minority children in physical activity settings (e.g., Cuddihy et al., 2006; Raustrop et al., 2006; Raustrop et al., 2007; Rowlands et al., 1999; Tudor-Locke et al., 2001; Tudor-Locke et al., 2006).

It is important to note that obesity and physical activity level can be predicted by gender differences. This is not surprising because gender

is the most frequent correlate of physical activity identified in previous research (Cavill et al., 2001; Constantinos, Chedzoy, & Bennett, 2003; Duncan, Schofield, & Duncan, 2006; Sallis et al., 2000; Tudor-Locke et al., 2006). For example, Duncan et al. (2006) observed significant differences in activity between both genders, with boys 14.2 and 13.8% more active than girls on weekdays and weekends, respectively. A study by the CDC that assessed physical activity among 9-13 year-old children also reported a significantly higher proportion of boys (81%) than girls (74%) participated in free-time physical activity (CDC, 2002). However, there is a few research examined both genders' physical activity level and BMI in their physical education classes (e.g., Tudor-Locke et al., 2006).

To address these issues, the current study examined the relationship between pedometer-based physical activity level (i.e., step counts) and body composition (i.e. BMI) among low socio-economic minority children in an elementary after-school physical activity program. Research question addressed was: What relationship exists between pedometer-based physical activity and BMI differed by gender?

## Methods

### Setting and Participants

This study was part of a larger project conducted in a federally funded 21st Century Community Learning Center (21st CCLC) after-school program serving mostly high-risk African-American and Hispanic-American 3rd, 4th, 5th, and 6th graders. Notably, African and Hispanic-Americans who are known to be at an increased risk for obesity, hypertension, cancer, and other lifestyle-related diseases (USDHHS, 1996). Twenty-first CCLC after-school programs are designed to capture an underused portion of the day to provide additional academic and learning opportunities for young people during the after-school hours (Chung, Kanter, & Stonehill, 2002). The 21st CCLC after-school physical activity

program starts at 3 p.m. and ends at 6 p.m. from Monday to Thursday throughout the regular school year. The program runs Monday through Friday from 8 a.m. to 3 p.m. The program includes 30 minutes during the school year.

The primary focus of the after-school physical activity program is to provide children opportunities to engage in maximum amounts of enjoyable moderate-to-vigorous physical activity (MVPA), to form positive attitudes toward physical activity, and to learn how to live physically active and healthy lifestyles. To this end, the Coordinated Approach to Child Health (CATCH) is adopted for the program. Originally titled The Child and Adolescent Trial for Cardiovascular Health, the CATCH is a program based on a school-based research study funded by the National Heart, Lung, and Blood Institute (NHLBI). A basic CATCH physical activity lesson is as follows: (1) warm-up: activity games such as count down or fast walk, (2) go fitness: it emphasizes fitness components associate with a health lifestyle such as cardiovascular efficiency, muscular strength, flexibility, wellness and nutrition. Frequent flier, steel abs challenges, bear tag are several examples, (3) go activity: it embraces the notion that children need to be exposed to a variety of movement possibilities. The goals are to create interest, improve skills, foster fair play, have fun, and encourage participation in physical activities. Volleyball, basketball, and soccer skills are several examples of go activity, (4) cool-down: it helps children's bodies return to a normal level. Examples include stretching and walking.

Participants included 131 students in grades 3-6 (64 boys and 67 girls; 67% African-American, 30% Hispanic-American and 3% Caucasian) from one school district located in south-central Texas. Participants came from one public elementary school. The mean age of boys was  $9.94 \pm 1.34$  (mean  $\pm$  SD) and the mean age of girls was  $10.27 \pm 1.04$  (mean  $\pm$  SD). The student population of the school district consisted of children from families of lower to middle income. Approximately 90% of

the students in the school were eligible for free or reduced lunch. Data collection took place during spring 2006. During the monitoring frame, all physical activity classes were engaged in 6-days intermittent aerobic sports and games units (e.g., basketball, ultimate Frisbee, lacrosse, soccer, frequent flier, bear tag, and walking). All physical activity classes were taught by two physical education specialists (one female and one male) with teaching experience ranging from 7 to 10 years. These physical education specialists were trained to employ numerous techniques to maximize the amount of time students spend in activities during after-school physical activity classes. Physical education specialists, specifically, received a two-hour training session before implementing the lessons and a 10-minute booster training prior to starting each lesson. The following training objectives were applied: (a) to be aware of the lesson objectives; (b) to assess the CATCH curricula; and (d) to promote students' participation in physical activity; and (e) develop teachers' organizational, management, and instructional skills. As recommended, physical education specialists maximized students' activity for at least 50% of class time (USDHHS, 1996). It indicates that children acquired physical activity lasting at least 15 min. Informed consent letters were signed by all parents/guardians of participants, and each participant signed an informed assent form as recommended by the Institutional Review Board.

## **Instruments**

**Physical activity assessment.** Yamax Digiwalker SW-200 pedometers (Tokyo, Japan) were used to assess children's physical activity levels in the form of step counts, because they have consistently demonstrated superior accuracy compared to other pedometer brands (Le Masurier, Lee, & Tudor-Locke, 2004; Schneider, Crouter, Lukajic, & Bassett, 2003). These electronic pedometers are battery-operated devices containing a spring-suspended, horizontal arm that moves up and down in response to vertical

accelerations of the trunk that occur during ambulatory movement. This movement opens and closes an electrical circuit; each cycle is registered as a step and the accumulated total is displayed digitally. These pedometers have been shown to be a valid tool for the measurement of energy expenditure in a variety of physical activities in 8- to 10-yr-old children (Eston, Rowlands, & Ingledew, 1998; Rowlands et al., 1999). Pedometers were worn on the right side of the body on the belt or the waistband of children's clothing during physical activity class periods.

**Anthropometric measurements.** A physician's balance beam and a stadiometer with the sliding vertical bar and hinged horizontal head lever were used to measure children's weight and height. Then BMI, an index of children's body composition, was calculated by dividing the children's body weight in kilograms by height in meters squared.

### **Procedure**

Three steps were taken to collect data. First, a background questionnaire was used to collect simple demographic information (i.e., age, grade, gender, and ethnicity). Second, children's weight and height were recorded during regularly scheduled physical activity classes. They were told to remove their shoes, stand tall and still, and have heels against the stadiometer. Third, children were oriented to put on pedometers and were allowed to explore how it worked during two physical activity classes prior to formal data collection. Instructions included positioning the pedometer on a waistband at a point above the midline of the thigh and wearing it during physical activity classroom hours. Children were also told to participate in activities as usual while on pedometer. After children got familiar with the pedometers, the researcher started to collect data by recording the number of steps each individual child took over six consecutive physical activity classes. More detailed, pedometers were distributed to the children as they arrived for physical activity classes. After each class, the

researcher collected the pedometers, recorded steps taken, reset the pedometers to zero, and returned them to the children in the next class. Vincent and Pangrazi (2002) recommended gathering three to four days of activity to ensure reliable results. Therefore, 11 participants were excluded from the study because they completed less than six days of pedometer monitoring. The intraclass correlation coefficient for six consecutive physical activity classes of pedometer monitoring was 0.71.

### **Data Analysis**

Four sets of analyses were conducted. First, descriptive statistics were conducted to provide an overall outlook of pedometer-based physical activity level (i.e., step counts) and BMI. Descriptive data were presented as means  $\pm$  SD. Body mass index (BMI) was computed as  $\text{kg}\cdot\text{m}^{-2}$ . Then, the Pearson product-moment coefficients of correlations were computed to determine significant relationships between pedometer-based physical activity level and BMI differed by gender. A simple linear regression was conducted to further examine such relationships. Pedometer-based physical activity level served as a predictor variable and BMI served as a criterion variable. Finally, one-way analysis of variance (ANOVA) examined if the mean scores of physical activity level and BMI differed by gender. The dependent variables were the step counts and BMI and the independent variable was gender. Data were analyzed using the Statistical Package for Social Sciences Version 13 (SPSS Inc., Chicago, IL, USA) and the alpha level was set at  $p < 0.01$ .

### **Results**

Table 1 contains means, standard deviations and correlations for pedometer steps and BMI in both gender groups. Descriptive statistics shows that boys took more steps than girls ( $M = 1639.56$ ,  $SD = .617.91$ ;  $M = 1351.66$ ,  $SD = 526.14$ ,

Table 1

*Means, Standard Deviation, and Correlation between Pedometer-Based Physical Activity and BMI*

	<i>M</i>	<i>SD</i>	Step Counts	BMI
Boys (n = 64)				
Step Counts	1639.56	617.91	-	-.35**
BMI	17.45	6.34	-.35**	-
Girls (n = 67)				
Step Counts	1351.66	526.14	-	-.45**
BMI	20.88	7.91	-.45**	-

\*\* . Correlation is significant at the 0.01 level (2-tailed)

respectively) and had less BMI than girls ( $M = 17.45$ ,  $SD = 6.34$ ;  $M = 20.88$ ,  $SD = 7.91$ , respectively). Pearson correlation analysis indicates that there was an inverse and significant relationship between both boys' and girls' pedometer-based physical activity level (i.e., step counts) and their BMI ( $r = -.35$ ,  $p < .01$  and  $r = -.45$ ,  $p < .01$ , respectively).

Simple linear regression analyses were then calculated within each gender. Results of the simple linear regression analyses further confirmed this relationship and showed that children's pedometer-based physical activity level emerged as a significant negative predictor of their BMI ( $\beta = -.35$ ,  $p < .01$  for boys and  $\beta = -.45$ ,  $p < .01$  for girls, respectively) and explained 18% of the variance for boys and 20% of the variance for girls (see Table 2). Figure 1 and Figure 2 present the predicted regression lines against the spread of pedometer-based physical activity vs BMI for

each gender. The scatterplots for the two variables indicates that the two variables were linearly related such that as both gender groups' pedometer-based physical activity increased their BMI decreased. One-way ANOVA tests identified statistically significant differences between pedometer based physical activity and BMI mean scores for boys and girls,  $F(1, 129) = 8.26$ ,  $p = .005$ , and  $F(1, 129) = 7.47$ ,  $p = .007$ , respectively.

## Discussion

At-risk minority children have not been extensively studied in the literature on the relationship between physical activity and obesity. Most studies focusing on the relationship between physical activity and obesity have been conducted in middle class Caucasian adults and children (Duncan et al., 2006; Rowlands et al., 1999). It is clear that lack of a relevant and comparable data

Table 2

*Results of Simple Regression on Students' Pedometer-Based Physical Activity Level*

Predictor	B	$\beta$	R <sup>2</sup>	t value
Step Counts	-.033	-.213	.45	-2.48*

\*P < 0.05 (2-tailed)

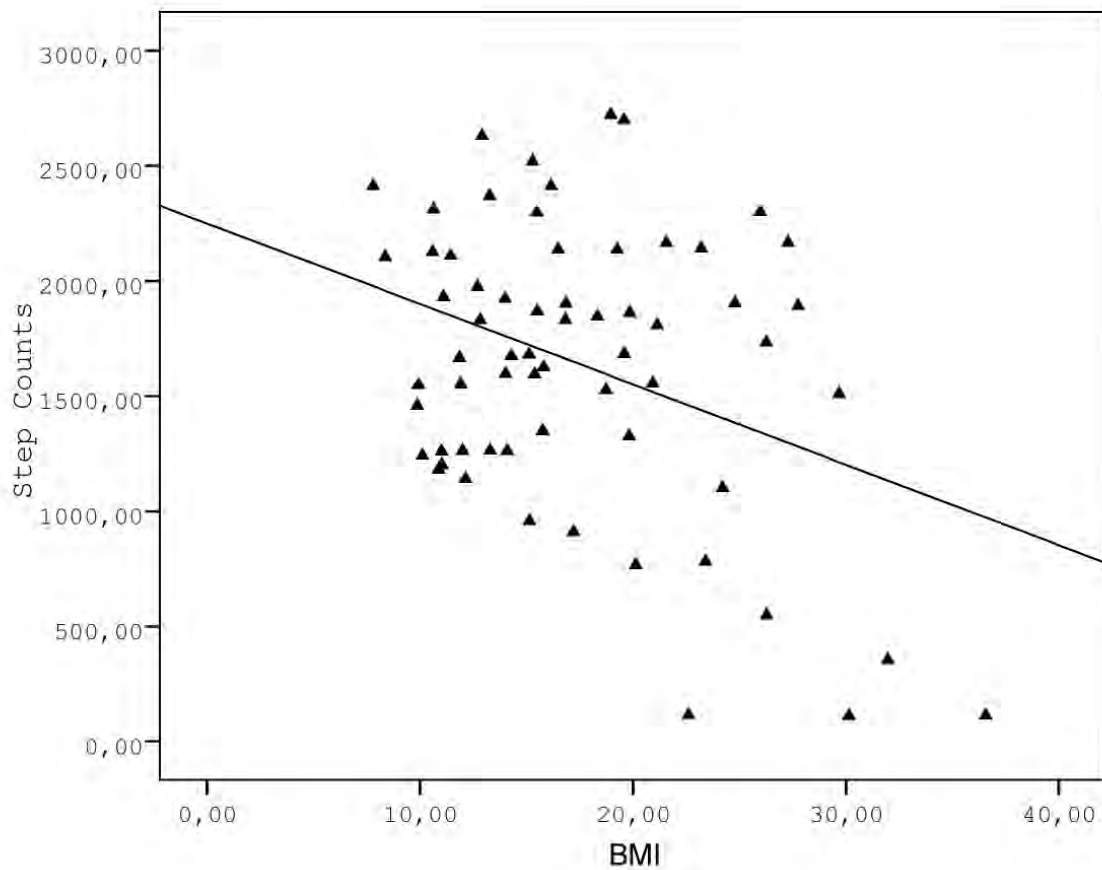
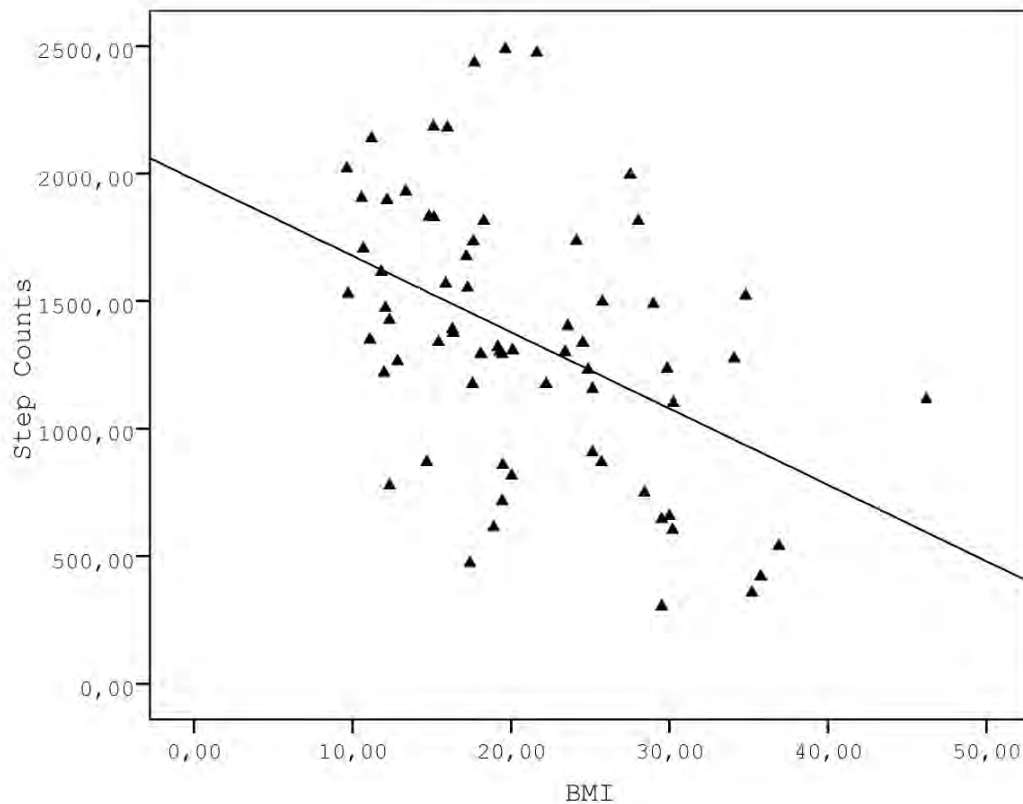


Figure 1. Regression of boys' pedometer-based physical activity level (step counts) and body mass index (BMI).



*Figure 2.* Regression of girls' pedometer-based physical activity level (step counts) and body mass index (BMI)

may cause reliance on general U.S. population. Therefore, there is a need to understand the relationships between at-risk minority children's participation in physical activity and its health consequences. Specifically, the present study identified at-risk minority boys and girls' physical activity level and relations with their body composition and provided valuable information to change their lifestyles positively.

Current research clarified the interaction between these two variables with at-risk minority children of different genders in an after-school physical activity program. The present study's pedometer-based physical activity mean score indicated that a range of 1,000-2,000 steps was

achieved in after-school physical activity classes that were 30 minutes in length. This is in line with Flohr and Todd (2003) and Tudor-Locke et al. (2006) studies. Evidence from this study also confirms previous findings that boys are more active than girls (Cavill et al., 2001; Sallis et al., 2000; Tudor-Locke et al., 2006). The current study also states that girls have higher BMI than boys. These differences may be because of boys engaging in more physical activity than girls throughout the day. Therefore, future researchers need to described the patterns of school children's daily pedometer-determined physical activity, not only in physical education settings but also during recess time, lunchtime, and before and after

school. This will assure reliable results. This study also suggests that more attention should be provided related to intervention studies in girls.

Results also revealed both gender groups' pedometer-based physical activity level and body composition was inversely correlated. The relationship is both statistically significant and meaningful. This finding is consistent with previous studies (Bar-Or, 2000; Raustorp et al., 2006; Rowlands et al., 1999; Tudor-Locke et al., 2001). Rowlands et al. (1999), for example, reported that pedometer-based physical activity levels were negatively correlated with body fat in 8- to 12-year-old boys and girls. Bar-Or (2000) also found that obese children and adolescents were less physically active than their non-obese peers. In these previous studies, however, physical activity level was measured by the total number of steps participants took in each single day. Such a design limits conclusions about causal inference and generalizability. This is because (1) pedometers measure the up-and-down motion of the hip in a vertical plane and would not distinguish frequency and velocity of movement. Therefore, some activities would be missed or underestimated (e.g., swimming, bicycling, or weight training), and (2) participants could also fool some pedometers into recording steps by shaking them. A controlled physical activity setting, however, could eliminate these limitations and improve the reliability and validity of pedometers. Pangrazi et al. (2003a) state that the pedometer appear to be acceptable for the physical education classes for teachers who want an economical and easy-to-maintain measuring tool. The present study, therefore, assessed children's physical activity level by averaging steps they took over six controlled consecutive lessons, thus strengthening the reliability of the data.

The finding that an inverse relationship existed between pedometer-based physical activity and body composition, for both gender groups, provides an empirical support for the importance of physical activity in at-risk minority children's healthy weight. This finding is very reasonable

because physical activity is one of the most important factors to reduce body fat percentage not only increase consumption of calorie intake but also increase basal metabolic rate (USDHHS, 1996). Therefore, focusing on an increase in physical activity should be the main goal to reduce body fat percentage and to get optimal health benefits.

The findings of this study may have important implications for physical education teachers. To maintain children's healthy weight, teachers should maximize students' activity time in physical education classes for at least 50% of class time (USDHHS, 1996). To provide that, teachers can motivate children to become aware of how much activity they do and how active they may be. Particularly, a major use of pedometers in physical education is to help children monitor their activity and set realistic goals. Therefore, teachers should guide children in establishing specific goals that will maximize their physical activity level (Pangrazi et al., 2003b). Teachers, for example, should establish a baseline activity levels (Morgan, Pangrazi, & Beighle, 2003). As Morgan et al. (2003) suggest that teachers should average the number of steps that each students take in class for four days and then find the average for the whole class. Then, teachers can set a realistic goal physical activity level for their students, monitor their activity levels or encourage them to be more active. Teachers also classify the step counts by lesson type, grade level and gender.

Although the present study seems to cover a different approach for understanding children's pedometer-based physical activity level and their body composition by conducting with a controlled educational setting, some important issues remain unclear for future research on this topic. For example, participants in this study were at-risk minority students and came from one rural school district located in south-central Texas. Therefore, findings of this study may not generalize to other after-school physical activity programs in different geographic regions or with more diversity. Studies that expand the sample populations and programs

are therefore recommended. Finally, all the measures in this study were taken six consecutive days. As a result, our knowledge about how children's physical activity and BMI might change over time as a result of participating in this program is limited. Therefore, a longitudinal design is recommended for future research in this area of inquiry.

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