EFFECT OF PHYSICAL EDUCATION ON DAILY PHYSICAL ACTIVITY LEVELS IN 4TH AND 5TH GRADERS

by Melissa B. Lincourt

The purpose of this study is to determine whether 4th and 5th graders exhibit an increase in daily physical activity (PA) when they participate in physical education (PE) class as opposed to days they do not attend PE. Forty-three participants (26 Females, 18 Males) in 4th and 5th grade wore an accelerometer for seven consecutive days. Additionally, they completed the Fitnessgram physical fitness test battery. There was a significant increase in PA during the school day and the entire day on days with PE versus days without PE. Furthermore, less than 50% of the PE class time was spent in moderate-to-vigorous PA. Even though students spent less than half of the PE class time in moderate-to-vigorous PA, PE served to increase students’ PA levels both during the school day and after school thus promoting energy expenditure and the associated health benefits.
EFFECT OF PHYSICAL EDUCATION ON DAILY PHYSICAL ACTIVITY LEVELS IN 4th AND 5th GRADERS

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by
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Chapter One: Introduction

Introduction

Obesity among US children has become a major health concern. Approximately 20% of US children and adolescents ages 2-19 years old are considered obese (11). Childhood obesity has been shown to be an independent risk factor for adult obesity and the chronic health problems that are associated with obesity (16). In fact, obese children, ages 5-17, are more likely to have elevated blood pressure, higher cholesterol levels, and are more likely to have type II diabetes than children who are of normal weight (19). Causes of childhood obesity are likely related to lack of physical activity and unhealthy dietary patterns (18). Several published reports suggest children and adolescents spend more time on sedentary activities, such as viewing television, using the Internet and playing computer games, instead of engaging in regular physical activity (12, 7, 13). The current physical activity guidelines state that children should engage in at least 60 min of moderate intensity physical activity per day (18). However, many children fail to meet this recommendation. Healthy People 2010 recommends 20 minutes or more of vigorous exercise (≥6 METS) 3 days per week. However, less than 3% of students meet this guideline as well (19).

Regular physical activity during adolescence is associated with improvements in many physiological and psychological aspects of health (15). Physiological benefits include a decreased risk of cardiovascular disease, diabetes, and hypertension (18). Adolescents’ risk of becoming obese as an adult is also decreased when participation in physical activity occurs regularly. Another benefit of regular participation in physical activity and exercise is healthy growth and development of the cardiorespiratory and musculoskeletal systems in youth (14). Regular physical activity can also help with social interactions, achievement, and mental well-being in youth (14).

Schools provide the ideal setting to increase physical activity levels; more that 90% of children are enrolled in schools (17). However, school structure also can be a barrier to physical activity during the school day. Most of the time in a typical school day is spent in sedentary behaviors. Studies suggest that students who are inactive during the school day do not make up for it with increased physical activity outside of school (18).
There is evidence that physical education classes are not adequately meeting their goal of being the primary institution to promote physical activity among children (15). Some physical education classes only provide students with 3 minutes of moderate to vigorous physical activity in a single class, which is less than 10% of class time (5). As a result, physical education teachers as well as classroom teachers are being taught to incorporate more physical activity into their classroom through different intervention programs.

While the school based interventions programs are helpful for increasing physical activity for the children and have been monitored, their methods of measuring physical activity may lack precision and objectivity. Such interventions have used observation using the SOFIT (System for Observing Fitness Instruction Time) program or have used self-report questionnaires to measure physical activity (5, 6). Accelerometry has been used extensively in numerous studies. However, it usually is used to measure activity during an intervention activity or for only one day during a week; few studies use accelerometry for numerous days of data collection (1, 5, 17). Even so, the appropriate use of accelerometry has been shown to be a useful tool to rectify previous measurement issues in the study of childhood physical activity patterns (14). Accelerometers provide a way to objectively measure physical activity before, during and after the typical school day. Additionally, physical activity can be assessed during specific activities, such as physical education class and other activities (i.e., sport and recreational activities, homework, recreational screen time, etc.) that may be active or sedentary in nature. Therefore, the purpose of this study is to determine whether 4th and 5th graders exhibit an increase in daily physical activity (and thus energy expenditure) when they participate in physical education (PE) class as opposed to days they do not attend PE class. The subjects involved in this study will be monitored with an objective monitoring device (e.g., Actical accelerometer) to determine if participation in PE results in an increase in physical activity (e.g., energy expenditure) during the school day time-block, during the afterschool time-block and overall daily physical activity.
Classroom Interventions

There have been many classroom-based interventions to help children become more active during the school day. Many of these interventions have been created to help increase activity levels in a classroom based setting instead of just sitting and learning a lesson. These classroom-based interventions can be essential for schools that have eliminated or lessened the time students spend in physical education classes and/or recess.

TAKE 10!: One example of this type of intervention is a program called TAKE 10! This is a physical activity promotion program that integrates activity into elementary schools academic curriculum. Its purpose is to provide physical activity that reinforces academic concepts and skills. It consists of ten-minute physical activity sessions implemented during regular class time that substitute for a seated activity (18). Teachers are provided with activities for each grade that are correlated with core curriculum areas such as science, mathematics, language arts, social studies, and character education (18). The goal is for teachers to carry out one or more 10-minute session per day on top of the regular physical education classes and recess time. In one study evaluating the TAKE 10! program, a few select students wore accelerometers during each activity to estimate energy expenditure (18). The researchers concluded that the TAKE 10! program provided moderate to vigorous intensity physical activity to the students. This study showed that this program can offer an effective way of increasing students physical activity levels through classroom activities and lessons (18).

Physical Activity Across the Curriculum: Similarly, the program Physical Activity Across the Curriculum (PAAC) is based on the same type of idea. This program was a 3-year intervention to target children in 2nd through 5th grade (7). PAAC trains teachers to incorporate physical activity into regular academic curriculum. The goal for teachers is to accumulate 90-100 minutes a week of physical activity, not including recess or physical education (7). They were to deliver moderate-intensity physical activity at different times throughout the day. Height and weight of each child was measured to calculate BMI to track any progress being made. The researchers concluded that PAAC has the potential to increase physical activity, therefore energy expenditure, in the classroom without taking time away for academic lessons being taught (7).
**SPARK Program**: The SPARK program, which is a 2-year physical education program, has also been implemented as a type of classroom intervention. It consists of physical education classes that are designed to promote high levels of physical activity, teach movement skills, and be enjoyable. A typical SPARK session lasts 30 min and has two parts: health-fitness activities (15 min) and skill-fitness activities (15 min) (15). The program consists of nine sport-related lessons, ten health-related lessons and a self-management program. The self-management program gave students behavior change skills to help incorporate physical activity outside of school (15). These programs were put in place to make the most out of a physical education class. The researchers from this study reached the conclusion that with good teacher training and support, physical education classes have the potential to provide a greater amount of physical activity to students than a typical PE class (15). Other programs such as Switch-Play intervention and Exercise Your Options have also been implemented in some schools and are based on the same types of principles (8).

As mentioned in the previous studies, increasing the amount of physical activity children receive is an important aspect in the fight against childhood obesity. Sometimes this can be hard with many schools cutting physical education classes as well as recess time. Classroom-based interventions that get children moving during the day can help. They incorporate academic lessons with physical activity to try and not take away any time from learning. These types of intervention tools can be beneficial for many schools and children to increase daily physical activity.

**Benefits of Physical Activity**

*Academic Benefits*: In addition to physical activity helping to combat childhood obesity some studies have also linked physical activity to academics. Castelli, Hillman, Buck, and Erwin (2007) seek to look at the relationship between academic achievement and physical fitness in a group of 3rd and 5th grade students. Specifically, they recruited 259 public school students from four different schools. Two of the schools were high performing/low poverty and another two were low performing/high poverty (4). Physical fitness was determined by the use of the Fitnessgram test battery. Students were first familiarized with testing procedures and then administered the testing protocol. Students performed the PACER test, muscular strength tests (push-ups and curls-ups) and the back-saver sit and reach test. Height and weight were also
obtained to calculate BMI. Academic achievement was determined by the use of the ISAT which is a standardized test given to students, grades third through eighth, yearly in Illinois public schools. The results from both tests were run though statistical analysis and proved to be significant (4). The researchers found that physical fitness was related to academic performance in third and fifth grade students. Specifically, performance in reading and math are both related to aerobic fitness and BMI. Also, BMI is inversely related to academic performance (4).

**Cognitive Benefits:** Along the same lines as academic benefits is the realm of cognitive function. Hillman, Castelli, and Buck (2005) examined the relationship between cognitive function and aerobic fitness in children and adults. To do so, 24 children and 27 adults were recruited and placed in either a high fit or low fit category (10). Fitness data was collected by the use of the Fitnessgram test battery. Four tests were administered to the participants, which included the PACER test, push-ups, curls-ups, and sit and reach test. Height and weight measures were also obtained for a measure of BMI. Neuroelectric and behavioral responses to a stimulus discrimination task were used to assess cognitive function (10). After analysis, results show that fitness may be related to better cognitive functioning in children and may even help improve cognitive health in children and adults. Specifically, fitness was positively associated with cognitive processing speed and also with neuroelectric function and behavioral performance in preadolescent children (10). This study helped to provide support for the benefits of fitness on cognition.

The previous studies support the importance physical activity and fitness can have on an individual. The data supports that higher levels of aerobic fitness are related to better academic performance and cognitive functioning. However, even though studies have shown data that supports this, schools are still cutting back recess and physical education class and adding more academic learning. School and communities need to take action and think about adding back in more physical activity in hopes that it will be beneficial. One aspect that should be looked at is school recess.

**Physical Benefits:** Participating in physical activity can have an impact on one’s behavior particularly in the classroom. This is why having activities such as planned recess time is an important aspect of a child’s school day. Recess is a break during the school day that allows students to play on their own and usually this recess time is unstructured (2). According to the
National Association for Sport and Physical Education, recess is to be given once a day for at least twenty minutes or more (2). Often recess time and classroom behavior can be related. Previous studies have looked at the effects of recess on classroom performance. In most cases they found that students were able to focus better on the teacher and specific tasks after recess (2). Barros, Silver, Ruth, and Stein (2009) examine the relationship between recess time and classroom behavior as well. Specifically, they look at children ages eight to nine who either have daily recess or do not receive daily recess. To document data, teachers were given a questionnaire. This questionnaire asked about the number of days per week recess was given, how many times per day it was given, and the amount of time that was spent in recess (2). The children were categorized into two groups based on the amount of exposure they were having to a recess break. A group that had none/minimal recess (<1 break of 15 minutes/day) and a group that had some recess (2). Classroom behavior was then assessed by using the teacher’s rating of classroom behavior. The results were that classroom behavior was better for children who had some recess than those who had none/minimal recess. However, among the children that did receive daily recess there was no significant difference in classroom behavior scores and the level of exposure (2).

**Physical Activity Across the School Year**

Christodoulos, Flouris, and Tokmakidis (2006) examined obesity and physical activity in school children during the academic year and into summer. A total of 178 elementary school children participated in this study. Students had their height, weight, and body mass index recorded as a baseline measure. The Physical Activity Recall Questionnaire was used to assess physical activity over the year (5). To assess physical fitness a battery of various tests were administered. Cardiorespiratory fitness was tested using the 20 meter shuttle run and flexibility was tested via sit and reach (5). Agility, explosive strength and muscle endurance were also tested. Christodoulos et al. (2006) found that during the school year children advance significantly in their physical fitness. However, no such improvement was made during the summer months. Also, extracurricular physical activity during the academic year helps to fight against the development of obesity and reduces the poorer performance/health state that can follow summer break. Christodoulos et al. (2006) concludes since most physical activity in
children takes place outside of school many different approaches should be taken to provide children with enough physical activity to have health benefits.

**Measuring Physical Activity**

Studies have used various techniques to measure the levels of physical activity that children are receiving. The intervention studies previously mentioned have used techniques such as observations, accelerometers, pedometers, questionnaires, and self-reported levels. All of these techniques measure physical activity in different ways and have varying levels of validity and reliability. Having valid methods of estimating physical activity is essential to understanding the relationship between physical activity and chronic diseases and their risk factors (14). Different types of measurements do have their limitations when it comes to the young adult/children population. It has been said that an ideal measure of physical activity for use in children is hard to pin down (14). There is a need for an accurate and practical measure of physical activity that can be easily used in a school setting (14).

**Observation:** Numerous studies have used the SOFIT (System for Observing Fitness Instruction Time) system to assess physical activity levels of children in the school system (15, 9). This method consists of observing three students in 20-second intervals for a total of 10 min. The observer records the physical activity of the student using a scale 1 to 5 (7). A score of one is equal to lying down and five is equal to being very active. Programs that have used this are the SPARK Program and Physical Activity Across the Curriculum (PAAC). In the PAAC program SOFIT observations took place each week. The researchers randomly selected what day of the week the observations took place as well as which children were observed. The observer was not to interact with the children at all or encourage them, as it would affect the results.

The same type of observation system was used in the SPARK program. During this observation four children were observed every 20 seconds during 4 minute blocks throughout the class period (15). The same activity level scale of scores 1 to 5 were used as well. The caloric cost of the activity level was estimated based on heart-rate monitoring data (15). These programs both have found increases in physical activity, but exactly how much energy expenditure has increased is unknown from simple observation.

The previous studies examine how the SOFIT program of observation for measuring physical activity levels works. Although it does measure various levels of physical activity
anywhere from not active to very active there are no concrete levels of energy expenditure. While the technique can tell you if physical activity levels have increased it cannot tell how much energy expenditure each activity requires. For this you will need something that might be slightly more accurate that just observation, which bring us to the use of accelerometers.

**Accelerometers:** Accelerometers have also been used to assess physical activity in the classroom. In the TAKE 10! program students were to wear the accelerometers only during the programs 10 min activities. Results were that students who perform 5-10 sessions per week could be expected to burn 150-300 kcal per week (18). This accumulated energy expenditure may create a long-term impact on developing overweight and obesity.

Along the same line, the intervention program called the Moving School had students wear accelerometers only during the main subject lesson that the program taught. The concept behind the moving school was that static sitting posture was to be replaced by dynamic sitting, standing, and walking around (3). The accelerometers were worn to compare activity of students in the moving school to a more traditional school where they just participated in static sitting. The accelerometers showed that children in the Moving School program were significantly more active (3).

Another study compared the use of a pedometer to an accelerometer in different school activities (cross country-run, PE class, and physical activity breaks) (14). They did find significant and meaningful correlation methods. They also found that there was no meaningful difference between estimates of moderate-to-vigorous activity between the pedometer and the accelerometer (14). However, as with any study, they did have a few limitations. For instance, they only recorded accelerometer data on one type of PE activity (track and field). Also, they mention that the selection of accelerometer cutpoints needs to be taken into consideration in future studies. There is a current debate that surrounds the translation of accelerometer counts into estimated activity intensity, specifically correct cutpoints to be used with children (14). Several validated moderate intensity activity cutpoints have been proposed for children, so those should be taken into consideration.

The SPARK program also used accelerometers by measuring out-of-school physical activity for 1 weekday per semester and 1 weekend per school year (15). The accelerometers in the study were considered the primary physical activity measure. However, they were not able to
make baseline measures before the study began. The results showed that there were no significant group differences on any accelerometer data (15).

Cooper, Page, Fox, and Mission (2000) examine the amount and patterns of activity of 3 different groups of people over a one-week period. Specifically, they are looking at normal, overweight, and obese individuals using accelerometers. Eighty-four individuals were included in the study. Participants were asked to wear the accelerometer on their left hip, for all hours that they are awake for 7 days (6). Body mass index of each individual was also calculated. Cooper et al. (2000), found that obese participants were significantly less active than non-obese participants during weekdays, weekends, and evenings (6). However, this did not hold true during the workday. The difference in activity levels could be seen better when looking at males than females. Cooper et al. (2000) concluded that accelerometry is a very useful tool to examine activity levels and can be useful to see periods of inactivity for possible interventions.

Along the same lines as the previous study, Mallam, Metcalf, Kirkby, Voss, and Wilkin (2003) use accelerometers to measure physical activity levels for seven days in a group of school children. There was a total of 215 participants from three different schools that all had different levels of physical education class and sporting facilities (13). The private preparatory school (School 1) had 9 hours a week of physical education. The village school (School 2) offered 2.2 hours of physical education a week and the inner city school (School 3) offered 1.8 hours of physical education a week (13). Mallam et al. (2003) found that overall girls were less physically active than boys. They concluded that the amount of physical activity done by school children does not depend on the amount of time given for physical education because children will compensate out of school.

Accelerometer and pedometers can be very useful tools to measure steps/counts taken. This can get you slightly closer to see exactly how much physical activity levels are actually increasing. However, they are not always readily available for use and are not as affordable as other techniques of measuring physical activity. A more affordable approach can be done with the use of questionnaire or self-reported data.

**Questionnaires:** Self-reported data in the form of questionnaires can be useful information to find out what type of activities children are engaging in after school. Although precaution needs to be taken when looking at self-reported data, insight into what outside
activities and physical activities being performed can be beneficial. The SPARK program used this technique as one of its many methods for measuring physical activity. This questionnaire was a 1-day recall of physical activity being completed outside of class. Children were to report their participation in a list of 20 different activities on a checklist. To score these questionnaires a summary score based on the intensity weightings of each activity was given (15). The PAAC program also did the same type of measurement. For this program a version of the Physical Activity Checklist Interview (PACI) was given to assess the previous day’s physical activity levels (7). For PACI, children recalled activities that they have done before or after school for a length of at least 15 minutes.

Questionnaires using self-reported data can be very helpful in many studies. Often times the researchers cannot control for activities that take place outside of the study, so questionnaires can provide insight into these. It can only help to make results a little more accurate by getting the full picture of someone’s day.

There are many different ways to measure children’s physical activity levels. One theme that is present during all of these studies it measuring physical activity during just one part of the day. Many of the previously mentioned studies only measure physical activity during a certain lesson or during a PE class. The data supports that these activities that are meant to increase physical activity in fact do increase it. However, there is no data on how this might affect the rest of the student’s day.

Chapter Three: Methods

Participants

Students were recruited from the 4th & 5th grade classes at Stewart Elementary School in conjunction with the principal and the physical education teacher at Stewart Elementary. Participation in this study was completely voluntary. The physical education teacher asked the students in all three 4th and all three 5th grade physical education classes to participate in this study. Each child was given a packet of information that explained the study and included an informed consent form and questionnaire to take home to their parent/guardian. Every Thursday, information from the school is put in each child’s backpack to be taken home for a parent/guardian to review. Children who brought the signed consent form back to the physical education teacher were included in the study.
Our subject population consisted of 44 children (18 males and 26 females) ages 9 to 11 enrolled in the 4th or 5th grade at Stewart Elementary School.

**Procedures**

After obtaining consent from the potential subjects’ parent/guardian, an Actical accelerometer was placed at the right hip in the midline of the leg at the beginning (approximately 9:00 am) of the first activity recording school day. This device is completely noninvasive and simply monitors changes in movement. The subjects wore the monitor for five school and two weekend days during their normal daily activities from the time they woke up each day until they went to bed each evening. Each subject was instructed on the placement and care of the monitor. A parent/guardian was asked to record the exact time of day when the child put the monitor on in the morning before school and when the child removed the monitor just prior to bedtime (Appendix C). This information was used only as a checking procedure against the data stored in the monitor.

The physical activity monitor was collected at the beginning of the school day after at least a week of data collection. The data from the monitor was downloaded to a computer for data reduction and analysis at Miami University.

Each subject was also asked to complete a short questionnaire (Appendix B) regarding their out of school physical activity participation (i.e., youth sport, other structured activities).

**Statistical Analysis**

This study is a cross-sectional, within-subjects design. Physical activity levels were compared on school days with physical education class versus school days without physical education class for each subject. Additionally, specific time blocks, throughout each day were compared. The time blocks were split into time spent in school and time spent outside of school. Time during the school day was set as 9am-4pm and time outside of school was set as 4pm-10pm or when the monitor was removed for bedtime. Descriptive data was collected, summarized, and reported as means +/- standard deviation (SD). These variables include: age, gender, weight, height, BMI percentile, BMI Z-score, average accelerometer counts/min on days with PE class and days without PE class, and Fitnessgram physical fitness test battery data.
Accelerometer cutoff points were based on Puyau et al., (2004) and are as follows (counts per minute; cts/min): sedentary <100, light 100 to <1500, moderate intensity 1500 to <6500 and vigorous intensity 6500 & up. Pearson’s correlations were used to determine the relationship between PA, FitnessGram scores, gender, BMI percentile and BMI-Z scores. Stepwise linear regression analyses were used to determine the extent of the relationships between PA, fitness (Pacer), gender and BMI. Paired T-tests were used to compare physical activity volume during the school day with PE class vs. without PE class as well as comparing after school physical activity volume. Additional T-tests were used to determine the role that gender played in the physical activity volume during the school day and during after school hours on days with PE and days without PE. The percentage of time spent in moderate to vigorous physical activity during PE class was first calculated as a percentage of the forty-five minute PE class using the cutoff points previously mentioned. A paired T-test was then used to determine if less than 50% of the time was spent in moderate to vigorous physical activity. This was done by subtracting 50% from the percentage of time spent in moderate to vigorous physical activity for each subject.

Specific Aim One: Do children exhibit an increase in physical activity volume (counts of activity per day) and/or physical activity intensity (counts per minute) during the school day with physical education class?
Hypothesis: There will be no increase in school day physical activity when children participate in physical education class.

Specific Aim Two: Do children exhibit an increase or a decrease in after school physical activity volume (counts of activity per day) and/or physical activity intensity (counts per minute) with participation in a physical education class?
Hypothesis: There will be no difference in after school physical activity with participation in a physical education class.

Specific Aim Three: To determine the amount of time children exhibit moderate to vigorous intensity levels of physical activity during the physical education class.
Hypothesis: Less than 50% of the physical education class time will be spent in moderate to vigorous intensity physical activity during a typical physical education class.
Specific Aim Four: Is time spent in moderate-to-vigorous PA during PE class related to BMI %, and/or gender?

Hypothesis: Time spent in moderate-to-vigorous PA during PE class is related to BMI % and/or gender.

Chapter Four: Results

Results

Preliminary analysis of the data shows that 4th and 5th grade children do exhibit an increase in physical activity volume during the school day with PE class as opposed to days without PE class. Table 1 displays the characteristics of the study participants involved in the analysis.

Table 1. Characteristics of study population

<table>
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<th>Descriptive Statistics</th>
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Table 2 shows the means and standard deviations of the physical activity data during the school day on days with PE class vs. days without PE class. This analysis indicates that there is a significant difference ($p < 0.001$) between the days. The mean data suggests the significantly
greater physical activity volume occurs on days with PE class vs. days without PE class. Additionally, this data was analyzed to test for any gender effects (Table 3). There was still a significant difference ($p < 0.001$) for both males and females ($p < 0.001$) for physical activity volume on days with PE versus days without PE. The increase is PA volume being during days with PE.

Table 2. Means and standard deviations of total PA counts during the school day

<table>
<thead>
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<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
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<td>total counts PE class</td>
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<td>52010</td>
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<tr>
<td>total counts no PE class</td>
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<td>42619</td>
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</table>

* = significant difference between total PA counts during the school day on days with PE vs. days without PE ($p < 0.001$)

Table 3. Means and standard deviations of total PA counts during the school day for males and females.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
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</thead>
<tbody>
<tr>
<td>Males-total counts PE class</td>
<td>176061*</td>
<td>49699</td>
</tr>
<tr>
<td>Males-total counts no PE class</td>
<td>89275</td>
<td>40195</td>
</tr>
<tr>
<td>Females-total counts PE class</td>
<td>173639*</td>
<td>54964</td>
</tr>
<tr>
<td>Females-total counts no PE class</td>
<td>87789</td>
<td>45296</td>
</tr>
</tbody>
</table>

* = significant difference between total PA counts during the school day on days with PE vs. days without PE between males and females ($p < 0.001$)

Pearson’s correlations indicate a negative correlation between weight and the Pacer test as well as between weight and the push-up test; suggesting lower body weight is related to better performance on both the Pacer and push-up tests. Additionally, a positive correlation can be seen between the pacer and curl-up test; suggesting the higher the performance on the push-up test, the higher the performance on the curl-up test as well.

Stepwise linear regression analyses indicated that the Pacer test score (aerobic fitness) was a significant, independent predictor of physical activity (counts/minute) on days the subjects participated in PE class. BMI-Z score, gender and grade were not significant predictors of PA on days with PE class. Additionally, PA on days with PE was found to be a positive, significant predictor of both Pacer and Push-Up fitness test performance while BMI Z-scores were found to be a significant, negative predictor.
Table 4 shows that children exhibit a significant increase in after school physical activity volume with participation in PE class. There was a significant difference ($p < 0.05$) between after school physical activity volume on days with PE class vs. days without PE class. Comparison of the means suggests there is a significantly greater level of physical activity during after school hours on days with PE class vs. days without PE class. However, when the data was analyzed to examine the gender effect; the difference in PA volume during after school hours did not exist. The means and standard deviations can be seen in Table 5.

Table 4. Means and standard deviations of total PA counts during after school hours

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>total counts PE class</td>
<td>140972*</td>
<td>89676</td>
</tr>
<tr>
<td>total counts no PE class</td>
<td>112013</td>
<td>83931</td>
</tr>
</tbody>
</table>

* = significant difference between total PA counts during after school hours on days with PE vs. days without PE ($p < 0.05$)

Table 5. Means and standard deviation of total PA counts during after school hours for males and females.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males-total counts PE class</td>
<td>149667</td>
<td>85374</td>
</tr>
<tr>
<td>Males-total counts no PE class</td>
<td>123807</td>
<td>91592</td>
</tr>
<tr>
<td>Females-total counts PE class</td>
<td>132034</td>
<td>94255</td>
</tr>
<tr>
<td>Females-total counts no PE class</td>
<td>99691</td>
<td>73782</td>
</tr>
</tbody>
</table>

Data analysis also shows that less than 50% of the forty-five minute PE class is spent in moderate to vigorous physical activity. Analysis of this data shows that approximately 35% of the PE class time was spent in moderate to vigorous physical activity. Further analysis of this data shows that during both PE class time slots (9:45-10:30 or 11:20-12:05) the time spent in moderate-to-vigorous physical activity was not significantly different.
Chapter Five: Discussion

Discussion

The purpose of this study was to determine whether 4th and 5th graders exhibit an increase in daily physical activity (and thus energy expenditure) when they participate in PE class as opposed to days they do not attend PE class. The results of the present study showed that there was an increase in daily physical activity when the students participated in PE. Not only was there an increase in PA during the school day, but there was also an increase in after school PA on the days the students participated in PE. To further investigate this finding the data was statistically analyzed by gender to determine if the overall increase in PA on days with PE class differed between boys and girls. Males exhibited significant differences in PA during the school day on days with PE vs. days without PE, as did the females. This increase being greater PA on days with PE, supporting the fact PE class is an important outlet for increasing PA. Another important finding is that less than 50% of the PE class time is spent in moderate to vigorous PA. Healthy People 2010 recommends spending 20 minutes or more in vigorous PA, 3 times a week (19). This finding can be of use when it comes to designing activities for PE class. Since childhood obesity is on the rise it can be important to use outlets such as PE to help combat this public health issue. Designing classes that have students participating in a greater amount of moderate to vigorous physical activity might be of some benefit to their health (18,13).

This study has shown that on days with PE class after school PA volume also increases significantly compared to days without PE class. Many schools seem to be decreasing the amount of time and the number of days students spend in PE class to allow for more academic instruction (18, 9). These findings can be an implication to schools that increasing the time students have to participate in physical activity and even PE class will help them to be more physically active outside of school, thus increasing their energy expenditure. Increasing energy expenditure then can lead to multiple physiological and psychological health benefits (5, 15). When the data was examined with all participants included, there is a significant difference in the PA in after school hours on days with PE vs. days without PE. However, when the data was examined as a function of gender there was no longer a significant difference in PA during the after school hours. These findings (Table 5) suggest that both boys and girls exhibited small but
insignificant increases in PA during the afterschool hours, but the increase in PA was not large enough and the variability in PA during the afterschool time block was too great when separated by gender to result in a statistically significant result.

Additionally, the findings from this study indicate a relationship between the Fitnessgram Pacer test and the average physical activity volume during PE class for each subject. This suggests that the more physical activity the students have, the more aerobically fit they will be. The Pacer can be an easy test for PE teachers to use to look at a child’s cardiovascular fitness, suggesting the more physically active you are during PE, the better the performance on the Pacer test and thus more aerobically fit.

The present study has some limitations. The students were asked to wear their accelerometers for a week from the time they woke up until the time they went to bed. However, there was no way to make sure the students were always wearing their accelerometer and often times they forgot to, which caused there to be missing data. Also, there were days that some students were late to PE class or had to leave early for multiple reasons, which can also cause some variance within the data.

In conclusion, the findings of this study suggest that there is an increase in PA volume (and thus energy expenditure) during the school day and during the after school hours on days students participate in PE class. These findings indicate that PE does result in a significant increase in the level of PA during the school day and during after school hours as well. This increase in PA can have potential health benefits and could potentially help combat childhood obesity and the problems associated with it because of the increase of PA (8). Additionally, the finding that less than 50% of the PE class time is spent in moderate to vigorous PA can be of importance. This finding can have implications for the way PE classes are taught and the type of activities that are used each day. Finding activities that facilitate increased time in moderate to vigorous PA will then help children expend more energy and potentially reap additional health benefits.
References


Appendix A

Informed Consent

Dear parent/guardian of a Stewart Elementary 4th or 5th grader,

Your child has been asked to participate in a research study for the Department of Kinesiology and Health at Miami University. The primary investigators of this study are Dr. Randal Claytor, a professor at Miami University and Melissa Lincourt, a graduate student majoring in exercise science. Participation in this study will require your child to wear a physical activity monitor for four days and participate in normal daily activities. Participation in this study is completely voluntary and will not affect your child’s relationship with the Stewart Elementary School teachers/staff in any way!

The purpose of this study is to determine whether 4th and 5th grade children experience an increase in daily physical activity when they participate in physical education (PE) class as opposed to days they do not have PE class.

Your child will be required to wear a physical activity monitor for four consecutive days (Monday through Thursday; two days with PE class and two days without PE class). The monitor will be placed on the child’s clothing at the right hip by either Dr. Claytor or Melissa Lincourt, with supervision from either Mr. Clear (physical education teacher) or Mrs. McDowell (Principal) at the beginning of the school day on the first day of participation in this study. Thereafter, your child and/or you are asked to put the monitor on each morning as soon as your child awakes and dresses for school. Also, your child and you are asked to remove the monitor just prior to your child going to bed each night (we also ask that you record the time of day when your child puts the monitor on and takes the monitor off each day). The monitor will be collected from your child by Dr. Claytor, Melissa Lincourt or Mr. Clear at the end of the school day on the fourth day of your child’s participation. This physical activity monitor is completely noninvasive and simply monitors changes in movement; its dimensions are approximately 1 X 1 X 0.5 inches and it weighs only a few ounces. The monitor is held in place by a clip and safety pins. The
monitor is sturdy and water proof. Additionally, your child and you are asked to complete a short questionnaire about your child’s physical activities done outside of the school day (the questionnaire is part of this packet of information – please help your child complete the questions) and return it to Mr. Clear (physical education teacher) about afterschool physical activities that involve sports and/or recreation.

Lastly, your child may be selected to wear a harness and face mask during one physical education class period. Only 5 children from each grade will be selected to do this part of the study and participation in this part of the study by your child is completely voluntary and will not affect your child’s participation in the other part of the study. Your child may decline to wear the harness and face mask at any time. The harness holds a very small computer and the face mask allows us to measure how much your child breathes so that we can determine how many calories your child burns in a typical physical education class period. The harness and face mask weighs only about 3 pounds and does not affect a child’s ability to breathe, in fact the harness and face mask are designed to be used by children during physical activity, play and exercise.

If you have any questions about your child’s participation in this study, you please feel free to contact Dr. Claytor by phone (513-529-5815 – office) or email at claytorp@muohio.edu, Melissa Lincourt, at lincoumb@muohio.edu, Mr. Clear, or Mrs. McDowell - at the school.

If you have any questions or concerns about this study or your child’s rights as a study participant, you may contact the Office of Advancement of Research and Scholarship at 513-529-3734 or email: humansubjects@muohio.edu.
Please Return This Part of the Page to Mr. Clear

(You may send this back to school with your child or you may hand deliver this form to Mr. Clear)

I wish for my child _________________________ to participate in the previously described study. I understand my child’s participation is completely voluntary and that his/her name will not be associated with their physical activity measures or any other information collected in this study. Also, I understand that my child has the right to withdraw participation from this study without any prejudice at any time.

Parent/ Legal Guardian
signature_______________________________________________________

Relationship
__________________________________________________________________

Date
___________________________________________________________________

Witness_______________________________________________________________________

Date__________________________________________________________________________

___
Appendix B

Questionnaire

1. On most days of the week, what type of transportation do you take to school?
   A. Walk
   B. Bike
   C. Car/Bus
   D. Other ________________

2. Do you participate in youth sport or recreational activities outside of school? If yes, please continue on to question #3.
   A. Yes
   B. No

3. How many days a week do you participate in youth sport or recreational activities? (Combine all activities)
   A. 1
   B. 2
   C. 3
   D. 4
   E. 5+

4. How many hours a week are you involved in these activities? (Combine all activities)
   A. 1-2
   B. 2-3
   C. 3-4
   D. 4-5
   E. 5+

5. Do you breathe hard when you do these activities?
   A. Yes
   B. No
6. If you answered Yes to Question #5 – Do you get sweaty or red in the face when you do these activities?
   A. Yes
   B. No

7. Please list the youth sport / recreational activities that you do afterschool.
   A. __________________________________________________________
   B. __________________________________________________________
   C. __________________________________________________________
   D. __________________________________________________________
   E. __________________________________________________________
Appendix C

Accelerometer Recording Form

Child’s Name: ____________________________________________________

How to put on physical activity monitor:

1. First attach the monitor using the belt clip onto the child’s pants at the right waist. The monitor should be on the right hip in line with the seam of the pants.

2. Securely fasten the monitor to the child’s pants using the safety pins on either side of the monitor.

3. Make sure the monitor is straight up and down and fastened securely.

Physical Activity Monitor Wear Chart

<table>
<thead>
<tr>
<th>Day of the Week</th>
<th>Time Placed On</th>
<th>Time Taken Off</th>
<th>Additional Comments*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
*Please record (in this space) if your child removed the monitor for more than 1 hour for any reason. Please record how long the monitor was not worn and why.

**Reminders**

- This monitor is waterproof. If the child would like to swim with the monitor on they are able to do so, however the monitor must be attached to the swimsuit (at the right hip) somehow.
- This monitor needs to be worn from the time the child wakes each morning and gets dressed until the child goes to bed from Monday morning until Friday night.
- Please make sure your child returns this monitor to school on **Monday, May 9th**. A Miami University person will be at school to pick-up the monitors.