

The Comparison of Children's Caloric Expenditure During Elementary Physical Education Class and Free-Choice Recess Time

Shannon Simmons, Corban University, USA
Megan Turner, Corban University, USA

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Abstract

Background: The physical benefits of structured physical education (PE) classes and free-choice recess time in elementary school and how they compare to each other is unknown. National health objectives encourage 50% of PE class time being spent in moderate to vigorous physical activity (MVPA), while no set standards for elementary recess exist. The purpose of this study is to determine if a difference existed in the caloric amounts expended by elementary age children during structured physical education class compared to free-choice recess time.

Methods: Twenty-eight third and fourth grade children (male = 18, female = 10) were recorded, with a hip-placed accelerometer, during one day each of PE class and recess time. Each recording lasted exactly 30 minutes and were taken a day apart. Data was collected during a three week period in which the PE class participated in tennis and badminton.

Results: A paired samples t-test compared differences in steps, total energy expenditure (EE), total EE in males, and average kilocalories expended per minute. Steps: $t(26) = 3.79, p = .001$; total EE: $t(27) = 1.85, p = .075$; total EE (males): $t(17) = 3.78, p = .006$; energy expenditure per minute: $t(26) = 1.75, p = .091$. The average percentage of time spent in MVPA during PE was 64.37%.

Conclusion: There was a statistically significant difference in total EE in males and steps, with recess being higher than PE class. Further tests on the steps showed this also was only significantly different in the male children. It is important to note, on average, the children exceeded the national objective by spending over 50% of the PE class period in MVPA.

Keywords: childhood, physical activity, exercise, calories

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Introduction

For years the benefits of recess and physical education (PE) class have been unclear. People have debated the need for both of these to be scheduled into an elementary school day. Many research studies have looked at what could be done to improve these times to provide more opportunity for children to be physically active.

Physical Activity Recommendations for Children

According to the Council on Physical Education for Children, the recommendation for children aged 6-11 is at least 60 minutes a day of physical activity (Schachter, 2005, p. 38). Schachter concluded that physical education class time alone is not enough; therefore, other opportunities must be provided throughout the day. Recess has shown to be a vital part of a child's day because it provides students another break to get out of the classroom chairs and engage in some form of physical activity.

Other research studies also analyzed children's physical activity levels. Three different types of elementary schools, private, public village, and inner city, were participants in one study (Mallam, Metcalf, Kirkby, Voss & Wilkin, 2003). This study was done to see if differences in the children's overall activity level existed. For this research project, a total of 215 children participated in the study by wearing accelerometers for seven days. The private school had nine scheduled hours of physical education a week while the other two schools had only 2.2 and 1.8 hours a week, respectively. Research showed even though each school had a different amount of scheduled physical activity time during the educational day, in the end, the children all had similar amounts of physical activity. Outside of school, the children often made up for lack of exercise during the school day. Since this study involved three types of schools, it allowed for a comparison of the differences in class times and scheduling that commonly occur. Private schools have more freedom to adjust their schedule to give children more time in areas they deem important, such as physical activity.

The National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development Network researched third-graders to see if they met the Healthy People 2010 recommended goal (Nader, 2003). The guideline is for schools to have physical education class every day, with 50% of time being spent in moderate-to-vigorous physical activity (MVPA). With 814 participants, they discovered on average the third-grade students received only 25 minutes a week of MVPA during their twice a week physical education class.

Fairclough and Stratton (2006) collected all the research available on the topic of physical activity during elementary physical education classes. The journal article consisted of a review of 44 research studies on children ages 5-11. The goal of this review was to look at the percentage of class time spent in MVPA and see if it met the 50% recommendation. By using heart rate monitoring, observation, and accelerometers, they determined the class time MVPA of the elementary school children to be only 34.2%. This percentage is significantly lower than the set national guideline for physical activity.

Accelerometers

When testing elementary age children to determine if they meet the MVPA recommendations at school, many researchers use accelerometers. An accelerometer is a type of activity monitor which measures energy expenditure and intensity of physical activity. Most accelerometers are placed on the participant's hip in order to sense the most full body movements.

A study conducted in 2004 validated the accuracy of the Actical and Actiwatch accelerometers and focused specifically on use with children (Puyau, Adolph, Vohra, Zakeri & Butte, 2004). Researchers looked at the activity energy expenditure (AEE) and also the physical activity ratio (PAR). Activity energy expenditure is defined as energy expenditure (EE) minus basal metabolic rate (BMR). This equation can be written as $AEE = EE - BMR$. The physical activity ratio is defined as EE divided by BMR, or $PAR = EE/BMR$. For this study, the Actical accelerometer was placed on the right hip, directly above the iliac crest. The conclusion of the study showed both accelerometers' validity in measuring physical activity and predicting energy expenditure in children.

Daniel Heil (2006) also studied the reliability of the Actical Activity Monitor. His research showed the effectiveness of the Actical monitor on both children and adults in predicting activity energy expenditure. One result of the study was the similar accuracies in all three body placement locations (wrist, waist, and ankle). Heil's research validated the use of the Actical Activity Monitor in future research studies.

In one of the many studies done by Nicola Ridgers and her colleagues, 116 boys and 112 girls wore the ActiGraph accelerometer during recess (Ridgers, Stratton & Fairclough, 2005). The purpose of the research was to compare the activity levels between boys and girls and to see if the children were at least moderately active 50% of the recess time. Results found boys were more active than girls, having 28 minutes of physical activity in comparison to the girls only having 21.5 minutes during recess. These researchers proposed a new, more achievable recommendation of only 40% of recess time being spent in moderate activity. One notable problem in this study was the large amount of data lost because of the accelerometers malfunctioning.

Physical Education Class

The struggle for physical education classes to meet activity recommendations has been a problem for many years. In 1993, researchers wanted to determine how physically active children are during PE (Simons-Morton, Taylor, Snider & Huang, 1993). The national guideline then and now is the same, for 50% of class time to be spent in moderate to vigorous physical activity (MVPA). For this research study, trained observers recorded information on 157 fifth grade students in Texas elementary schools. To determine what classified as MVPA, the observers recorded dynamic movements that involved large muscle groups and any transfer of weight. The results showed on average, only 8.6% of class time was spent in MVPA, equivalent to 10.4 minutes out of the 121 minutes the children received each week in physical education classes. While this project did not have the resource of the energy monitors available today, the research still showed a large margin of difference between the 50% MVPA recommendation and the 8.6% achieved.

Due to the fact that physical education classes can vary in teaching focus, one research project used a special system to help classify the educational focus. SOFIT (System for Observing Fitness Instruction Time) was used to observe the students and record their physical activity levels (Nader, 2003). Each PE lesson was placed into one of six categories based on type of activity: management, knowledge, fitness, skill practice, game play, free play. The categories can create a difference in MVPA for the children based on what activities are offered during class.

In 2003, a research project used SOFIT and pedometers and discovered the average number of steps taken by children to equal one-third of the class time spent in MVPA (Scruggs et al.). During a thirty minute physical education class, 1800-1890 steps taken indicated children had engaged in MVPA for one-third of that time. None of the first and second graders studied reached the Healthy People 2000 50% MVPA recommendation (Scruggs et al., 2003, p. 1070).

Another study also looked at the percentage of children to reach the 50% MVPA guideline. In 2010, the physical activity of 380 children ages 8-11 was assessed during five different times of the school day, including recess and scheduled PE (Nettlefold et al., 2010). The results concluded that only 1.8% of girls and 2.9% of boys reached the 50% MVPA guideline during PE class time.

One of the most current studies on the role of physical education classes in children's daily physical activity was recently published by Chen, Kim, and Gao (2014). This study differs from similar studies because a Sensewear armband monitor was used, as opposed to other accelerometers placed on the hip. The researchers chose to use ≥ 4.0 METs as the threshold for MVPA and < 1.5 METs as the threshold for sedentary behavior, based on prior research. As in past studies, the percentage of class time spent in MVPA was not up to the standard 50% recommendation, even though a large part of the children's MVPA occurred during PE class. Also confirming other research, the boys were more active than the girls.

Physical Activity During Recess

In addition to the 50% MVPA recommendation for children during physical education classes, a national standard has been set by the National Association for Sport and Physical Education (NASPE), for free-choice recess time in elementary schools. Their position on what recess should consist of states every school should provide 20 minutes a day for recess (NASPE, 2006). NASPE also recommends 60 minutes a day of MVPA, part of which can take place during recess time at school. Recess is suggested to not take place either immediately before or after a PE class, but to be spaced out through the school day. NASPE recognizes free-choice recess time does not take the place of scheduled PE classes, but is extra time allowed for children to have more physical activity.

Nicola Ridgers has spent much time studying children's physical activity during elementary school recess. One study had 297 children participate by wearing hip accelerometers during school recess before and then six weeks after an intervention (Ridgers, Stratton, Fairclough & Twisk, 2007). A change in playground equipment served as the intervention to determine how it affected the children's MVPA. Results of the intervention showed boys being more active than girls. The difference in equipment helped the younger students increase their physical activity more than the

older children. It was also noted that when the recess time period was longer, the intervention had a greater effect, resulting in more time spent in MVPA.

Another one of Ridgers' many studies on the physical activity of children focused specifically on ethnicity, gender, and grade differences (Ridgers, Saint-Maurice, Welk, Siahpush & Huberty, 2011). She wanted to see if those variables showed a difference in children's physical activity during recess. This specific study had 210 participants from grades 3-6, who wore accelerometers on their waists for five consecutive school days. Results showed boys had higher activity levels than girls during recess. It also found third graders were more active than fourth graders and fifth graders being more active than sixth graders. This result could be an effect of the third and fifth graders having a shorter recess time than the fourth and sixth graders.

A specific "recess pack" intervention in a research study was used to determine the differences in physical activity during recess at four elementary schools (Elliot, et al., 2011). The recess packs consisted of different sports equipment to encourage physical activity in the children. Two categories the researchers looked at were: the potential differences in what types of activities both genders performed before and after the packs were introduced, and also the change in student activity level. A common discovery in this type of research was noted, showing girls being less active than boys. The females chose activities such as sitting, talking, and jumping rope, whereas the males played games of basketball and football. The conclusions made were based on school staff interviews after the intervention had been put into place. This study was not validated by any activity monitors.

Another study measured the effectiveness of an intervention; the "Ready for Recess" program (Huberty et al., 2011). Two data collection times were recorded, in September before intervention and April after the intervention had begun. A total of 93 third through fifth graders wore an ActiGraph accelerometer for one week at school during each collection time to measure physical activity during recess. Results showed the intervention increased both moderate and vigorous activity in the children. Moderate activity increased from 18.1% to 31.2%, while vigorous activity increased from 7.2% to 16.8% (Huberty et al., 2011, p. 254). Results also showed younger children and males as more active compared to the older children and females.

While many researchers have studied children's physical activity in either recess or PE classes, both are not usually compared. It is known from past research that national recommendations are not met by most elementary schools and males tend to be more active than females. This study will be looking at elementary age children and if they expend different caloric amounts in structured physical education class compared to free-choice recess time. Both are vital parts of a scheduled school day in helping children reach physical activity goals. It is unknown if one has a greater benefit than the other.

Methods

Study Participants

This study looked at third and fourth grade elementary school children from two classrooms at a small private school in Salem, Oregon. Out of forty children in the classes, twenty-eight of them had parental consent and chose to participate. In total, there were ten girls and eighteen boys. The children ranged from 8-10 years old. After weighing and measuring the children before data collection, it was determined that the average BMI was 17.068.

Protocol

Heights and weights were measured and recorded prior to data collection. Each scheduled day of data collection had four children from one class wearing the Actical accelerometer on their waists. The accelerometers were preset with the specific height, weight, age, and gender of each participant. A timer was also set to begin recording at the exact time either recess or PE class was scheduled to start. Data was recorded for exactly 30 minutes each time. Data collection took place over the span of three weeks in November 2014.

During recess time, the children had the freedom to choose whatever activity they wanted, both inside the classroom and outside on the field, court, and playground. For physical education class, the teacher always had a warm-up followed by instruction on how to play badminton or tennis and practice time. Every student was required to participate in all activities.

Results

Paired samples t-tests were run using the SPSS software. The tests compared different aspects of the children's activity during both PE class and free-choice recess time. These tests compared differences in average kilocalories expended per minute (*Table 1*), total steps taken (*Table 2*), total energy expenditure (EE) (*Figures 1 & 2*), and total EE in males. Energy expenditure per minute: $t(26) = 1.75, p = .091$; total EE: $t(27) = 1.85, p = .075$; total EE (males): $t(17) = 3.78, p = .006$; steps: $t(26) = 3.79, p = .001$. Percentages of time spent in moderate versus vigorous activity showed children spent the most time in moderate activity during recess (*Figure 3*). For PE, the average percentage of time spent in MVPA during class time was 64.37%.

Table 1 Average Energy Expenditure (EE) in kcal/min

Class	Activity Level	Mean	SD
PE	Moderate	1.81	0.52
	Vigorous	3.96	1.73
Recess	Moderate	1.89	0.64
	Vigorous	1.31	1.74

Table 2 *Number of Steps Taken During Class Period*

Class	Sex	Mean	SD
PE	Male	1130.82	236.04
	Female	1042.1	268.41
Recess	Male	1835.12	732.99
	Female	1372	780.71

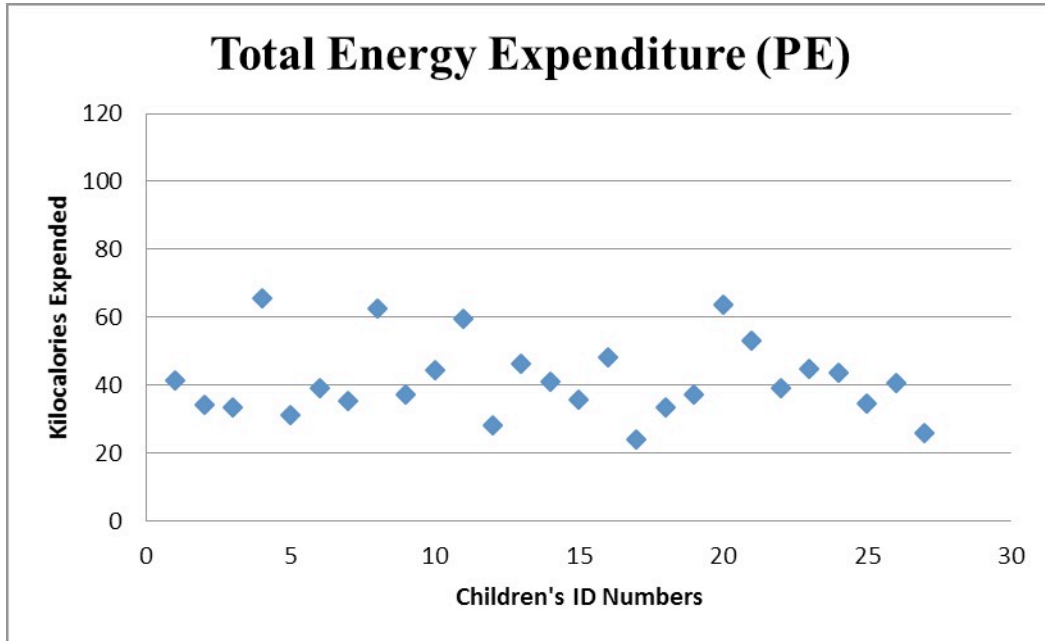


Figure 1: Total Energy Expenditure in kcal During Physical Education Class

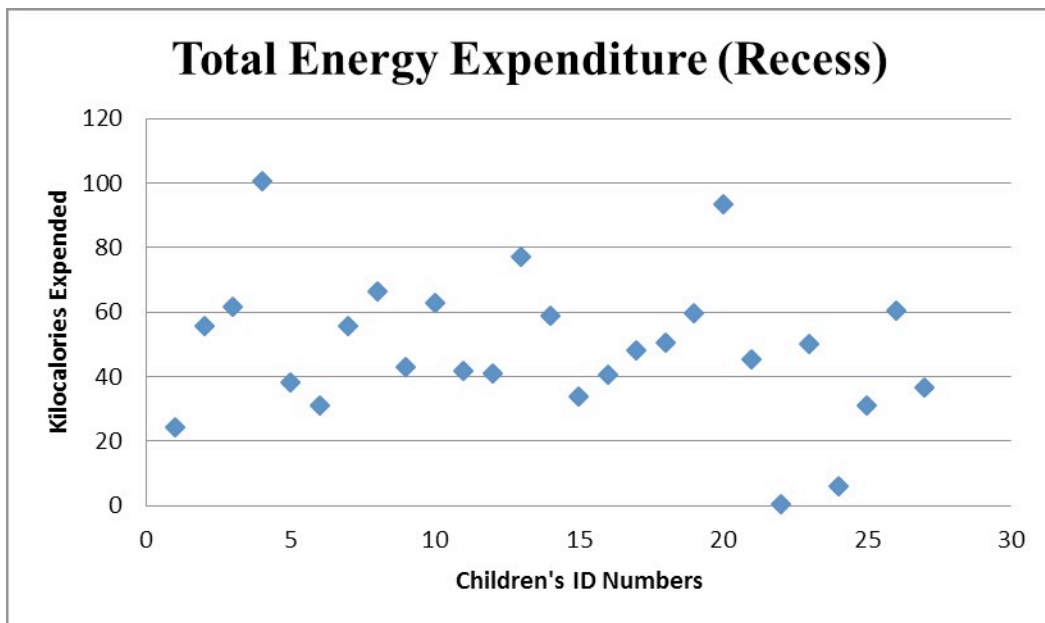


Figure 2: Total Energy Expenditure in kcal During Free-Choice Recess Time

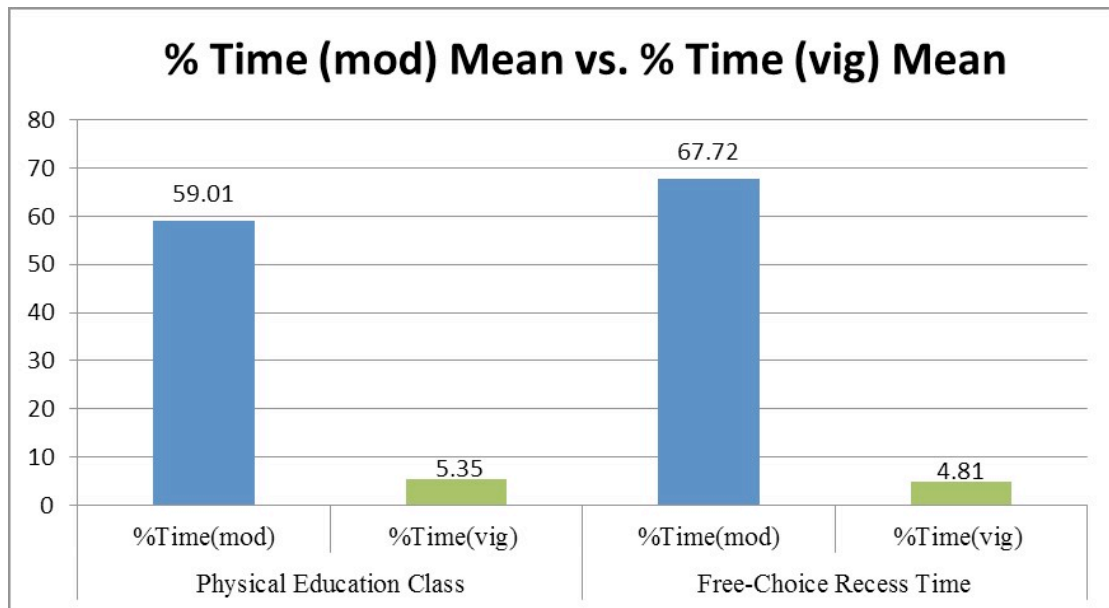


Figure 3: Percentage of Time Spent in Moderate (mod) Activity Mean vs. Percentage of Time Spent in Vigorous (vig) Activity Mean

Discussion

This present study started with the hypothesis of expecting elementary age children to expend higher caloric amounts in structured physical education class than in recess. Once background research was completed, it showed generally recess is more active than PE class. In this study, just like past research, results showed the children, particularly males, expended more calories during the free-choice recess than during PE.

The national Healthy People 2010 recommendation is for physical education to be scheduled into every school day with 50% of the time spent in MVPA (Nader, 2003). While the school in this study scheduled PE only two or three days of the week, the children did spend 64.37% of the class period in MVPA, exceeding the recommendation of 50%. The National Association for Sport and Physical Education recommends recess being offered for at least 20 minutes every day, which the school researched in this present study did (NASPE, 2006).

Also, in Nader's research (2003), physical education lessons were classified into six different categories. The PE classes observed in this study could be put into several of these categories, because the first part of class was focused on fitness (a warm-up) and knowledge (learning about a skill) and the second half of class was focused on skill practice (drills) and game play (tournament style games). Because PE teachers try to fit so much information into such a short amount of time, it can be hard to classify a single class into just one category.

This study matched with Ridgers' recess activity levels research showing boys being more active than girls during free-choice recess times (Ridgers, Stratton, & Fairclough, 2005). Other research has also shown this to be true such as the 2010 study by Nettlefold et al. and the 2014 study by Chen, Kim, and Gao.

According to Scruggs et al. (2003), 1800-1890 steps taken during a physical education class is equal to 33.33% of the class time being spent in MVPA. This study had completely different results which showed the average steps taken during PE were 1000-1150 which translated into 64.37% of the time being spent in MVPA.

Limitations for this study include potential interference by the children with the accelerometers while being worn. While the monitors were placed on the children's hips, many times the accelerometers were shifted and did not stay in place. Other limitations could be the awareness of the research project causing an increase in the children's desire to be physically active in an attempt to help the study.

Conclusion

Because of this research, more is now known of the comparison of children's energy expenditure during recess and physical education. Both are similar in caloric expenditure, with recess being higher, especially in males, which helps support the need for children to have a daily recess at school. While one is not significantly better than the other, this research shows the importance of having both available in elementary school.

Confirmation of males expending more calories than females during both recess and physical education classes was found in this study as well. The school proved to be a good example of how to meet the national objectives of providing a daily recess and having 50% of PE class time spent in MVPA. This research showed a statistically significant difference in total energy expenditure in males and total steps taken (significantly males), with recess being the time which had higher caloric expenditure and steps taken than physical education class.

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Contact email: ssimmons@corban.edu