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Assessment of Physical Activity Levels of Elementary School Students Participating in the Mornings in Motion Program

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To the Graduate Council:

I am submitting herewith a thesis written by Andrew Michael Howard entitled "Assessment of Physical Activity Levels of Elementary School Students Participating in the Mornings in Motion Program." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Kinesiology.

Dawn P. Coe, Major Professor

We have read this thesis and recommend its acceptance:

Dawn P. Coe, David R. Bassett, Dixie L. Thompson

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

**ASSESSMENT OF PHYSICAL ACTIVITY LEVELS OF ELEMENTARY SCHOOL
STUDENTS PARTICIPATING IN THE MORNINGS IN MOTION PROGRAM**

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Andrew Michael Howard
August 2012

DEDICATION

To my parents, Terry and Trisha, my brother Christopher, my girlfriend Stephanie, and all of my friends. Thank you all for your love, patience, understanding, and support. I never could have done it without you.

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ABSTRACT

Purpose: To objectively assess the physical activity levels of students during three different time blocks on days when the Mornings in Motion before-school activity program is offered, and on days when it is not. **Methods:** Subjects were 69 elementary school children (8.5 ± 1.9 years) who were all apparently healthy. Subjects were all enrolled in the Mornings in Motion before-school physical activity program that was offered on Mondays, Wednesdays, and Fridays. The program focuses on health related fitness through the implementation of aerobic activities, stretching to improve overall flexibility, as well as calisthenics to build muscular strength and endurance. Physical activity intensity and patterns were assessed over the course of five days (Monday-Friday) using accelerometry. Comparisons were made between days when the before-school program took place (Treatment) and days when it did not (Control). Three different time blocks, before-school (PRE), school-day (SD), and after-school (AS), were compared. Pairwise t-tests were used to calculate the comparisons between these different time blocks for the Treatment and Control days. **Results:** Subjects achieved a significant increase of 5.4 minutes per hour of moderate-to-vigorous physical activity during the PRE time block during Treatment days when compared to the Control days ($p < 0.05$). When adjusting for arrival time to the program, subjects spent 76.2% of their time in activity (22.5% in moderate-to-vigorous physical activity and 53.7% in light activity) during Mornings in Motion sessions. Participants that attended Mornings in Motion for greater than or equal to 15 minutes on Treatment days saw an increase of 3.6 minutes in moderate-to-vigorous physical activity when compared to those that attended for less than 15 minutes. **Conclusions:** Overall, participation in the Mornings in Motion program resulted in greater MVPA compared to control days. Enforcing mandatory attendance for the full length of the program would increase its impact on physical activity levels. Future studies

should continue to use objective measures of physical activity as well as use direct observation methodology and examine a larger number of subjects.

TABLE OF CONTENTS

ABSTRACT.....	v
TABLE OF CONTENTS.....	vii
CHAPTER 1:	1
Research Question 1:	3
Hypothesis 1:	3
Research Question 2:	3
Hypothesis 2:	3
Research Question 3:	3
Hypothesis 3:	3
CHAPTER 2:	4
Introduction.....	4
Physical Activity.....	5
Physical Activity Assessment.....	7
Physical Education.....	11
School-Based Interventions	12
<i>Physical Education Enhancement</i>	13
<i>Classroom Activity Breaks</i>	14
<i>Recess Modification</i>	16
<i>After-School Programs</i>	18
<i>Before-School Programs</i>	19
CHAPTER 3: MANUSCRIPT	21
Abstract.....	21
Methods.....	24
<i>Activity Program</i>	25
<i>Data Collection</i>	26
<i>Physical Activity Assessment</i>	27
<i>Statistical Analysis</i>	28
<i>Results</i>	29
Discussion.....	33
CHAPTER 4:	40
REFERENCES	41
APPENDICES	47

APPENDIX A:.....	48
APPENDIX B:.....	50
APPENDIX C:.....	53
VITA.....	55

CHAPTER 1: INTRODUCTION

Currently, 31.7% of all U.S. children are classified as overweight and obese, with 16.9% designated as obese ¹. Weight status has been shown to track from childhood to adulthood ^{2,3}, indicating the critical importance of addressing prevention and treatment of increased weight status early in life. The current levels of overweight and obesity require a great deal of attention and action in order to combat this epidemic. It is well known that two factors that have the greatest impact on weight status are diet and physical activity level ^{4,5}.

Physical activity in combination with caloric restriction has been shown to be an effective means of preventing obesity, as well as treating individuals who are currently overweight or obese ⁶. As the intensity and duration of physical activity increases, a caloric deficit can occur which contributes to weight loss. Recent NHANES data show that boys and girls between the ages of 6 to 11 years accumulate an average of 45 and 26 minutes of moderate-to-vigorous physical activity (MVPA) per day, respectively. In addition, 42% of children meet the current physical activity recommendations of 60 minutes of MVPA per day ⁷. These statistics demonstrate that most U.S. children do not meet recommended physical activity levels.

Children spend an average of seven hours attending school during a typical weekday, making it an optimal setting for increasing physical activity. Due to No Child Left Behind legislation, there has been an increased focus on academics, which along with budget cuts and changes in curricula has actually led to a decreased focus on physical education ⁸. Schools provide an ideal environment for teachers and health professionals to administer interventions. Administrators tend to support before- and after-school intervention programs due to the fact that

they do not interfere with academic time. This study seeks to address the effectiveness of a before school activity program on increasing physical activity levels in primary school children

A before-school program, Mornings in Motion, has recently been implemented in a number of East Tennessee elementary schools and is intended to increase students' physical activity levels before the school day begins. This program was developed by Next Level Training (Knoxville, TN), an organization that also offers training to athletes from middle school through college. Next Level trainers are responsible for implementing the program by leading children through the before-school physical activity workout program. This program focuses on health related fitness through the implementation of aerobic activities, stretching to improve overall flexibility, as well as calisthenics to build muscular strength and endurance. Even though this program is voluntary, there are over 470 students enrolled in the program with approximately 150 students regularly attending each morning in the Monday, Wednesday, and Friday sessions at our target school. The program has been well received by the students, parents, and school administrators because it provides students with a fun way to be active instead of sitting in the cafeteria before school starts. The support of the administrative personnel also contributes to the program being promoted and successful in the school environment.

The main goal of this study is to objectively assess the physical activity levels of students on mornings when the Mornings in Motion program is offered, and on mornings when it is not. A secondary purpose of this study is to objectively assess physical activity levels during the school day and outside of school on days the program is offered compared to days the program is not offered. Specific research questions are as follows:

Research Question 1:

Do participants in the Mornings in Motion program accumulate higher levels of moderate-to-vigorous physical activity before school on days that they participate in the program versus on days when they do not?

Hypothesis 1:

Participants will accumulate higher levels of moderate-to-vigorous physical activity before school on days that they participate in the program versus days when they do not.

Research Question 2:

Do participants in the Mornings in Motion program accumulate greater amounts of moderate-to-vigorous physical activity during the school day on days when they participate in the program versus days when they do not?

Hypothesis 2:

Participants will accumulate higher levels of moderate-to-vigorous physical activity during the school day on days that they participate in the program versus days when they do not.

Research Question 3:

Do participants in the Mornings in Motion program accumulate greater amounts of moderate-to-vigorous physical activity after school on days when they participate in the program versus days when they do not?

Hypothesis 3:

Participants will accumulate higher levels of moderate-to-vigorous physical activity after school on days that they participate in the program versus days when they do not.

CHAPTER 2: REVIEW OF LITERATURE

Introduction

Childhood obesity is a serious health issue and is so widespread that it is referred to as an epidemic. Decreases in physical activity and increases in sedentary behavior are contributing increases child overweight and obesity levels in throughout most countries in the world⁹⁻¹⁷. In the United States alone, obesity levels have risen over the past three decades¹. Overweight and obesity classifications in children are defined by $\geq 85^{\text{th}}$ and 95^{th} percentile, respectively, using age- and sex- specific growth charts developed by the Centers for Disease Control and Prevention (CDC). Roughly 31.7% of all American children are now classified as overweight and obese, with 16.9% designated as obese. This places the prevalence of obesity and overweight in America's pediatric population at the highest in the world¹⁸. There are a variety of causes contributing to this problem.

One of the major contributors to pediatric obesity is insufficient physical activity. It is recommended that children between the ages of 6 and 11 years old obtain 60 minutes or more of moderate-to-vigorous physical activity each day [3, 11, 13]. Only 42% of children are currently meeting these established recommendations⁷. Increasing physical activity levels is a very important aspect of decreasing the incidence of childhood obesity and improving overall health. A potential way for health professionals and school administrators to target youth is the implementation of interventions during the school day since most children spend a large percentage of their waking time in this setting.

This literature review will focus on a number of key areas. A brief review of physical activity and its benefits will be conducted. Physical activity levels in children will also be

examined along with the current physical activity recommendations. There will also be an overview of the measurement of physical activity in children. An examination of physical activity interventions utilized in the pediatric population will be provided. These interventions include the enhancement and addition of physical education programming, classroom activity programs, recess modification, after-school programming, and before-school programming

Physical Activity

Physical activity is defined as “any bodily movement produced by skeletal muscle that results in caloric expenditure ¹⁹.” Exercise is defined as “planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness ¹⁹.” It is important to note the differences between these two terms as they are often used in place of one another. Children, especially younger children, typically do not engage in planned and structured activity but rather they participate in play that is sporadic and intermittent in nature ²⁰. Physical activity is an integral part of lifestyle interventions that are used to treat overweight and obesity ⁶.

Recommendations for the appropriate amount of physical activity in children have been developed by a number of organizations and agencies. Under the direction of the Divisions of Nutrition and Physical Activity and Adolescent and School Health of the Centers for Disease Control and Prevention and the Constella Group, Strong et al. ²¹ performed a systematic review of more than 850 articles with the goal of developing a set of physical activity recommendations for youth to yield beneficial health outcomes. The articles were examined to determine the impact that each set of recommendations had on a number of health outcomes such as cardiovascular health, body mass index, mental health, and musculoskeletal health. After

completing the review of materials the researchers recommended that school-age youth should participate in 60 minutes or more of moderate to vigorous physical activity each day that is enjoyable and developmentally appropriate.

These recommendations influenced the 2008 Physical Activity Guidelines for Americans. According to the recommendations from the United States Department of Health and Human Services (HHS) children and youth should engage in 60 minutes or more of moderate-to-vigorous physical activity each day with at least three days incorporating bone- and muscle-strengthening activities ²². The Community Guide Branch of the CDC cites a number of areas where research is lacking in the promotion of physical activity. The most pertinent area to this literature review is the effectiveness of a before-school physical education program to increase students' total daily activity levels ²³.

As mentioned earlier, there has been an overall decrease in the amount of physical activity that children participate in during an average day. Troiano et al. found that boys and girls between the ages of 6 to 11 years accumulated an average of 45 and 26 minutes of moderate-to-vigorous physical activity per day, respectively. Further findings indicated that only 49% of boys and 35% of girls in the 6 to 11 year old range accumulated 60 minutes or more per day of moderate-to-vigorous physical activity ⁷. It is important that children develop healthy physical activity patterns at a young age as these patterns have been shown to carry over into adulthood ^{17,24}. Physically active children are more likely to be active as adults and have a greater chance of being protected against the onset of cardiovascular disease in the future ^{17,25}.

Physical Activity Assessment

Physical activity levels are measured through various methods. However, assessing physical activity in children can be challenging. Methodologies for assessing physical activity are either subjective or objective in nature. Subjective methods include physical activity questionnaires and recalls. One of the more commonly used questionnaires is the Physical Activity Questionnaire for Children (PAQ-C)²⁶. This questionnaire was developed by Crocker et al.²⁷ to assess physical activity levels and patterns in youth throughout the school year and allow for comparisons to be made across the globe. The PAQ-C uses a set of nine questions to estimate the duration and intensity of a child's 7-day physical activity.

While some researchers use physical activity recall questionnaires, some cite that this method of physical activity measurement is far from representative of the true activity levels that the individual engages in on an average day^{7,28}. This can be attributed to the challenging nature of relying on a subject remembering the duration and intensity of their physical activity. Questionnaires also require a higher level of subject investment with regard to cognitive recall which may lead to possible errors in the report of physical activity. This is especially true for children.

Another method of physical activity measurement is the physical activity recall. This method requires children to recall activities that they performed in the previous day or days. There are a number of these instruments available. Two of the more commonly used physical activity recalls when studying children and adolescents are the Previous Day Physical Activity Recall (PDPAR) and the Three Day Physical Activity Recall (3DPAR). However, as with the questionnaire mentioned earlier, physical activity recalls can also over- or underestimate levels

of physical activity and requires children to remember the types, intensity, and amount of time they spent being physical active. Trost et al.²⁹ found that the PDPAR accurately estimated the time spent in vigorous physical activity but incorrectly quantified the time spent in moderate physical activity. Due to some of the limitations associated with using questionnaires and recalls, it can be necessary to use objective methodology in order to accurately assess activity levels in children.

In order to obtain objective measurements of physical activity in children, various activity monitors have been employed. The most commonly used device to assess time and intensity of physical activity in free-living children and adolescents is an accelerometer²⁸. An accelerometer is a small computer-based device that measures accelerations and converts these measurements to an electrical signal. These signals are then stored in the on-board flash memory and downloaded onto a computer terminal for analysis.

In a study by Trost et al.³⁰ researchers listed a number of choices that must be made prior to using an accelerometer in a research setting. There are a number of accelerometers available on the market today and therefore a variety of options to choose from when using such an activity monitor in a study. The ActiGraph accelerometer (Actigraph, Pensacola, FL) is one of the more widely used devices in field-based testing in children^{28,30}. In a review by Trost et al.³⁰, researchers examined a number of studies comparing the Actigraph to other accelerometers and found that the Actigraph has a high level of intra- and inter-instrument reliability. For the current study the GT3X and GT3X+ models will be used.

Another decision that must be made by researchers is where to position the device on the subject. The GT3X and GT3X Plus models offer settings to collect data from multiple locations

on the subject such as the waist, wrist, and even ankle. When choosing the position of the accelerometer, it is worth noting that some positions will offer a higher degree of accuracy than others³⁰. The two different Actigraph models being used in the current study each allow for different areas of placement on the body, but both allow for placement around the waist. The waist allows for accurate measurement of acceleration during activity for both models and has been cited as the most accurate location for activity estimation in youth in a number of studies³⁰.

When using accelerometers another technical aspect that must be considered is the epoch setting. Accelerometers record activity “counts” and quantify them over certain user-defined periods of time. The period of time is called an epoch. The epoch setting of the accelerometer can be crucial when trying to ascertain the physical activity levels and the distribution of that physical activity into varying intensities. If an epoch is set too high or too low the researcher risks incorrectly estimating the physical activity patterns of the subject or subjects. Until recently, the use of a 60 - second epoch was fairly consistent in most studies that dealt with youth populations^{31,32}. However, this epoch length has the potential to incorrectly classify children’s physical activity levels due to the intermittent nature of their activities. In fact, most physical activity bouts in children last between 3 and 22 seconds^{33,34}. For this reason, Trost et al.³⁰ recommended the use of 15-second epochs when examining physical activity patterns in children.

A common problem with using accelerometers comes when trying to convert the activity measurement to energy expenditure values for children and adolescents. The most common method is to determine intensity-related cut points from a regression equation to show the relationship between counts and energy expenditure. In a study by Trost et al.²⁸, five different

sets of ActiGraph cut points that have been developed for children were examined for their accuracy and validity. These five different sets of cut points were developed by Freedson et al.³⁵, Puyau et al.³⁶, Treuth et al.³⁷, Mattocks et al.³⁸, and Evenson et al.³⁹ A group of 206 subjects between the ages of 5 and 15 years participated in this study with the sample being evenly distributed across the age range with a nearly equal number of boys and girls. The subjects each performed a variety of activities that included “free-living” physical activities that are typically performed by children, and included ambulatory and intermittent activities. During these activities, participants wore an ActiGraph GT1M, and their VO₂ was measured breath-by-breath using the Oxycon Mobile portable metabolic system. After examining their results, the researchers concluded that using 15 second epochs and the cut points developed by Evenson that classify sedentary activity as less than 100 counts per minute, light activity as greater than 100 counts per minute, moderate activity as greater than or equal to 2296 counts per minute, and vigorous activity as greater than or equal to 4012 activity counts per minute were best suited for use in children and adolescents. These cut points provided the most accurate estimate of the time spent in sedentary, light-, moderate- and vigorous-intensity activity for these groups.

While accelerometers do provide accurate estimates of the time spent at various activity intensities for children when using the proper methodology, there are a few possible issues that researchers may have to consider when using accelerometers with children. If the accelerometer is given to a child for an extended period of time, the researcher has to try to ensure that the child wears the accelerometer each day. There is the issue of the child remembering to put on the accelerometer at the beginning of the wear period, usually early in the morning after they wake up, and making sure to place the accelerometer in the proper position. Parents and guardians are able to assist with this, but there is still a chance that the accelerometer will not be placed

correctly or worn at all. According to research by Trost et al.³⁰, a wear time of seven days is recommended when conducting accelerometer studies in children and adolescents. This wear time recommendation helps to account for the data collection time that can be lost through inconsistent wear patterns in children.

Physical Education

Physical education is defined as, “instruction in the development and care of the body ranging from simple callisthenic exercises to a course of study providing training in hygiene, gymnastics, and the performance and management of athletic games⁴⁰.” Physical education has been present in the educational system in the United States since the late 19th Century⁴¹. According to a review article by Pate et al., the actual dose of physical activity that a child will receive in a given physical education class is not well established and varies from program to program⁴¹. That being said, these programs do provide children with an opportunity to increase the amount of physical activity in which they will participate in a given day.

However, with the implementation of the “No Child Left Behind Act of 2001” many schools have had to choose between academics and physical education in order to meet the requirements of that legislation⁴². There is a great deal of pressure on school administrators and educators for their students to succeed academically. With this increased focus on academics 14% of school districts nationally report decreasing the time spent in physical education classes in order to accommodate a greater amount of time in the classroom focusing on Math and English⁸. Therefore, the method chosen to increase physical activity in youth should be both effective and not infringe on academic time.

Another aspect of physical education that requires focus is the quality of the program being implemented. Some programs may fail to meet regulations set forth by the state as nearly 26% of physical education classes in the United States fail to comply with state-mandated requirements⁴³. Also, physical education classes may not have a focus on promoting high levels of activity for all participants. In one study by Simons-Morton et al.⁴⁴, it was found that elementary school children spent only 8.6% of their time in physical education engaged in moderate to vigorous physical activity. For a 30-minute physical education class, this translates to roughly 2.5 minutes of moderate to vigorous physical activity. This is an area for improvement; using the time allotted for physical education more effectively to increase activity levels.

School-Based Interventions

Physical activity levels in schools have decreased drastically over the past few decades. Due to inadequate funding as well as other systemic changes there has been a reduction in the physical education classes as well as time spent being physically active in schools (i.e. recess)^{9,10,45}. This combined with increased availability of technology (internet, video games, etc.) have led to a decrease in overall levels of physical activity and increases in sedentary behaviors. School infrastructure and physical environment, policies, curricula, and staff have a chance of positively influencing a child's health^{9,10,45,46}. More than 95 percent of American youth aged 5 to 17 are enrolled in school⁴⁷. These children spend between seven and eight hours in the school setting, which accounts for a great deal of their waking hours on a given weekday. As such, no other institution has more contact with children during the formative years of their lives.

Children arrive and leave school at various times in the morning and afternoon due to differing circumstances. A number of children arrive at school early due to riding buses or being

dropped off by parents who have to get to their place of employment for the day. Children who receive free or reduced meals also arrive to school early so that they are able to eat breakfast. Some children also attend after-school programs as well because their parents or guardians are working full-time jobs, and do not want to leave their children unattended at home while they are at work.

There have been a variety of approaches used to increase physical activity levels of school-aged youth. As mentioned before, the amount of time that children spend in school makes the implementation of a school-based intervention a viable option. School-based interventions include enhancing and providing additional physical education programming, introducing activity breaks during academic classes, changing the duration and type of activity performed during recess, and implementing after- and before-school activity programs.

Physical Education Enhancement

Physical education enhancement interventions seek to take the physical education curricula that are currently in place in a school and make adjustments to help children attain recommended levels of moderate-to-vigorous physical activity. These adjustments include changing the duration of the physical education class, the frequency of offering the physical education program, altering the activities performed during the program, or some combination of these ^{16,48}.

A study conducted by Sallis et al. ¹⁶ assessed the effectiveness of a physical education intervention titled SPARK. This program took seven schools and randomly assigned them to having physical education programs led by a trained physical education specialist, physical education led by trained classroom teachers, or no adjustments to physical education. Physical

education specialists and trained classroom teachers conducted 30 minute exercise sessions three days per week. This study examined 955 students through two consecutive cohorts of fourth graders. Baseline measures were collected at the beginning of the school year and a follow-up measure collected near the end of the school year. Post-intervention, physical education specialist-led groups and trained classroom teacher-led groups accumulated an average of 22 minutes and 15 minutes of additional moderate-to-vigorous physical activity per week respectively, when compared to the control group.

Another program titled PE2GO was implemented in six different school systems across the United States. Martin et al.⁴⁹ conducted this intervention that reached 6000 fourth- and fifth-grade students. This physical education program sought to increase physical activity by providing training sessions to classroom teachers to allow them to lead effective physical education classes. Physical education specialists as well as trained teachers then led a recommended three physical education sessions per week for 30 minutes each. Data were collected at baseline as well as at mid-and post-intervention time points. Subjects accumulated an average of 23 minutes and 36 minutes of additional physical education time at mid- and post-intervention, respectively, when compared to baseline.

Classroom Activity Breaks

Classroom activity programs are interventions that incorporate a classroom based physical activity promotion program that integrates activity into the academic curriculum. This is usually accomplished by having a trained teacher or physical education specialist lead the classroom in a 10-minute activity break during the school day. Educators are often reluctant to incorporate activity breaks during class based on the assumption that they will lead to a decline

in academic performance in participants. However, when examining the results of the following studies, there is no evidence that supports this assumption.

TAKE10!⁵⁰ had the goal of increasing the physical activity levels of elementary school children by incorporating one or more 10-minute physical activity breaks into each school day. These breaks were in addition to current physical education classes and recess time. Teachers were asked to attend a 2-hour training session that instructed them on proper execution of the grade-appropriate activities including frequency, intensity, and duration. A group of students (n=71) from three classrooms from grades 1, 3, and 5 had their activity levels monitored with accelerometers. At the end of the week of monitoring, each class had participated in eight or nine activity sessions and gained 88.9 minutes (first grade), 91 minutes (third grade) and 86.1 minutes (fifth grade) of physical activity. Most of this activity during the activity sessions fell within the moderate-to-vigorous range as the MET levels (6.16 and 6.42 METs) across all grades.

Another program with activity breaks as the main focus is the Physical Activity Across the Curriculum (PAAC)⁵¹. This program recruited 26 elementary schools that were then randomly assigned to either the intervention or control group for a period of three years. The subjects in both groups were in grades 2 and 3 at baseline and 4 and 5 at conclusion. During this time children were given 90 minutes worth of activity breaks spread throughout the school week, in addition to the 60 minutes of physical education that they already received. A sample of 77 students from PAAC schools and 90 students from control schools wore accelerometers to measure their physical activity. Results indicate that students in the PAAC group gained an average of 26 minutes of moderate-to-vigorous activity per week when compared with the control group.

A program titled Promoting Lifestyle Activity in Youth (PLAY)⁵² incorporated physical activity breaks into the school day as well as placed an emphasis on the importance of physical activity in one's life. A total of 35 schools agreed to participate in the study with a total of 606 fourth grade students. Schools were assigned to one of four groups which included "PLAY & PE", "PLAY only", "PE only", and "No Treatment." Over the course of the 12 - week program, teachers led students through a 15-minute lesson each school day that promoted a physically active lifestyle as well as directly increasing physical activity levels. Physical activity was objectively measured through the use of a pedometer to count the number of steps that the participants accumulated. Students in "PLAY & PE" groups accumulated an additional 1,583 steps on average when compared to the "No Treatment" group.

Recess Modification

Recess modification interventions take the standard recess time built into the school curriculum and make adjustments to the duration of the time as well as its structure. While most recess time periods are fairly unstructured and children are allowed to do whatever they want, some interventions will actually incorporate staff training as well as a structured activity program during this time in efforts to increase activity levels in the participants.⁵³ The playground equipment available as well as the organization of the playground area may be modified⁵⁴.

A study by Ridgers et al.⁵⁴ examined the effects of modifying playground structure on physical activity levels in children. Subjects were randomly assigned to either the intervention (n=256) or control (n=214) groups based on the school they attended. The playground redesign incorporated "zoning" in which the playground was color-coded to match the intended activities in each area. There was a red "sports zone," a blue "multi-activity area," and a yellow "quiet zone." Additional equipment including basketball goals and soccer goals were added to the

“sports zone” and seating was added to the “quiet zone.” Physical activity levels were assessed through the use of heart rate monitoring and accelerometry. Baseline data was collected for both groups as well as at six week and six month time points. At the end of the study, children in the intervention group accumulated an average of 4.5% more time in MVPA during their recess sessions than did participants in the control group.

Another recess modification study, titled “Ready for Recess,” was conducted by Huberty et al.⁵³ Researchers implemented this intervention at two different schools to a group of 3rd, 4th, and 5th – grade students (n=93). The intervention included a staff training component, the separation of the playground into different activity zones, and the modification of available playground equipment. Baseline and post-intervention physical activity measures were collected using ActiGraph accelerometers. Post-intervention measures showed an increase of 21.4 minutes of moderate-to-vigorous physical activity throughout the school day.

Verstraete et al.⁵⁵ conducted a study to determine the effect of providing game equipment to children on physical activity levels during morning recess and school lunch break. This equipment included jump ropes, a variety of balls, plastic hoops, badminton sets, and numerous other items. Seven elementary schools were included in this study with a total of 235 students participating in the study. The students were randomly assigned to either the intervention or control group based upon their school. Physical activity levels were measured at baseline and three months after the intervention had been in place through the use of accelerometry. At the 3-month time point, children in the intervention group accumulated 13% more time in MVPA during morning recess and school lunch breaks.

After-School Programs

One popular method of increasing levels of physical activity in youth is by providing an after-school program. These programs tend to keep students for a period of time after school dismisses and promote activity through group exercise, team sports, or some other activity⁵⁶. Some programs will even add an educational component that will help to enforce the importance of physical activity for health and well-being⁵⁷. A major downside to after-school programs is the potential for transportation issues, since mass transportation like school buses will have already ceased operating so parents and educators have to find alternative means for returning students to their homes^{56,57}.

Sports to Prevent Obesity Randomized Trial (SPORT) is an after-school program implemented by Weintraub et al.⁵⁶ that targeted obese children through a 6-month supervised soccer program. The program was offered 3-4 days per week with each session lasting for roughly 75 minutes. Participants were randomly assigned to either the “intervention” group or the “active placebo” control group. The intervention group’s program included warm-up, stretching exercises, and soccer skills practice. Participants saw significantly higher physical activity levels than those in the control group with increases of 10.6 minutes and 4.4 minutes for moderate physical activity and vigorous physical activity respectively.

Howe et al.⁵⁸ conducted an after-school program targeting young African American boys (n = 106) from the 3rd through 5th grade. After collecting baseline data, the students were randomized into either an intervention or control group. The control group received no encouragement to make any sort of changes to their lifestyle. The intervention group received a 2-hour intervention for 10 months. During this intervention, participants were given 30 minutes to do some of their homework and then 80 minutes of physical activity. The 80 minutes were

broken up into 25 minutes of skill development, 35 minutes of vigorous physical activity, and 20 minutes of toning and stretching exercises. Each of these components was separated by a five minute break. Activity was deemed vigorous if the children's heart rate was at least 150 beats per minute, as assessed by a heart rate monitor. At the end of the 10-month program, the subjects in the intervention group that attended more than 60% of the programs had an average increase of 34.8 min per day of moderate-to-vigorous physical activity.

Dzewaltowski et al.⁵⁹ conducted the HOP-N After-School Project over the course of three years in seven schools. Across the three-year time-span 951 3rd to 4th grade students participated in the study. The physical activity program lasted for 30 minutes per day and was modeled after the Child and Adolescent Trial for Cardiovascular Health (CATCH)⁶⁰ physical activity program. Accelerometers were used to assess physical activity levels in participants. Overweight children in the intervention groups performed roughly six minutes more moderate-to-vigorous physical activity per day at the conclusion of the intervention when compared to baseline measurements. Intervention sites also saw 14.2 minutes per day more time being physically active than the control groups at the end of the second year.

Before-School Programs

Before-school programs take place prior to the start of the school day. Some of these programs will take the place of "bus hall," in which students are mostly sedentary. Bus hall is a time when students are dropped off early at school by parents before they go to work, or arrive early due to riding the bus. This is a period of time that an intervention can be implemented to increase physical activity without interfering with the school day. Most before-school programs target active transportation to-and-from school ⁶¹.

Mendoza et al.⁶¹ used the walking school buses and incorporated active commuting as a method to increase physical activity in youth. Researchers assessed baseline physical activity levels in 4th-grade students (n=149) from eight schools. Students were then randomly assigned to intervention or control groups at the school level. The intervention schools participated in a walking bus route to school each morning for 4 weeks. Children also walked home from school following the same route. At the end of the 4-week period, children in the intervention group saw an average of a seven minute per day increase in moderate-to-vigorous

In reviewing the literature, the number of before-school activity programs was limited. The current study follows a different before-school approach. As mentioned earlier, an area that CDC cites as needing research is the effectiveness of a before-school physical education program to increase students' total daily activity levels. The purpose of this current study is to examine the effectiveness of the Mornings in Motion activity program on increasing the physical activity levels of the participating students.

CHAPTER 3: MANUSCRIPT

Abstract

Purpose: To objectively assess the physical activity levels of students during three different time blocks on days when the Mornings in Motion before-school activity program is offered, and on days when it is not. **Methods:** Subjects were 69 elementary school children (8.5 ± 1.9 years) who were all apparently healthy. Subjects were all enrolled in the Mornings in Motion before-school physical activity program that was offered on Mondays, Wednesdays, and Fridays. The program focuses on health related fitness through the implementation of aerobic activities, stretching to improve overall flexibility, as well as calisthenics to build muscular strength and endurance. Physical activity intensity and patterns were assessed over the course of five days (Monday-Friday) using accelerometry. Comparisons were made between days when the before-school program took place (Treatment) and days when it did not (Control). Three different time blocks, before-school (PRE), school-day (SD), and after-school (AS), were compared. Pairwise t-tests were used to calculate the comparisons between these different time blocks for the Treatment and Control days. **Results:** Subjects achieved a significant increase of 5.4 minutes per hour of moderate-to-vigorous physical activity during the PRE time block during Treatment days when compared to the Control days ($p < 0.05$). When adjusting for arrival time to the program, subjects spent 76.2% of their time in activity (22.5% in moderate-to-vigorous physical activity and 53.7% in light activity) during Mornings in Motion sessions. Participants that attended Mornings in Motion for greater than or equal to 15 minutes on Treatment days saw an increase of 3.6 minutes in moderate-to-vigorous physical activity when compared to those that attended for less than 15 minutes. **Conclusions:** Overall, participation in the Mornings in Motion program resulted in greater MVPA compared to control days. Enforcing mandatory attendance for the

full length of the program would increase its impact on physical activity levels. Future studies should continue to use objective measures of physical activity as well as use direct observation methodology and examine a larger number of subjects.

Introduction

Childhood obesity rates have reached epidemic proportions in the U.S. In the 6-11 year old age group, 32.6% of American children are classified as overweight and obese, with 14.6% designated as overweight and 18.0% as obese.¹ Physical activity has been shown to be an effective means of preventing obesity, as well as treating individuals who are overweight and obese.^{6,21,62,63} It is recommended that children participate in at least 60 minutes of developmentally appropriate, moderate-to-vigorous activity on a daily basis.^{21,22} In 2008, the National Health and Nutrition Examination Survey (NHANES) data showed that boys and girls between the ages of 6 and 11 years accumulated an average of 45 and 26 minutes of moderate-to-vigorous physical activity per day, respectively. In addition, only 42% met recommendations for daily physical activity.⁷ Due to the fact that children spend a large portion of their waking hours in a school environment, the school day provides an excellent opportunity to assist children in meeting physical activity recommendations.

Schools are potential settings for physical activity interventions to be implemented. Some interventions try to incorporate increased physical activity during the school day.^{55,56,59,60} However, due to the emphasis placed on academic time and achievement on standardized tests, it may be difficult to implement programming during the school day. Administrators tend to support before- and after-school programs more readily due to the fact that they do not interfere with academic time. After-school programs keep students for a period of time after school dismisses and get them active through group exercise, team sports, or some other activity.⁵⁶

These programs do offer an opportunity for participants to achieve increased levels of physical activity, with some of the programs accomplishing this goal successfully.⁵⁶ A major downside to after-school programs is the potential for transportation issues, since mass transportation like school buses will have already ceased operating so parents and educators have to find alternative means for returning students to their homes.^{56,57} Before-school programs are not widely utilized, but serve as a viable option for teachers and health professionals to increase children's activity levels.⁶¹

Mornings in Motion is a before-school program that is currently being implemented in a number of elementary schools in East Tennessee to increase students' levels of physical activity. With the assistance of trainers from Next Level Training (Knoxville, TN) children are led through a voluntary, before-school physical activity workout program in the school gymnasium. There is a focus on health related fitness through the implementation of aerobic activities, stretching to improve overall flexibility, as well a variety of calisthenics to build muscular strength and endurance. This program has received a great deal of recognition since its inception in early 2010, including the National Healthy Living Innovation Award from the U.S. Department of Health and Human Services. The Mornings in Motion program was recognized by First Lady, Michele Obama as being the top K-12 school fitness program in the country. The program also won the P.E. Best Practice Award; Tennessee Ambassador of Goodwill; Rural Health Association of Tennessee Special Exemplary Project Award.

This study seeks to address the impact of a before-school activity program on physical activity levels in elementary school children. There are very few studies that have examined the impact of before-school activity programs. This program's ability to reach a large number of students at one time with its availability to all students, its relative cost-effectiveness of needing

very little staff or equipment, and the diversity of the routines performed, along with other unique aspects, warrants measuring the changes in physical activity with participation in the program. Therefore, the purpose of this study was to determine whether participants accumulate higher levels of moderate-to-vigorous physical activity (MVPA) before school on days when they participate in Mornings in Motion and days when they do not. A secondary purpose of the study was to assess any increases in the amount of MVPA during the school day on days when participants participate in Mornings in Motion and days when they do not.. The third purpose of this study was to assess any increases in the amount of MVPA during after school on days when participants participate in Mornings in Motion and days when they do not.

Methods

Study Participants

Participants were 69 children (ages 5-10 years old) enrolled in a single elementary school in East Tennessee. The student population is diverse in its socioeconomic status and racial/ethnic makeup. Over 67% of the students in this school are categorized as economically disadvantaged based upon data collected by the school system. Race/ethnicity distribution of this elementary school is as follows: 60.2% Caucasian, 24.5% African American, 10.6% Hispanic, 3.2% Asian / Pacific Islander, and 1.4% Native American / Alaskan. Children from grades K-4 were represented and there was an equal distribution of boys and girls (n=35 and n=34, respectively). Students who were enrolled in the Mornings in Motion program were recruited at the elementary school through letters and permission forms sent home to their parents or guardians. Students who returned parental permission forms and provided verbal assent were included as potential participants in the study. This study was approved by the University of Tennessee, Knoxville Institutional Review Board.

Activity Program

Mornings in Motion is a before-school physical activity program that is offered Monday, Wednesday, and Friday mornings every week. This program, which takes place in the school gymnasium, begins at 7:45AM each morning and ends at 8:15AM. Trainers from Next Level Training (Knoxville, TN) lead the students through a program that incorporates a variety of exercises. There is a focus on increasing muscular strength and endurance, flexibility, and cardiovascular endurance through the use of plyometrics, dynamic stretching, and aerobic activities, respectively. The trainers focus on keeping the children constantly moving throughout the 30-minute time block. Students perform a warm-up activity each morning which usually involves dynamic stretching. Following the warm-up, students move into plyometrics, core and muscle toning, and aerobics. The last five minutes are devoted to stretching the muscles that were focused on through the morning's activities. Children are able to participate regardless of personal fitness levels and are encouraged to move from the time the program begins until its conclusion. Table 1 contains a list of the typical activities performed during a session of Mornings in Motion.

Activity	Repetitions/Duration
Stretching	2 Minutes
Running in Place	30 Seconds
Burpees	10 Repetitions
Jumping Jacks	15 Repetitions
Push-Ups	10 Repetitions
Jumping in Place	30 Seconds
Crunches	15 Repetitions
Running in Place	30 Seconds
Burpees	10 Repetitions
Jumping Jacks	15 Repetitions
Push-Ups	10 Repetitions
Running in Place	30 Seconds
Stretching/Cooldown	5 Minutes

Data Collection

Data collection occurred over a six-week period during the fall (October – December). Each week a group of subjects were assessed from Monday morning at 7:45 AM to Friday morning at 8:15 AM that same week. Investigators visited on Monday, Wednesday, and Friday to distribute accelerometers, assess wear consistency, and collect accelerometers, respectively.

Investigators arrived at the school at 7:15 AM, before the Mornings in Motion program began each Monday morning. Verbal assent was obtained from each child to ensure that they comprehended their involvement in the study as well as their comfort with participation. If a child was unwilling to participate on the first day of data collection the child was asked again the following week to see if they had changed their mind. However, if they still did not want to participate then they were removed from the list of potential participants.

Next, each child was fitted with an accelerometer attached to an elastic belt and given instructions on how to adjust the belt and when to wear it. The children were instructed to wear the belt and accelerometer during all waking hours and to remove the belt while sleeping and any type of water activity (shower, swimming, etc.). These instructions were also presented to the child in a printed format to give to their parents or guardians along with the researcher's contact information should the parents or guardians have questions regarding the belt and accelerometer. Investigators returned on Wednesday mornings to confirm that the participants were wearing their accelerometers and accelerometer belts. If a child was not wearing his/her belt, the investigators placed a new belt on the child and s/he was reminded to return both belts on Friday. On Friday, at the conclusion of the Mornings in Motion program, the accelerometers and belts were collected from the participants.

Physical Activity Assessment

The Actigraph GT3X and GT3X+ (Pensacola, FL) were used to assess each participant's physical activity throughout the course of this study. These monitors are tri-axial in their design which allows for collection of acceleration data in all three planes of movement. The accelerometers were initialized each week before data collection began and set to 15-second epochs and the low frequency extension (LFE) setting in order to capture the children's activity with a high level of accuracy. The cut points used to determine intensity of activity were developed and validated by Evenson et al.³⁹ and are appropriate for this population. These cut points classify sedentary activity as less than 100 counts per minute, light activity as greater than 100 counts per minute, moderate activity as greater than or equal to 2296 counts per minute, and vigorous activity as greater than or equal to 4012 activity counts per minute.

An Actigraph was attached to an elastic belt placed around the participant's waist. It was positioned over the right hip and worn from the time of arrival before school on Monday morning to 8:15AM Friday morning. The Actigraph was then collected and the data were downloaded using ActiLife software (version 5.10.0). The physical activity data were then sorted into the four different categories (sedentary, light, moderate, and vigorous) as using the Evenson et al.'s cutpoints.³⁹

These data were then grouped into days in which Mornings in Motion occurred (Monday and Wednesday) and non-Mornings in Motion days (Tuesday and Thursday) for each subject. Each subject served as his/her own control. Three different times were examined on each day: the time in which Mornings in Motion would take place before school (7:45AM – 8:15AM); the school day (8:30AM – 3:30PM); and after-school (3:30PM – removal of accelerometer for bed). After the time for treatment and control days were divided into these three time slots, the average

number of minutes that each subject spent in sedentary, light, and MVPA were calculated for each time point for treatment and control days. Finally, the data for the Treatment days was broken down into two categories. The subjects that arrived within the first 15 minutes of the Mornings in Motion program were placed in one group and the subjects that arrived with less than 15 minutes remaining were placed in the other. This dichotomization was created to allow for an examination of the impact the length of attendance had on results that the program produced.

A day was considered to be valid if the subject wore the accelerometer for at least 10 hours. A subject's data were included in statistical analyses if they had at least one valid treatment day and at least one valid non-treatment day. Subjects with more than valid treatment or non-treatment day had the values for these days averaged together for use in statistical analyses. Since a comparison was being made between three different time blocks with different durations, the average amount of time spent at the various activity levels was calculated on a minute per hour basis. This was done by taking the 30 minutes prior to the start of the school day multiplying the data collected by two. Time spent in the school day and after school time blocks was averaged to minutes per hour by adding all of the minutes spent at each activity level per respective time block and then dividing those totals by the number of hours that each time encompassed. This allowed for a common method of comparison to be able to be used between all three times.

Statistical Analysis

Means and standard deviations were calculated for all data. Paired-samples t-tests were used to calculate the effect of treatment (Mornings in Motion days) and control (non-Mornings in

Motion days) on physical activity levels for the before-school, school day, and after school time blocks. Independent-samples t-test were used to calculate the difference in effect of attending the program during a treatment day for 15 minutes or more and attending the program less than 15 minutes. A frequency analysis was used to examine the number of minutes of MVPA each subject was accumulating to form distribution tables for the Treatment and Control days as well as to form distribution tables for those attending the program during a treatment day for 15 minutes or more and attending the program less than 15 minutes. An alpha level of 0.05 was used to determine significance in both t-test analyses. All statistical analyses were performed using SPSS (Version 19).

Results

After examining the physical activity data, 51 subjects had valid days of physical activity in both the treatment and control categories. The average age of the sample was 8.5 years and 28% were classified as overweight or obese. The average minutes per hour of time spent at each activity intensity level (sedentary, light, MVPA) were examined for the three different time points. These time points were the 30 minutes prior to the start of the school day (PRE), during the school day (SD), and time after school (AS). Data were compared at these time points for the days the students participated in the Mornings in Motion program (Treatment) and the days they did not (Control). The mean number of minutes per hour spent at each activity intensity level for each of the three time blocks is shown in Table 2. Students spent a significantly greater amount of time in MVPA ($p < 0.05$) during the treatment day compared to the control day during the (PRE) time period. There were no significant differences between the two conditions for any of the other time periods.

Activity Intensity	Treatment (PRE)	Control (PRE)	Treatment (SD)	Control (SD)	Treatment (AS)	Control (AS)
Sedentary	29.2 ± 10.4	32.2 ± 8.9	32.3 ± 7.5	35.1 ± 8.8	29.9 ± 6.4	32.6 ± 8.4
Light	21.9 ± 5.9	24.1 ± 7.9	24.0 ± 5.3	21.9 ± 7.6	24.8 ± 4.7	22.7 ± 6.6
MVPA	8.9 ± 6.6*	3.7 ± 2.4*	3.7 ± 1.9	3.0 ± 1.7	5.3 ± 2.8	4.7 ± 2.7

* denotes significant differences between Treatment and Control ($P < 0.05$)

Figure 1 shows the mean percentage of time spent in sedentary, light, and MVPA per hour during the PRE time block for both the treatment and control groups, respectively. Since participants arrived sporadically throughout the program, the PRE time block was examined further. On the treatment days subject arrival time was accounted for to see the effect it had on the distribution of time spent at the different activity intensities. Figure 2 shows the PRE time block on treatment days after adjusting for subject arrival time. This figure shows the average percentage of time spent at various activity levels throughout the time subjects were actually present for the program. On average, the children spent approximately 76% percent of the time in the program engaged in either light or MVPA.

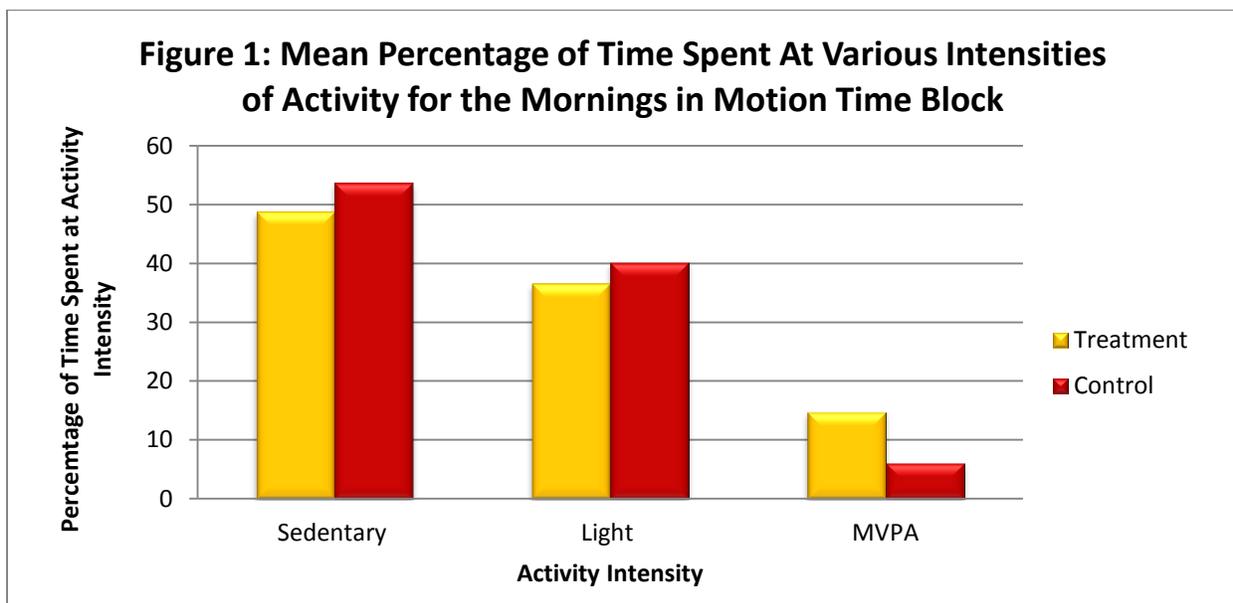
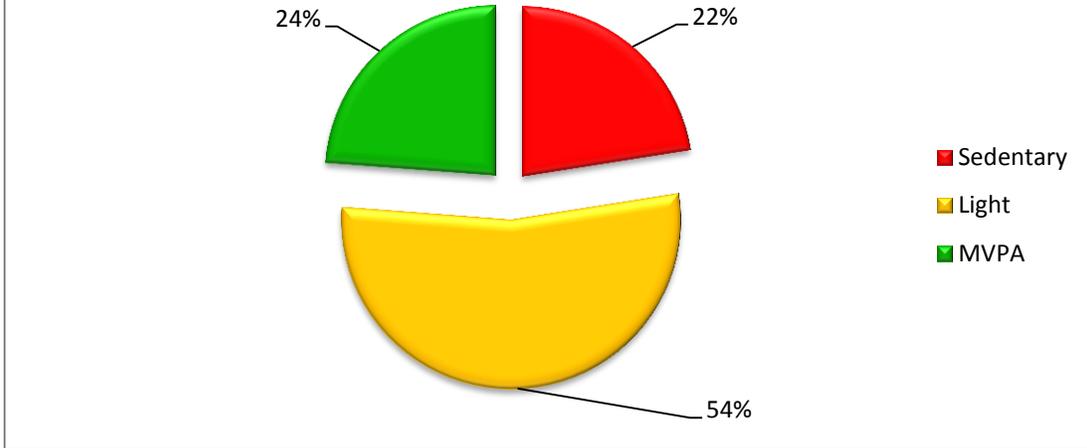
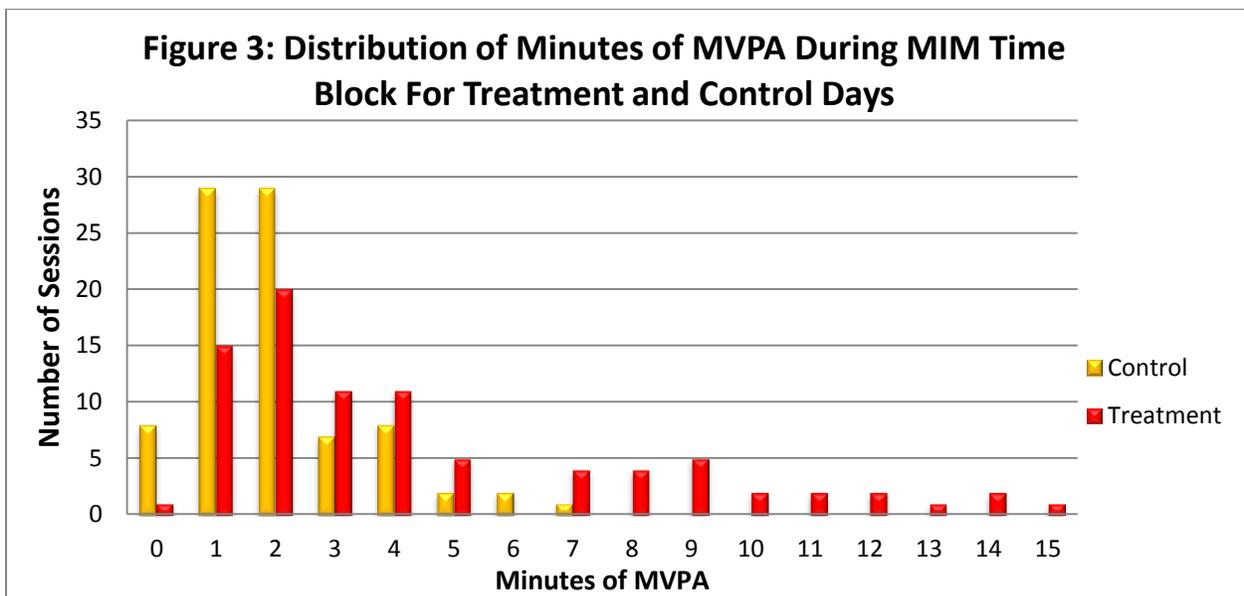


Figure 2: Distribution of Activity Intensity During Time Spent in Mornings in Motion



Data was also examined to see the distribution of subjects into categories based on the number of minutes of MVPA they accumulated during the Mornings in Motion time block on both Treatment and Control days. The data of each subject on each day were treated as separate data points. Figure 3 provides a visual of the distributions of the Treatment and Control groups respectively.

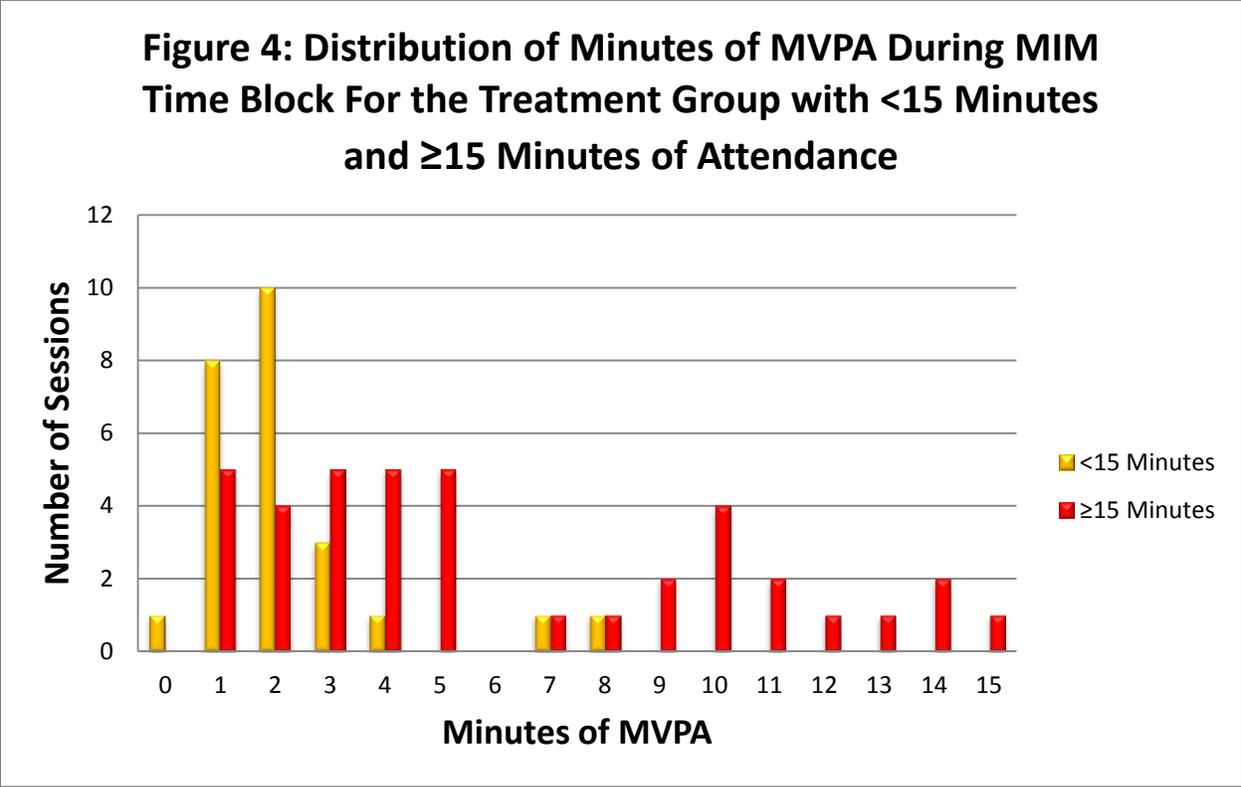
Figure 3: Distribution of Minutes of MVPA During MIM Time Block For Treatment and Control Days



Finally, the data for the treatment days was broken down into two categories. The subjects that arrived within the first 15 minutes of the Mornings in Motion program were placed in one group and the subjects that arrived with less than 15 minutes remaining were placed in the other. Data were compared between these two groups to show the actual number of minutes spent at each activity intensity level. Students spent a significantly greater amount of time in MVPA ($p < 0.05$) when 15 minutes or more remained in the program versus when there was less than 15 minutes remaining as seen in Table 3.

Table 3: Minutes Spent at Various Intensities for The Intervention Group During Mornings in Motion (mean \pm SD)		
Activity Intensity	< 15 Minutes of MIM	\geq 15 Minutes of MIM
Sedentary	19.1 \pm 5.8	12.3 \pm 7.0
Light	8.8 \pm 4.8	11.9 \pm 4.4
MVPA	2.0 \pm 1.8	5.6 \pm 4.4*
* denotes significant differences between Treatment and Control ($P < 0.05$)		

Data was also examined to see the distribution of subjects into categories based on the number of minutes of MVPA they accumulated during the Mornings in Motion time block for both the less than 15 minutes and the greater than or equal to 15 minutes groups. The data of each subject on each day were treated as separate data points. Figure 4 provides a visual of the distributions of the less than 15 minutes and the greater than or equal to 15 minutes groups respectively.



Discussion

The purpose of this study was to determine whether participants accumulate higher levels of MVPA before school on days when they participate in Mornings in Motion versus days when they do not. A secondary purpose of the study was to assess any changes in the amount of MVPA during the school day on days when participants participate in Mornings in Motion versus days when they do not. The final purpose of the study was to assess any changes in the amount of MVPA after school on days when participants participate in Mornings in Motion versus days when they do not. The current study revealed a significantly greater amount of moderate-to-vigorous physical activity before school on days when subjects participated in Mornings in Motion but no difference during the school day or after school.

This study is unique to the literature because there are limited data on activity levels in programs that take place before the start of the school day. Previous literature shows a focus on during and after-school interventions to increase physical activity levels. Generally, after school programs show an increase in MVPA between 2.9 and 34.8 minute per day.¹¹ While some of these programs show greater increases than that of the current study, it should be noted that these programs vary in their duration from 30 minutes and 80 minutes. Also, after-school programs face possible transportation issues with their participants. These problems can limit the number of children that are able to participate. The current program can serve more students since it does not face these issues. However, sporadic arrival time can be an issue with the current program.

It was hypothesized that the students would engage in significantly more MVPA before school with participation in a morning activity program. The results demonstrate significantly greater MVPA with participation in Mornings in Motion versus control days. During days when Mornings in Motion occurred, subjects saw an average increase of 5.2 minutes per hour in MVPA when compared to the control days. When adjusting for arrival time to the program, subjects spent 76.2% of their time in activity (22.5% in MVPA and 53.7% in light activity) during Mornings in Motion sessions. Those subjects that attended Mornings in Motion for greater than or equal to 15 minutes saw an increase of 3.6 minutes in MVPA when compared to those who attended the program for less than 15 minutes. The Walking School Bus, another morning program, saw a seven minute increase in MVPA per day⁶¹. However, it should be noted that The Walking School Bus contained an after-school element as well and was only available to students who lived within a certain radius of the school. Mornings in Motion is available to all students who attend the school in the current study, which increases its potential to reach a greater number of students.

The second and third hypotheses were that there would be a significant increase in the amount of MVPA throughout school day and during the after school time block, respectively, with participation in a morning activity program. The results do not show a significant increase throughout the course of the day as a whole. A change in activity levels during the school day would be unexpected as it is highly structured and the program does not make any changes to this structure. There was a marginal, non-significant, increase in the activity levels during the after school time block. This is similar to findings by Dale et al.⁶⁴ in which researchers examined the physical activity patterns of elementary school children. Children were exposed to “active” and “restricted” school days in which they were given or denied physical activity respectively. On “active” days when subjects were exposed to activity during the school-day there was also significantly increased activity found in the after-school period. On “restricted” days the subjects actually saw reduced activity during the after-school period. The lack of significant differences in the after-school time block in the current study is most likely due to the fact that subjects were not denied all opportunity for physical activity on control days. They were simply not participating in the Mornings in Motion program.

When examining the distribution of minutes spent in MVPA for subjects during the Treatment and Control days within the Mornings in Motion time block, there are few subjects that spent more than four minutes in MVPA on Control days. The majority of the subjects on the Control days spent between one and two minutes in MVPA during the Mornings in Motion time block. However, the subjects’ data from Treatment days demonstrated a greater amount of time in MVPA with values as high as 15 minutes of time being spent in MVPA. The average amount of time spent in MVPA on Treatment days was significantly higher than Control days. The Treatment days were split into those subjects that spent greater than or equal 15 minutes

attending Mornings in Motion and those subjects that spent less than 15 minutes in Mornings in Motion. The distribution of minutes spent in MVPA for these two groups was examined as well with the less than 15 minutes group achieving between one and three minutes in MVPA for a large number of the subjects in that group. The greater than or equal to 15 minutes group achieved between one and five minutes of MVPA for a large number of their participants. A number of these participants achieved a higher number of minutes with some getting between seven and 15 minutes. These breakdowns show the increased number of minutes that a participant can achieve when they attend Mornings in Motion for the majority of the session. The concluding minutes of the session are spent cooling down and stretching which does not yield many minutes in MVPA.

This intervention does not infringe upon academic time during the school day. It also does not require special arrangements to be made for transportation which is a problem that a number of before or after school programs encounter. Although students are not required to attend this program, more than 100 students regularly participate in the program on the mornings it is offered. The program is also safe for participants since it takes place in the school under the guidance of professional instructors and teachers. There is a low level of subject burden associated with participation in this program as the students don't have to learn any specific pattern or routine. Students do have to learn new skills initially when starting the program. Additionally, the instructors provide a variety of activities of differing intensities and durations that engages the students and reduces boredom during the program. These aspects make before school programming an attractive option for a physical activity intervention, which can be disseminated to a large group of children in a relatively small space. These characteristics demonstrate the potential for programs of this nature to be implemented in schools throughout

the country. However, it is important to note that unless the instructor donates their time for free, implementing such a program does cost the school system some money.

The current program is particularly interesting in that it has the potential to significantly contribute to the activity needed to meet the current physical activity recommendations. The results show that there is an increase in the physical activity levels of the participants on the mornings that the program is offered. This is an important benefit that may help to prevent or reduce obesity levels in this group. Also, the activities in the program focus on increasing flexibility, muscular strength and endurance, and improving aerobic endurance. The variety of activities allows for participants to learn the importance of physical activity for their overall health. The activities in the program also contribute to the achievement of the recommendations for at least three days of bone and muscle strengthening activity.²²

There are many strengths of this study. The use of accelerometers allowed investigators to objectively quantify the amount of time and the intensity of physical activity that each student performed. Also, most of the children tested were known to be regular attendees based upon information gathered from previous sign-in sheets before the start of the study. The current program is an award-winning program, including national and local awards, that is well-established and has been used in the school for over a year, which allows the children to have a high familiarity with the activities being performed.

A major limitation of this study is the small sample size. The 51 subjects included in the analysis make it difficult to generalize the results due to the small, limited sample. Another limitation was the sporadic arrival of the children to school throughout the school week. A large number of children are dependent upon the school bus for transportation to and from school. If there is a delay with the bus then the children may potentially arrive later and therefor have less

time to participate in Mornings in Motion before the start of the school day. In fact, if delayed long enough, some children were not able to participate in the program. Additionally, some of the activities performed involved mostly motion of the upper body, like pushups, and therefore the accelerometers would not be able to pick up activity that would otherwise be classified as MVPA. Distributing the accelerometers to the children and having to count on them to remember to wear it throughout the week served as another limitation. As mentioned earlier, investigators attended each morning that the program took place in order to ensure proper accelerometer placement and wear, but did not do so on off-days. Due to this fact, there was no way to determine the true accelerometer wear pattern until after the data had been downloaded at the end of each week of data collection. Without being able to enforce a specific wear pattern, a number of days of data were found to be invalid. Most subjects had at least one Treatment and one Control day to use but some subjects did not have enough valid days to be able to be used in the data analysis.

The main objectives of this study were to determine the potential increases in MVPA before school with participation in a morning activity program, to assess any increases in the amount of MVPA throughout the school day, and to assess increases in the amount of MVPA throughout the after school time period on days with participation in a the same activity program. A significant increase in MVPA before school was found with participation in Mornings in Motion but no significant increases during the school day or after school. The results obtained in this study reinforce the potential viability of this and other morning programs. Significant increases in MVPA were seen even with attendance being inconsistent for some subjects. If attendance to the entirety of the program could be more highly enforced, there would likely be more significant results. With many schools offering free - or reduced – price breakfast programs

and a bus hall in the morning before school begins, morning programs should be considered as a legitimate option to increase physical activity levels in children.

CHAPTER 4: CONCLUSIONS

The main objectives of this study were to assess the impact of the before-school physical activity program, Mornings in Motion, on the activity levels of participants in the program. This impact was examined for the before-school, during school, and after-school time periods. A significant increase in MVPA was seen when on Treatment days during the before-school time block when comparing the average time in MVPA per hour across all three time blocks. Future studies should continue to use objective measures of physical activity, including direct observation, as well as examine a larger number of subjects. An attempt should also be made to incorporate methodology to increase parental buy-in to increase the number of valid wear days to allow for a more powerful statistical comparison.

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APPENDICES

APPENDIX A:
Parental Introduction Letter

November 9, 2011

Dear Parent,

The purpose of this letter is to invite you to permit your child to participate in a research study entitled: *Assessment of physical activity levels of elementary school students participating in the Mornings in Motion© before school program*. This study will be open to all children enrolled in grades K – 4 at the Willow Brook Elementary School who participate in the Mornings in Motion© program. The specific details of the study are provided in the attached consent form. This study is being conducted by Dawn Coe, Ph.D., a pediatric exercise physiologist from the Department of Kinesiology, Recreation, and Sport Studies. Please contact Dr. Coe with any questions concerning this study (phone: 865-974-0294, email: dcoe@utk.edu).

Thank you for your consideration.

Regards,

Dawn Coe, Ph.D.

APPENDIX B:
Parental Informed Consent

Permission to Take Part in a Research Study

Title: Physical activity levels and patterns of activity during an elementary school day.

Principal Investigators: Dawn P. Coe, Ph.D.

David R. Bassett, Jr., Ph.D.

Dixie L. Thompson, Ph.D.

Co-Investigators: Andrew Howard, B.S.

Your permission is required for your child to take part in a research study. This permission form explains the purpose and requirements of the study. Please read this form carefully. You will be given a chance to ask questions. If you decide to permit your child to be in the study, you will be given a copy of this form.

Why is this study being done?

This study is being done to assess physical activity levels of elementary school students participating in the Mornings in Motion© before school program.

How long will the study last?

Your child's participation in the study will last five (5) consecutive days (Monday – Friday).

How many people will be in the study?

Up to 300 children, enrolled at Willow Brook Elementary School and participating in the Mornings in Motion© program will be involved in the study.

What will my child do during the study?

During the study, your child will be fitted with a physical activity monitor. The physical activity monitor is a small box, the size of a small pager that is worn on a belt around the waist. The monitor will be worn daily for one school week (Monday – Friday). The monitors will be put on your child on Monday morning before the Mornings in Motion© session and will be taken off of your child on Friday morning after the Mornings in Motion© session. The monitor will be worn at school as well as at home. Your child will not keep the monitor once the study is completed. You will be given a document that shows proper placement of the monitor and contact information in the event that you have a question regarding the monitor.

What are the risks to my child as a participant in the study?

Risks associated with this study are minimal. Your child may experience mild skin irritation from the belt that contains the physical activity monitor in the event that it slides up over their pants. We will instruct your child how to adjust the belt to avoid this situation from occurring.

Are there any benefits to my child for taking part in the study?

There are no direct benefits to your child from this study. However, the results will help us to understand more about the level of physical activity during your child's typical day.

Who do I call if I have questions about the study?

Questions about the study should be directed to Dawn Coe, Ph.D.: 865-974-0294 (Phone #), dco@utk.edu (E-mail) and if needed, a meeting can be set up. Questions about your child's

rights as a research participant should be directed to the University of Tennessee, Knoxville, Office of Research Compliance Officer at 865-974-3466.

Will anyone know my child is in the study and how is my child’s identity being protected?

A record of your child’s participation in the study will be kept private and all data will be kept in a confidential file in a locked cabinet in a locked University of Tennessee faculty office for three (3) years following the completion of the study. After that, your child’s data will be destroyed. Only the co-investigators will have access to your child’s data. Study results may be prepared for presentation at professional meetings and for publication in journals. However, none of your child’s personal information will be revealed. Therefore, your child’s identity will be protected.

What if my child does not want to be in the study?

If your child does not wish to participate or becomes upset on one of the testing days, we will attempt to console and comfort your child, and try to collect data on another week. If your child does not wish to participate or becomes upset again during the next week, your child will be removed from the study. Additionally, if your child decides that s/he no longer wants to participate in the study, we will remove your child from the study.

PERMISSION OF PARENT OR GUARDIAN

I have read or have had read to me the description of the research study. The investigator or her representative has explained the study to me and has answered all of the questions I have at this time. I have been told of the potential risks, discomforts and side effects as well as the possible benefits (if any) of the study. I freely permit my child,

_____, to take part in this study.
(Printed name of child)

Printed Name of Parent/Guardian

Signed Name of Parent/Guardian

Date & Time

Printed Name of Investigator

Signed Name of Investigator

Date & Time

APPENDIX C:
Assent Script

- Hello, my name is (insert name of researcher). I am a researcher/student and I study kids and body weight, and activity. Your mom, dad, guardian, etc. said it would be ok for you to help us out with some of these things. We are going to be doing some things for the next few minutes. I will explain what you will be doing during this time, and if you have any questions about what I am talking about, please ask.

- I will ask you to wear this belt with a small box on it (show Actigraph). This little box will tell us how much you move. It will not hurt you and you have to wear it for 5 days; that is one full school week. You will wear it every day. I will come and put it on you on Monday morning and take it off on Friday morning. I would like for you to try really hard to wear it every day, but if it still bothers you, you may take it off.

VITA

Andrew Michael Howard was born on October 25, 1986 in East Ridge, Tennessee, and raised in Cleveland, Tennessee. He graduated from Walker Valley High School in May 2005. His college career began at the University of Tennessee in Knoxville, Tennessee in August 2005. He received a Bachelor of Science in Education degree in Exercise Science in August 2009. He started at the University of Tennessee, Knoxville in August 2010. In August 2012, he received a Master of Science degree in Exercise Physiology from the Department of Kinesiology, Recreation, and Sport Studies at the University of Tennessee in Knoxville, Tennessee.