Assessment of Physical Activity Levels of 3rd and 4th Grade Children Using Pedometers during Physical Education Class

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Abstract

The purpose of this study was to determine the amount of physical activity in which children engage during physical education classes and factors that mediate their participation. Third and 4th grade students wore pedometers during each 30-min physical education class for one school year. Steps per class were collected daily during structured and unstructured (recess) days, and during inside and outside physical education lessons. Factorial ANOVA revealed third and fourth grade boys took significantly more steps than third and fourth grade girls, and those involved in youth sports accumulated more steps during a 30-min physical education class compared to those who were not involved in youth sports. Dependent t tests verified steps accumulated during classes held outside were significantly greater compared to those accumulated during classes held inside, and steps accumulated on free (recess) days were significantly greater compared to those accumulated on structured days. The results highlight the need for recognition of the contexts of gender and youth sport participation when planning and implementing an appropriate physical education experience for children.

The prevalence of overweight and obesity in children is increasing compared to past decades (Freedman, Srinivasan, Valdez, Williamson, & Berenson, 1997; Ross & Gilbert, 1985) and may be related to a decline in physical activity (Vincent, Pangrazi, Raustorp, Tomson, & Cuddihy, 2003). Obesity is related to cardiovascular and metabolic risk factors in many adults and these risk factors are also prevalent in obese children (Weiss et al., 2004). Since obesity tracks into adulthood for many children (Maffeis et al., 2002), it is important to attend to this matter to prevent premature illness and death in children and adults.

Physical activity declines rapidly during childhood and adolescence and with greater age-related differences occurring between grades 1 and 6 (Trost et al., 2002). Pre-school and elementary students spend the majority of their recess time being sedentary (McKenzie et al., 1997) and there is a significant decline in children's physical activity from the fourth to the fifth

grade (Sallis, Alcaraz, McKenzie, & Hovell, 1999). A substantial proportion of children participate in less than one daily moderate to vigorous physical activity of 10 min or longer in duration (Simons-Morton et al., 1990), indicating that many children may not be obtaining adequate amounts of physical activity well before adolescence. This age-related decline in physical activity may occur early in life.

Inquiries have also been made in an attempt to understand whether activity levels differ between boys and girls, and at what age these differences may take place. For example, during non-school days, there is no difference in activity levels between boys and girls ages 6 to 17 (Janz, Golden, Hansen, & Mahoney, 1992; Gavarry, Giacomoni, Bernard, Seymat, & Falgairette, 2003). However, the report of the Surgeon General on physical activity and health concluded that males aged 12-21 years are more likely than their female counterparts to participate in vigorous physical activity (US Department of Health and Human Services, 1996). A later analysis of several national surveys shows this trend is still applicable (Pratt, Macera, & Blanton, 1999). While this occurrence is generally not refuted, the question of when this gender difference begins to occur is still debated.

Gender differences in activity patterns occur after age 13 (Strauss, Rodzilsky, Burack, & Colin, 2001), 10 (Santos, Guerra, Ribeiro, Duarte, & Mota, 2003), and even as young as 3 years of age (Bradley, McMurray, Harrell, & Deng, 2000). Boys tend to be generally more active and engage in higher intensity exercises than girls (Myers, Strikmiller, Webber, & Berenson, 1996; Trost, Pate, Freedson, Sallis, & Taylor, 2000; Trost et al., 1996), thus suggesting that boys are more active due to intensity level during physical activity. While it seems gender differences may take place earlier than 10 years of age, activity patterns are the key to these differences (Trost et al., 2002).

Since schools exhibit relatively stable environments that support exercise and sports, as well as the opportunity to be active with peers (Caspersen, Pereira, & Curran, 2000), there is an opportunity to explore and substantiate the above findings so that patterns of physical activity can be delineated in younger children. Schools also provide a resource for describing activity levels in children because they offer structured activity classes (physical education) and unstructured time (recess). Examining physical activity levels during structured and unstructured periods in school can allow greater insight into the daily physical activity patterns of children.

Studies have been conducted to examine activity levels of children during recess in preschool and elementary school (Dale, Corbin, & Dale, 2000; McKenzie, Sallis, Nader, Broyles, & Nelson, 1992; McKenzie et al., 1997), but none have actually compared physical activity levels during recess with those during physical education classes. Physical activity levels may be higher during structured physical education class compared to recess (Welk & Corbin, 1995), but it has also been reported that activity levels were higher during free play opportunities (McKenzie et al., 1995). Comparing activity levels during physical education and recess is needed due to the lack of information available comparing these two variables. This comparison can also help to design physical education classes that promote appropriate amounts of physical activity in children.

Thus, the purpose of this study was to determine the amount of physical activity in which children engage during physical education classes, and what factors influence this amount. Variables such as gender, grade level, free days (recess), classes held inside and outside, and children's involvement in sports are examined to gain an understanding of their relationship with physical activity.

Methods

Participants

The participants for this study were male (n = 62) and female (n = 74) third and fourth grade students attending a private elementary school in Dallas, TX. Participants, aged 8-10 years (M = 9.4, SD = 0.6), were recruited to wear a pedometer for 30 min a day for 114 days during physical education class for one school year. A written informed consent form was made available and signed by each participant and parent. This study was approved by the Texas Woman's University's Institutional Review Board.

Instruments and Procedures

The pedometers used for this study were My Life Stepper Series MLS 2000 pedometer by Yamax (Tokyo, Japan). Yamax pedometers have been found to be one of the more accurate spring-levered pedometers, and thus were chosen for this study (Schneider, Crouter, & Bassett, 2004; Schneider, Crouter, Lukajic, & Bassett, 2003). Pedometers were hand checked at the beginning of the study based on instructions provided by the manufacturers. Spare pedometers and batteries were aquired in case of breakage or premature wear.

Students were instructed to attach the instrument to the hip; by either clipping it to the belt (for boys) or the band of the shorts (for girls) close to the anterior portion of the iliac crest. Students were instructed to attach assigned pedometers prior to each class. All pedometers were numbered and set out in numbered trays. For example, the student assigned to the pedometer labeled with the number 13 retrieved and placed back the pedometer in the tray labeled with the number 13. This assured that each child used the same pedometer throughout the year and that the pedometer was retrieved and placed back in the same tray each day.

At the end of each day's class, students were instructed to remove the pedometer, open it and place it face up in its respective tray without resetting it. Students were encouraged to look at but not to discuss or be concerned with pedometer readings. The step count was recorded on a data sheet by the teachers and then reset for the next class. In the event of suspected erroneus readings on the pedometer, the data was recorded with an asterisk and the pedometer was replaced with a spare. At the end of the day, the suspected pedometer was hand checked. If the pedometer was working properly when checked, the data was kept. The steps were not recorded if the pedometer had malfunctioned.

A 24-hr step count was collected on each child to examine the relationship between daily step counts and PE step counts. Children wore the pedometer for one full weekday during the middle of the spring term (March). Prior to collecting 24-hr activity levels, pedometers were reset and sealed with a plastic cable tie. Students were instructed to keep the pedometer sideways when handling so as to not count steps. Students were given the pedometer at the beginning of the school day and returned it at the same time the following morning. Children were asked to remove the pedometer

Table 1. ***Descriptive characteristics of 3rd and 4th grade boys and girls***

	Boys				Girls			
	Third Grade (n=30)		Fourth Grade (n=32)		Third Grade (n=36)		Fourth Grade (n=38)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age (years)	8.9	0.2	9.9	0.3	8.8	0.3	9.9	0.2
Height (in)	54.9	2.9	57.1	2.5	54.2	3.0	55.8	3.9
Weight (lbs)	73.7	13.8	83.9	18.9	68.9	10.3	78.2	6.1
BMI	17.0	1.8	17.9	2.9	16.5	2.3	17.5	2.6
Average Steps/Class	1,788.0	183.9	1,826.1	214.5	1,589.2	171.1	1,529.8	168.8

Note: M = mean; *SD* = standard deviation.

only when changing clothes, bathing, swimming, or sleeping. Upon return of the pedometer, the teacher asked if the pedometer was left off at times other than instructed and if so, the steps were not recorded. Otherwise, the teacher immediately recorded the step count on the appropriate data sheet. Steps accumulated during the 30-min physical education class were included in this 24-hr reading.

At the end of the spring term (May), students were asked how many competitivive sports teams they were on since the beginning of the school year. At this time, height and weight was measured and BMI was calculated.

Physical education classes took place in an air conditioned gymnasium and at an outside facility that included a basketball court and grass field. The outside facility had no covering and offered no shade. On rainy days, classes shared the gym and data were not recorded since this was not considered a variable in the study.

Design and Analysis

All data were entered and analyzed with SPSS 11.0. Descriptive statistics were used to characterize the participants according to gender by age, height, weight, BMI and average steps per 30-min class.

Multiple linear regression was used to determine which variables contributed most to activity levels in physical education class. Average steps per class (ASC) was used as the dependent variable with gender, age, grade, and participation in youth sports used as independent variables. Based on these results, a factorial ANOVA was used to examine differences in step counts based on the two best predictors. The two factors with the highest standardized beta weights were used in the ANOVA. Significance for regression and factorial analyses were set at $p \leq .05$.

A repeated measures ANOVA was used to determine differences between steps accumulated during classes held outside and steps accumulated during classes held inside, as well as steps accumulated during structured days and steps accumulated during free days (recess). Dependent *t* tests were conducted for pairwise comparisons, with the Bonferroni procedure applied to control for family-wise error rate ($p \leq .0125$).

Spearman's r correlation coefficients were generated to examine the relationship between 24-hr activity level and class activity level. Spearman's r was used due to evidence of skewness and kurtosis in the 24-hr measurements. Significance for the correlation was set at $p \leq .05$.

Results

Descriptive data for boys and girls were obtained at the beginning of the study and are presented in Table 1. Steps per class were averaged over the 114 total days sampled. The population sample consisted of 66 third grade girls and boys, and 70 fourth grade girls and boys. The ethnic status of the children was predominantly Caucasian, including five Asian Indian and three African-American students. Boys and girls in this study fell below the age-related 75th percentile for BMI (Kuczmarski, Ogden, & Grummer-Strawn, 2000).

Prediction of Average Steps per Class

A multiple linear regression was conducted using the standard method to evaluate how gender, age, grade, and participation in youth sports predicted ASC. The linear combination of predictor variables was significantly related to the ASC, $F(4, 122) = 19.25$, $p < .001$. The sample multiple correlation coefficient was .62, indicating that approximately 38% of the variance of the ASC in the sample was accounted for by the linear combination of the predictors.

Table 2 presents the indices to indicate the relative strength of the individual predictors. Two of the four bivariate correlations were statistically significant ($p < .05$) and the same indices were significant with regards to the partial correlations. The individual variance explained by gender is 22% ($-.47^2 = .22$) while participation in youth sports accounted for 9%.

Table 2. ***The bivariate and partial correlations of the predicators with average steps/class (ASC)***

Predictors	Standardized Coefficients (Beta Weights)	Correlation between each predictor and the ASC	Correlation between each predictor and the ASC controlling for all other predictors
Gender	-.46	-.57*	-.47*
Age	.03	-.01	.02
Grade	-.07	-.02	-.04
Youth Sports	.27	.46*	.30*

* p < .05

Gender presented the highest standardized beta weight followed by participation in youth sports, while grade and age presented very small standardized beta weights (see Table 2). Additionally, neither grade or age had significant bivariate or partial correlations. Third grade boys took only 38 fewer steps per class compared to fourth grade boys, and third grade girls actually took 59 more steps per class compared to fourth grade girls (see Table 1). Based on these results, it was decided to include gender and participation in youth sports as independent variables with ASC as the dependent variable in the factorial ANOVA.

Effects of Gender and Involvement in Youth Sports on Average Steps per Class

A 2 X 5 ANOVA was conducted to evaluate the effects of gender and involvement in youth sports on ASC. The ANOVA indicated no significant interaction between gender and youth sports, $F(4, 117) = 1.67$, $p = .162$, partial $\eta 2 = .05$, but a significant main effect for gender $F(1, 117) = 17.44$, $p < .001$, partial $\eta 2 = .13$. Figure 1 illustrates the significantly greater amount of steps per physical education class in boys compared to girls. After dividing the total steps accumulated by 30 min, boys achieved a step count of 60. 2 per min, with girls achieving a step count of 51.9 per min.

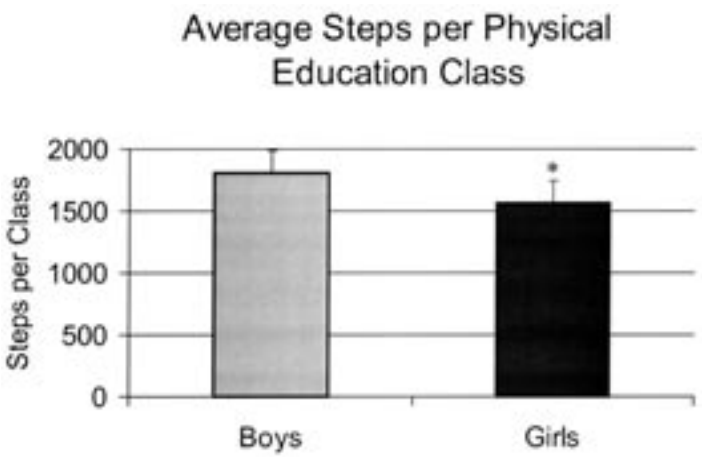

Figure 1. Third and 4th grade girls take significantly fewer steps per 30-minute physical education class than 3rd and 4th grade boys *($p < .001$).

The ANOVA also indicated there was a significant main effect for participation in youth sports $F(4, 117) = 3.31$, $p = .013$, partial $\eta 2 = .10$. The follow-up tests consisted of all pairwise comparisons for participation in youth sports. The Tukey HSD procedure was used to control for Type I error across the pairwise comparisons. The results of this analysis indicate significant differences in ASC as participation in youth sports increases (see Figure 2). While one boy in the study did not participate in any youth sports and four participated in only one sport, there were 10 girls who did not participate in youth sports and 13 who participated in just one. Forty boys participated in three or more youth sports compared to 23 girls who participated in three or more.

Comparisons of Environment and Structure

A one-way within-subjects ANOVA indicated a significant

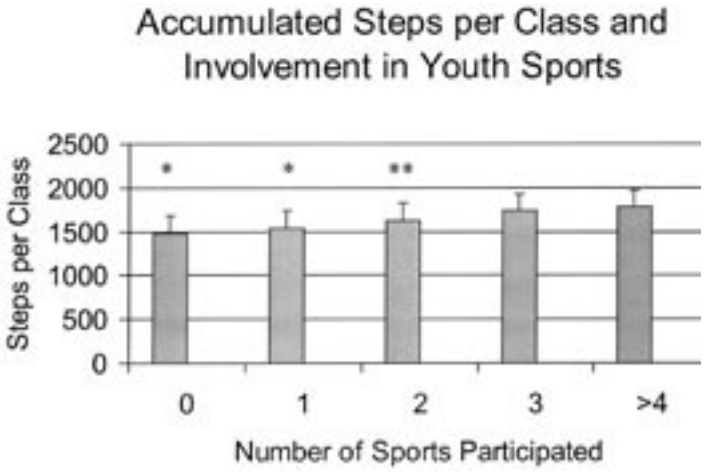

Figure 2. Children participating in no or 1 youth sport accumulated significantly fewer steps than those involved in 3 or 4 youth sports *($p < .05$) and those involved in 2 youth sports accumulated significantly fewer steps than those involved in 4 youth sports **($p < .05$)

effect, Pillai's Trace = .96, $F(2, 136) = 1718.41$, $p < .001$, partial $\eta 2 = .96$. Dependent t tests for pairwise comparisons revealed that ASC during classes held outside ($M = 1{,}874$, $SD = 220$) were significantly greater than ASC during classes held inside ($M = 1{,}393$, $SD = 197$), $t(135) = 58.76$, $p < .001$, $\eta 2 = .96$, and ASC during free days ($M = 1{,}993$, $SD = 502$) were significantly greater than ASC during structured days ($M = 1{,}874$, $SD = 220$), $t(135) = 3.55$, $p = .002$, $\eta 2 = .08$. Figure 3 illustrates the differences in step counts between inside and outside days, as well as differences in step counts between structured days and free days.

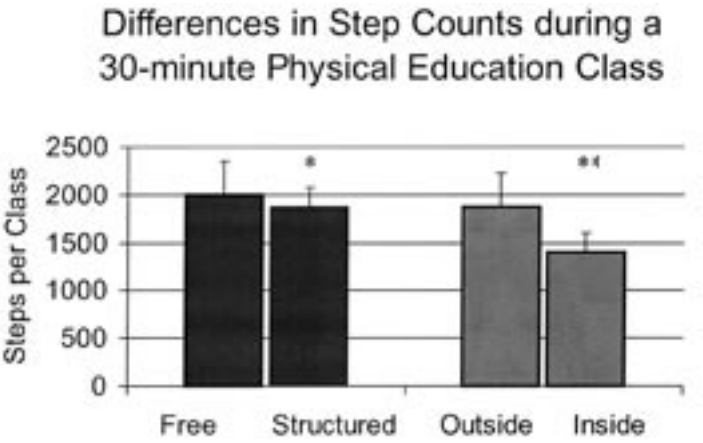

Figure 3. Third and 4th grade children accumulated significantly fewer steps during structured class days compared to free class days *($p < .001$), and took significantly fewer steps during inside class days compared to outside class days **($p < .001$).

Relationship between 24-hr and Average Steps per Class

Students accumulated 13,057 ± 4101 steps during one 24-hr period (boys accumulated 15,436 ± 4660 steps and girls accumulated 11,179 ± 2,264 steps). Correlation coefficients computed among ASC and student 24-hr activity levels as

measured by the pedometer were significant, r (100) = .64, $p <$ .001, indicating a positive relationship between steps accumulated during a 30-minute physical education class and those accumulated on a weekday for a 24-hr period.

Discussion

Activity obtained during physical education class can contribute to overall daily activity. In order for this to be achieved, 33% of a 30 min physical education period (roughly 10 min) must be spent engaged in moderate-to-vigorous physical activity (McKenzie et al., 1995; Scruggs et al., 2003). When using pedometers to quantify this level of physical activity, children must accumulate at least 1,800 steps in a 30-min period, or 60 steps per min (Scruggs et al., 2003). Boys in our study achieved this criterion, but girls did not.

Our finding of greater activity levels during physical education in boys compared to girls is in agreement with others (LeMura, Andreacci, Carlonas, Klebez, & Chelland, 2000; Nader, 2003). The reason for this difference in activity level may be due to boys' stronger perception of sport competence and strength compared to girls' perceptions (Crocker, Eklund, & Kowalski, 2000). The nature of the physical education curriculum may be more inclined to teaching sports skills, which may contribute to the lower levels of physical activity by females (Scruggs, Beveridge, & Watson, 2001). The activity level difference between genders may also be due to the lack of aesthetic components in physical education, such as dance and rhythmic movements (Hicks, Wiggins, Crist, & Moode, 2001). Girls are typically involved in these types of movements, which are not offered in physical education classes as frequently as sport movements and skills.

A minimum of 11,000 steps/day for girls and 13,000 steps/day for boys is required to achieve the President's Challenge for the Presidential Active Lifestyle Award if using pedometers as a means of measuring physical activity (President's Council of Physical Fitness and Sports, 2002). This requirement is based on studies that show 6-12 year-old girls accumulate between 10,497 and 11,274 steps/day while boys accumulate between 12,300 and 13,989 steps/day (Tudor-Locke, 2002). Over a 24-hr period, boys in the present study accumulated more steps than what is required for the Presidential Active Lifestyle Award whereas girls met the minimum requirement. The 24-hour reading in the present study included steps during physical education class and without this contribution, boys would have just met the minimum with 13,629 steps and girls would not have met the minimum with 9,621 steps. Thus the present study shows the effective contribution of a 30-min physical education class to overall daily physical activity. However, the results for the 24-hr period must be interpreted with caution. The single day sample obtained for comparison may not be representative of multiple days or weekend days.

Some studies have indicated that as age increases or grade level increases, physical activity decreases (Luepker, 1999; Myers et al., 1996). The age or grade at which this decline in physical activity begins to take place is still debatable (Caspersen et al., 2000; Kimm et al., 2002; Sallis, Prochaska, Taylor, Hill, & Geraci, 1999; Trost et al., 2002), but seems to begin around 13 to 14 years old (Riddoch & Boreham, 1995). The present study found no evidence of a decline in physical activity level during physical education class between third and fourth grade children, suggesting that the decline occurs sometime after the 4th grade, or age 10. Differences between these and other findings may be due to methodological differences, duration of measured variables, or defined activity thresholds regarding low, moderate, and high intensity activity. The results of this study, with regard to activity levels between grade level, were made cross-sectionally rather than on the same group of children over a two-year period and may not reflect a true representation in this population. Additionally, third and fourth graders in the present study participated in the same curriculum, which may have contributed to these findings.

Children in the present study who participated in organized youth sports outside of school were inclined to be more active during physical education class. While the number of students who participated in one or no sports is a limitation of this study, there was still a significant positive relationship suggesting a link between physical education and organized sports. Furthermore, children who participate in sports exhibit positive motivation during physical education (Goudas, Dermitzaki, & Bagiatis, 2001). This positive motivation may translate into willingness to attempt new activities during physical education classes, thus manifesting higher physical activity levels. It is possible that the children who participated in organized sports in this study exhibited a greater motivation to participate during physical education classes, and the more involvement in sports, the more motivation during physical education. Additionally, children who participate in organized sports may be more experienced in certain movement skills, allowing them to participate at a higher level and with greater confidence in their abilities during class.

Studies directly comparing physical activity levels during physical education and recess are lacking and although our finding was significant, the effect size when comparing structured days and free days was rather small and must be interpreted cautiously. Children in the present study took more steps and were more active during recess than during physical education class, consistent with findings of others (Welk & Corbin, 1995). In classes other than physical education and recess, children are sitting at desks and tables and physical activity is restricted. Physical education classes, although activity related, are still structured and somewhat restrictive. Therefore, children may be more active during recess because of the strict environment imposed upon them throughout the school day. Children in the present study may have increased physical activity levels during recess to compensate for the restrictive physical activity they experienced during the school day. While children do not compensate physical activity levels after school following sedentary school days (Dale et al., 2000), it is not known whether children compensate for physical activity at recess during school. Recess is the only true "free" period during school, and it may be then when children participate in sports or other movement skills they truly enjoy. It is at this time when children may feel most comfortable, thus enhancing activity levels.

Recess periods in the present study were held outside at the same facility as the outdoor physical education classes. While steps recorded during recess were slightly higher compared to outdoor structured days, there was a larger difference in the amount of steps children accumulated during physical education classes held outside compared to physical education classes held inside. Inside and outside physical education classes were 30 minutes in length

and were also the same in format, with regards to time spent during introduction, fitness, lesson focus, and conclusion. Physical activity levels may have been higher outside due to the space constraints of the gym as opposed to the larger, open fields. The difference in activity levels may also be due to the nature of the lesson taught, such as a track and field unit outside or cooperative games held inside.

We measured 24-hr step counts to determine the association of daily and physical education activity levels. Children who were more active throughout the day tended to be more active during physical education classes. Children who were more active in physical education were those who participated in youth sports and it may be these children who accumulated higher activity levels during the 24-hr period. Children not involved in organized sports may participate in more sedentary activities such as TV viewing or video game playing, and these types of activities seem to have a negative relationship with physical activity levels (Eisenmann, Bartee, & Wang, 2002; Grund, Krause, Siewers, Rieckert, & Muller, 2001; Hernandez et al., 1999).

Conclusion

This study provides insight about physical activity patterns of third and fourth grade elementary school students participating in daily physical education classes. Boys accumulated a greater number of steps per day compared to girls, and children participating in organized sports accumulated a greater number of steps compared to those who did not. Additionally, classes held outside were more conducive to greater amounts of physical activity compared to those held inside. Although the intensity of physical activity in children in this study was not directly measured, we can interpret our findings with confidence since the data was collected within a strict 30-min period and over 114 days throughout the school year.

Gender and extra-curricular background should be considered when developing physical activity lessons for students, along with facilities. Students' responses to different lessons, whether sports or dance and if held inside or outside, can influence physical activity levels. Considering these variables when designing lesson plans can optimize physical activity levels in children participating in physical education classes.

Physical education class should be a positive means to enhance physical activity in children. Teachers and researchers should understand that physical education is not necessarily a physical fitness class, but a means to teach lifetime fitness as well as age appropriate fundamental and sport skills. Physical education teachers who focus on providing children with high amounts of physical activity may be sacrificing instruction time. While accumulating 1,800 steps per 30-min class is favorable for contributing to overall daily physical activity, it is unclear n the maximum number of steps that is appropriate with regards to proper instruction by the teacher. Accumulating too many steps may not be appropriate because instruction time by the teacher may be reduced. Since physical education incorporates fitness and sports activities, future studies should examine the best lessons or teaching styles that integrate appropriate teacher instruction with optimal physical activity.

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Authors‘ Notes

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