Abstract

EFFECTS OF A BEFORE SCHOOL PHYSICAL ACTIVITY PROGRAM ON PHYSICAL ACTIVITY AND ON-TASK BEHAVIOR IN ELEMENTARY SCHOOL-AGED CHILDREN

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The prevalence of obesity in children has dramatically increased over the last few decades and physical inactivity has been identified as a main contributor. Schools are an ideal setting for children to engage in physical activity. Unfortunately, opportunities for children to participate in physical activity during the school day have decreased as more emphasis has been placed on academic work. The purpose of this study was to evaluate the effects of a before school physical activity program on elementary school-aged children's physical activity levels and on-task behavior. The *First-Class Activity Program* (*First-Class*) was implemented utilizing the HOPSports Training System. HOPSports is an interactive multi-media system that utilizes DVR technology to engage large numbers of students in physical activity. Physical activity levels were measured with accelerometers and on-task behavior was observed at three different time periods (i.e., baseline, intervention, post-intervention). Twenty-seven students attended the program during the intervention data collection period. During *First-Class*, children spent an average of 46.4% of time in moderate-to-vigorous physical activity. Repeated measures analyses of variance were conducted to examine differences in physical activity and on-task behavior between baseline, intervention, and post-intervention for varying intensity levels (i.e., sedentary behavior, and light, moderate, vigorous, and moderate-to-vigorous physical activity). Effect sizes

(*ES*) were calculated using Cohen's delta to estimate the size of the mean differences. As hypothesized, no significant differences ($p > .05$) in school day physical activity [not including activity during *First-Class*] were found between the three time periods. For on-task behavior, significant differences ($p < .01$) were found among baseline, intervention, and post-intervention measures. Fisher's LSD post hoc tests indicated that on-task behavior increased from baseline to intervention ($p < .01$; $ES = 1.17$) and decreased from intervention to post-intervention ($p < .01$; $ES = 0.95$). Overall, there was an 18% increase in on-task behavior from the baseline to the intervention data collection period. In conclusion, a before school activity program can have positive effects on physical activity and classroom behavior in elementary school-aged children. Children did not compensate by decreasing physical activity levels during the school day on days they attended *First-Class.* Additionally, children had higher percentages of on-task behavior on days they attended *First-Class* compared to days they did not attend *First-Class*. This is the first study to demonstrate the effects of a before school program on physical activity and on-task behavior. A before school activity program does not interfere with academic time and may help students meet physical activity recommendations, while preparing them to learn.

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DEDICATION

I would like to dedicate this thesis to my grandfather, Paul S. Lapcevic. My grandfather was my role model and inspiration and I learned so much from him throughout the years. His accomplishments and dedication to the health and fitness field have inspired me to follow in his footsteps. I want to thank my grandfather for sharing so much knowledge and wisdom with me to make me the person I am today.

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CHAPTER 1: INTRODUCTION

The prevalence of obesity in children has increased dramatically over the last few decades (Ogden et al., 2006). These rising rates of obese children pose serious health concerns. Obese children are more likely to have risk factors associated with cardiovascular disease, such as hypertension, hypercholesterolemia, and Type II diabetes, than their non-overweight counterparts (Dietz, 1998; Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007; Must et al., 1999; Schwimmer, Burwinkle, & Varni, 2003; Sorof, Lai, Turner, Poffenbarger, & Portman, 2004). Looking beyond the physiological effects of obesity, psychosocial consequences, such as low self-esteem, social discrimination, depression, and anxiety, have also been shown to affect obese children (Dietz, 1998; Koplan, Liverman, & Kraak, 2005; Williams, 2001). In addition, obese children tend to become overweight adults (Deshmukh-Taskar et al., 2006; Herman, Craig, Gauvin, & Katzmarzyk, 2008; Serdula et al., 1993).

Physical inactivity has been identified as a main contributor to the increased prevalence of obesity (Brock et al., 2009; Trost, Kerr, Ward, & Pate, 2001; Weinsier, Hunter, Heini, Goran, & Sells, 1998) and increases in physical activity are related to improved measures of health (Strong et al., 1995). With many studies showing a decline in physical activity levels as children age (Trost et al., 2002; Vincent & Pangrazi, 2002; Wilde, Corbin, & Le Masurier, 2004), it is important to make physical activity an integral part of an individual’s lifestyle in the early years.

Physical activity guidelines specific to children have been developed. In 2008, the United States Department of Health and Human Services (USDHHS) published physical activity guidelines for Americans. It is recommended that children and adolescents participate in at least 60 minutes of physical activity each day. The majority of the 60 (or more) minutes should be devoted to moderate-to-vigorous intensity physical activity, including at least 3 days a week of vigorous intensity physical activity. It is also recommended children engage in muscle-strengthening and bone-strengthening activities on at least 3 days per week (USDHHS, 2008). The activity patterns of children tend to be sporadic (Bailey et al., 1995). Therefore, the recommended amount of physical activity can be accumulated in short bouts throughout the day.

The Surgeon General issued a report stating the need for public and private sectors to commit to promoting physical activity (USDHHS, 1996). Schools are a key setting to encourage a healthy lifestyle. Schools provide a safe environment with access to the facilities and equipment needed to promote physical activity. For children whose physical activity levels are restricted due to factors such as unavailable resources and safety concerns (Pellegrini & Smith, 1998), schools may be the most desirable place to engage in physical activity.

Although the need for physical activity in schools is becoming more evident, the opportunities to participate in physical activity during school are decreasing. Much of the physical activity children engage in during school is during physical education classes and recess. Due to budgetary constraints and the pressures to increase curricular time, physical education is often sacrificed (National Association for Sport and Physical Education [NASPE] and American Heart Association [AHA], 2006). Although it may be thought of as hindering the learning environment, physical activity may actually be beneficial in the school setting.

Mahar et al. (2006) examined the effects of classroom-based physical activities (i.e., *Energizers*) on school day physical activity and on-task behavior in elementary school-aged children. *Energizers* are short 10-minute activities that allow students an opportunity to participate in physical activity during instruction time. Children who participated in the *Energizers* accumulated significantly more physical activity during the school day compared to the control group. In addition, a significant increase in on-task behavior was observed after participation in physical activity.

As children spend most of their waking hours in school, it is important that they engage in adequate amounts of physical activity in school. It appears that not only are the opportunities for physical education declining, but also that children may not be very active during physical education lessons. Studies have found most children do not reach the Healthy People 2010 target of spending at least 50% of physical education lessons at a moderate-to-vigorous physical activity level (McKenzie, Nader, Strikmiller, Yang, Stone, Perry, et al., 1996; Nader, 2003; Stone et al., 2008; USDHHS, 2000). Due to the declining rates of physical activity during school, Dale, Corbin, and Dale (2000) examined whether children would compensate for restricted physical activity during the school day with increasing levels of physical activity after school. Results from this study showed that children did not compensate in activity levels at home after a sedentary school day. Children actually spent more time being physically active after school on active days compared to restricted days.

Mahar et al. (2006) demonstrated the importance of additional physical activity opportunities throughout the school day, not only in increasing physical activity levels, but also in enhancing classroom behavior. Before school starts may be an opportune time for children to engage in activity. A before school activity program does not interfere with academic time and may help students meet physical activity recommendations, while preparing them to learn. This is an unexplored area as there are currently no studies that assess the effects of a before school activity program on physical activity and on-task behavior.

Purpose Statement

The purpose of this study was to investigate the effects of a before school activity program on physical activity and on-task behavior in elementary school-aged children.

Research Hypothesis

The following hypotheses were examined:

1. Elementary school-aged children will not compensate by being less active during school hours (8:00 am – 2:00 pm) on days they participate in the before school activity program compared to days they do not participate in a before school activity program.

2. Elementary school-aged children will have a higher percentage of on-task behavior when participating in the before school program compared to days they do not participate in the program.

Definitions

For the purpose of this study, the following terms were defined:

***Accelerometers* –** An accelerometer is an activity monitor that detects accelerations produced by normal body movement.

***Body Mass Index (BMI)* –** BMI is a measure of weight relative to height. It is calculated by dividing weight in kilograms by the square of height in meters.

***Moderate Intensity Physical Activity (MPA)* –** Moderate intensity activity refers to activity corresponding to a MET value ≥ 4, but < 7 (Troiano et al., 2008). Moderate intensity activity increases the heart rate and breathing rate.

***Motor Off-Task Behavior* –** Motor off-task behavior is any gross motor response that breaks the classroom rules and/or interrupts the learning situation. Gross motor behaviors may include getting or being out of one’s seat, turning around at least 90°, running, walking around the room, and/or waving arms. Also noted as inappropriate gross motor behaviors are behaviors generally labeled as aggressive, such as hitting, kicking, pushing, pinching, slapping, striking another person with objects, grabbing another's property, and throwing objects. Some motor behaviors may be inappropriate in certain classroom environments, while deemed appropriate in other classroom situations.

***Noise Off-Task Behavior* –** Noise off-task behavior includes both verbal noise and object noise. Verbal off-task noise is any oral response that breaks the class rules and/or interrupts the learning environment. This may include inappropriate talking, yelling, blurting out, whistling, humming, screaming, singing, and laughing. If a child responds to a teacher's questions or instruction, then the student is on-task. Further examples of verbal off-task behavior include blurting out an answer instead of raising one's hand (if this breaks class rules) and talking to a neighbor instead of working on assigned tasks. Object off-task noise is any audible noise resulting from any behavior on the part of the child that may cause other children to be off-task. This includes behaviors such as slamming books, kicking furniture, or tapping a desk.

***Obesity* –** Obesity is the excess of adipose tissue that results from an imbalance of energy intake and energy expenditure (i.e., energy intake exceeds energy expenditure). Children and adolescents are considered obese with a body mass index at or above the 95^{th} percentile based on the Centers for Disease Control and Prevention age- and gender-specific growth charts (Ogden et al., 2006).

***On-Task Behavior* –** On-task behavior includes verbal and motor behavior that follows the class rules and is appropriate to the learning situation. On-task behavior is defined with reference to both the rules of the classroom and the assigned academic activity given by the teacher. If a student is working on the appropriate academic activity and is obeying the rules of the classroom, then the student's behavior is recorded as being on-task. Examples of on-task behavior might include working quietly at one's desk, engaging in group games when appropriate, responding to teacher questions, demonstrating activity to others when expected to do so, and engaging in conversation during class discussion.

Other or Passive Off-Task Behavior – Other or passive off-task behavior refers to times when there is no student interaction or when the student is not participating when he or she is expected to be involved. This category includes behaviors such as daydreaming and staring into space. For a student to be classified in this category, he or she must be engaged in no gross motor or verbal activity. Although uncommon, there may be a time when doing nothing is appropriate, for example, when an assignment is completed and nothing has been assigned. This category also includes minor motor behaviors, such as thumb sucking, fingernail biting, fiddling with hair, finger twiddling, chewing on a pencil or other object, or playing with one's pencil when this is not appropriate. These behaviors are only categorized as off-task when it is apparent that a student's attention is not directed toward the student's learning work. If, however, the student is engaged in appropriate activities while he or she exhibits these small motor behaviors, then his or her behavior is on-task.

Overweight – Overweight is defined as excess body weight in relation to one's height. Children and adolescents are considered overweight with a body mass index at or above the 85^{th} percentile, but less than the 95^{th} percentile based on the Centers for Disease Control and Prevention age- and gender-specific growth charts (Ogden et al., 2006).

Physical Activity – Physical activity is any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen, Powell, & Christensen, 1985). Actigraph accelerometers will be used to assess physical activity in this study.

***Vigorous Intensity Physical Activity (VPA)* –** Vigorous intensity activity refers to activity corresponding to a MET value ≥ 7 (Troiano et al., 2008). Vigorous intensity activity produces large increases in heart rate and breathing rate.

Delimitations

The study included the following delimitations:

1. Participants were elementary school children in grade 3 from a public school in eastern North Carolina.

2. Participants were only able to participate in the study if the informed consent was signed by a parent or guardian and returned before the beginning of the study.

3. On-task and off-task behavior was assessed using direct observation by two primary observers and one secondary observer.

4. Direct observation took place between 8:15 – 9:00 a.m. Direct observation was assessed for one week during baseline, one week during the intervention, and one week post-intervention.

5. Physical activity was assessed using accelerometers for one week during baseline, one week during the intervention, and one week post-intervention.

Limitations

The study was limited by the following:

1. Observers knew the expected outcomes and a risk of bias when coding on-task and off-task behavior may have existed.

2. Students may have been distracted with the observer in the room.

3. It was difficult to see the students during all times of the observation period.

4. The observers did not have control over when academic instruction time began in the classroom. The time between the end of the before school activity program and the start of instruction was not consistent throughout the data collection period.

5. Participants may have been more physically active than normal because they were wearing an accelerometer.

Significance of the Study

The national health objectives for 2010 include a reduction in sedentary behavior among children and an increase in physical activity. It is recommended that children participate in at least 60 minutes of physical activity each day. These activities should mostly consist of moderate-to-vigorous aerobic physical activity. Muscle-strengthening and bone-strengthening activities should also be incorporated into the 60 minutes of daily physical activity (USDHHS, 2008). Unfortunately, many children are not meeting these recommendations. Action Schools for Healthy Kids (2003) reported that fewer than 25% of children get at least 30 minutes of physical activity per day and fewer than 25% of children engage in 20 minutes of vigorous physical activity per day. Schools are a key setting to promote healthy lifestyles, as children spend most of their waking hours in this environment. However, opportunities for children to participate in physical activity during school are decreasing as more time is being focused on academic instruction. Although it may be thought of as hindering the learning environment, researchers have found evidence that physical activity can enhance classroom behavior (Jarrett et al., 1998; Mahar et al., 2006). To date, there are no studies that have examined the effect of a before school activity program on physical activity during school and on classroom behavior. Providing a before-school activity program may increase daily physical activity levels of children and have a positive effect on classroom behavior.

CHAPTER 2: REVIEW OF LITERATURE

The purpose of this chapter is to review the literature on the overall health and fitness of children and the significance of physical activity in school. Therefore, this chapter is divided into the following sections: (a) health and fitness of children, (b) importance of the school environment on physical activity, (c) cognitive functioning and classroom behavior, and (d) summary.

Health and Fitness in Children

Obesity

Obesity is essentially the result of an imbalance between calories consumed (i.e., food and drinks) and calories expended (i.e., metabolism and physical activity). Weight gain occurs when the amount of calories consumed exceeds the calories used. The interactions of genetic, behavioral, and environmental factors all contribute to obesity (U.S. Department of Health and Human Services [USDHHS], 2001).

Overweight in Children

The prevalence of obesity among children and adolescents has been increasing over the past few decades and remains a public health concern in the United States (Ogden et al., 2006). The Centers for Disease Control and Prevention (CDC) developed age- and gender-specific growth charts to define overweight and obesity by an individual's body mass index (BMI) (Ogden, Flegal, Carroll, & Johnson, 2002). BMI is calculated by dividing weight in kilograms by the square of height in meters. Children are considered obese with a BMI at or above the 95th percentile. Additionally, children are considered overweight having a BMI at or above the 85th percentile but less than the 95th percentile. According to results from the National Health and Nutrition Examination Survey (NHANES), the prevalence of obesity has tripled in children and adolescents aged 6 to 19 years between 1980 and 2006 (Ogden et al., 2006). Specifically, the prevalence increased from 5.0% to 12.4% for children aged 2 to 5 years, 6.5% to 17.0% for children aged 6 to 11 years, and 5.0% to 17.6% for adolescents aged 12 to 19 years (Ogden, Carroll, & Flegal, 2008). In 2004, the Institute of Medicine reported that approximately 9 million children over the age of 6 were overweight (Koplan, Liverman, & Kraak, 2005).

These rising rates of obesity in children pose serious health concerns. The negative effects related to adult obesity have been examined in many studies. Among these health concerns include: hypertension, type 2 diabetes, coronary heart disease, and some cancers (Belay, Belamarich, & Racine, 2004; Must et al., 1999; Thompson, Edelsbert, Colditz, Bird, & Oster, 1999). Although these health issues are not as well studied in the younger population, there is growing evidence that many of these implications are present in obese children. Obese children are more likely to have risk factors associated with cardiovascular disease, such as hypertension, hypercholesterolemia, and Type II diabetes, than their non-overweight counterparts (Dietz, 1998; Freedman et al., 2007; Must et al., 1999; Schwimmer et al., 2003; Sorof et al., 2004). Psychosocial consequences such as low self-esteem, social discrimination, depression, and anxiety have also shown to affect obese children (Dietz, 1998; Koplan et al., 2005; Williams, 2001).

Data from the Bogalusa Heart Study, a study of cardiovascular disease risk factors in early life, was used by Freedman et al. (1999) to examine the relationship between overweight and adverse risk factor levels. Odds ratios (*OR*) were used and the following associations were found between overweight in children (defined as BMI $\geq 95^{th}$ percentile in this study) and: total cholesterol (*OR* = 2.4), diastolic blood pressure (*OR* = 2.4), low-density lipoprotein cholesterol (*OR* = 3.0), high-density lipoprotein cholesterol (*OR* = 3.4), systolic blood pressure (*OR* = 4.5), triglycerides (*OR* = 7.1), and fasting insulin (*OR* = 12.6) compared to children with a BMI < 85^{th} percentile. Approximately 60% of overweight youth aged 5 to 10 years had ≥ 1 additional risk factor for cardiovascular disease and 25% of the overweight youth had ≥ 2 additional risk factors (Freedman et al., 1999).

Research suggests the adverse health consequences (i.e., hypertension, high cholesterol, types 2 diabetes) obese adults experience are becoming prevalent in overweight children. As children are experiencing more health issues related to being overweight, the need to overcome this epidemic is becoming more pertinent.

Physical Activity in Children

Physical inactivity has been linked as a main contributor to the prevalence of obesity and overweight (Brock et al., 2009; Trost et al, 2001; Weinsier et al., 1998). Physical activity is associated with a graded, inverse relationship with BMI, abdominal and visceral fat, and weight gain (Haskell, Lee, Pate, Powell, Blair, Franklin, et al., 2007; Institute of Medicine, 2007; Pate et al., 1995; Strong et al., 2005).

Moore et al. (2003) confirmed a strong effect of physical activity on long-term changes in body fat during childhood. Data were obtained from The Framingham Children's Study, an 8 year longitudinal study on the determinants of diet and physical activity in children beginning at ages 3-5 years. Each year, height, weight, and skinfold measurements were taken to determine change in body fat. Physical activity was assessed using Caltrac accelerometers twice a year over 3-5 consecutive days.

Each child was ranked and assigned to an activity tertile (low, medium, or high) based on his or her 8 year average activity score. In congruence with other studies, the results indicated an overall decline in physical activity (Trost et al., 2002; Vincent & Pangrazi, 2002; Wilde et al., 2004). However, the most active children had much less body fat by the time of early adolescence than those who were less active. Children in the highest activity category had a mean sum of skinfolds of 74.1 ± 7.0 mm compared to children in the moderate and low categories where mean sum of skinfolds were 94.5 ± 6.0 mm and 95.1 ± 6.8 mm, respectively. The results of this study support the belief that physical activity levels play a crucial role in development of overweight for both boys and girls.

Trost et al. (2001) examined the physical activity patterns and determinants of physical activity in obese and non-obese middle school children. Obesity was defined as a BMI ≥ 95^{th} percentile based on the CDC growth charts. Physical activity was assessed using accelerometers and data were collected over a 7-day period. Activity counts per minute were used to determine the amount of time spent in moderate (3-5.9 METs) and vigorous (≥ 6 METs) physical activity.

Compared to their non-obese counterparts, obese children participated in significantly less daily moderate physical activity (62.6 ± 4.5 vs. 78.2 ± 3.2 min/day) and significantly less daily vigorous activity (7.1 ± 1.3 vs. 13.5 ± 0.9 min/day). Obese children also participated in fewer 5, 10, and 20 minute bouts of continuous moderate-to-vigorous physical activity compared to non-obese children.

Increases in physical activity are related to improvements in measures of health (Strong et al, 2005). Regular physical activity in adults reduces the risk of developing coronary heart disease, Type II diabetes, hypertension, obesity, and psychological problems (e.g., anxiety and depression) (Pate et al, 1995). Inactive adults are 1.9 times more likely to develop coronary heart disease than physically active adults, independent of other risk factors (Powell, Thompson, Caspersen, & Kendrick, 1987).There also appears to be a dose-response relationship between activity and mortality, with mortality being greatest among low activity levels and lowest among the more active (Paffenbarger, Hyde, Wing, & Hsieh, 1986). The benefits of physical activity are not limited to adults.

In relation to children, a review by Strong et al. (2005) showed strong evidence of the benefits of physical activity on cardiovascular health, adiposity in overweight youth, and musculoskeletal health. Psychosocial benefits are also linked to physical activity. Regular physical activity can reduce mental stress, depression, and anxiety (Strong et al., 2005; Viru & Smirnova, 1995) while increasing energy levels, concentration, and mood (King, Taylor, Haskell, & DeBusk, 1989). Physical activity has also been shown to reduce the risk of engaging in other risky health behaviors.

Pate, Heath, Dowda, and Trost (1996) used Youth Risk Behavior Survey (YRBS) data from a sample of 11,631 adolescents to examine the association between physical activity and other health behaviors. Pate et al. concluded that low physical activity levels were associated with negative health behaviors, such as cigarette smoking, marijuana use, lower fruit and vegetable consumption, and greater television watching. Engaging in adequate amounts of physical activity may be effective in preventing negative health related behaviors.

Physical activity recommendations for adults to achieve health related benefits have been established for years. More recently, physical activity guidelines specific to children have been developed. It is recommended that children participate in at least 60 minutes of physical activity daily. Most of the 60 minutes should be moderate-to-vigorous intensity aerobic activity, including at least 3 days of vigorous intensity activity. Children should also engage in muscle-strengthening and bone-strengthening activities at least 3 days per week (USDHHS, 2008). The activity patterns of children tend to be sporadic (Bailey et al., 1995). Therefore, the recommended amount of physical activity can be accumulated in short bouts throughout the day.

These activities should consist of a variety of enjoyable activities that are developmentally appropriate (Strong et al., 2005).

As it has been shown that children decrease activity levels as they age, it is important that a physically active lifestyle be adopted at a young age (Trost et al., 2002; Vincent & Pangrazi, 2002; Wilde et al., 2004). Research suggests that regular physical activity can be used as a preventative measure to chronic diseases and also help to enhance quality of life (Sothern, Loftin, Suskind, Udall, & Blecker, 1999).

Tracking of Obesity and Physical Activity

The behavioral choices people make early in life can impact behaviors in the future. Physical activity is an important lifestyle behavior that tends to "track" from childhood and adolescent years into adulthood (Andersen & Haraldsdottir, 1993; Malina, 1996; Raitakari et al., 1994; Telama et al., 2005; van Mechelen & Kemper, 1995; Vanreusel et al., 1993). Similarly, overweight/obesity during childhood has been shown to continue into adulthood (Deshmukh-Taskar et al., 2006; Herman et al., 2008; Serdula et al., 1993). Adopting an active lifestyle at a young age may not only help decrease the prevalence of overweight/obesity in children, but also reduce the risk of becoming overweight/obese as an adult.

A longitudinal study by Deshmukh-Taskar et al. (2006) used cross-sectional surveys to evaluate the tracking of overweight status by collecting data in childhood (9-11 years) and young adulthood (19-35 years). For the purpose of this study, children were considered overweight with a BMI $\geq 85^{th}$ percentile, whereas young adults were considered overweight with a BMI $\geq 25 kg/m^2$.

Deshmukh-Tasker et al. (2006) used three different methods to assess the tracking of overweight: (a) correlations between baseline and follow-up BMI, (b) persistence of tracking in

BMI quartiles, and (c) percent of people who remained in the same overweight status groups from baseline to follow-up. Overall, there was a significant correlation (r = .66) between baseline BMI and follow-up BMI.

Three BMI quartile cut-points were determined: ≤ 25^{th} percentile (quartile 1), ≤ 50^{th} percentile (quartile 2), ≤ 75^{th} percentile (quartile 3), and > 75^{th} percentile (quartile 4) to examine the percent of individuals who remained in the same quartile during childhood and young adulthood. BMI cut-points for the quartiles were calculated based on the data. The percent of participants who remained in quartile 1, 2, 3, and 4 were 53.8%, 34.8%, 32.2%, and 61.9%, respectively. Also noted was a 15.2% shift from quartile 1 to quartile 3, 6.2% shift from quartile 1 to quartile 4, 29% shift from quartile 2 to quartile 3, 24.2% shift from quartile 3 to quartile 4, and a 15% shift from quartile 4 to quartiles 1 and 2 from childhood to young adulthood.

Participants were also categorized into different groups based on change in overweight status from childhood to adulthood: normal weight to normal weight (NW-NW), normal weight to overweight (NW-OW), overweight to normal weight (OW-NW), and overweight to overweight (OW-OW). It was found that 62.5% of the participants remained in the same overweight status categories from childhood to young adulthood. Specifically, 40% of the participants who were normal weight in childhood were also normal weight in young adulthood and 22.5% of the participants who were overweight in childhood were also overweight in young adulthood. Overall, the percentage of participants who were overweight increased from 24.7% to 57.7% between the two time points. Contributing to the increase in overweight status was the shift from normal weight in childhood to overweight in young adulthood (35.2%). However, the reverse effect, shifting from overweight in childhood to normal weight in adulthood was very low (2.3%). Based on these results there is evidence that overweight in childhood tracks into young adulthood.

Similar results were found by Herman et al. (2008), who tracked BMI over a 22 year span from childhood to adulthood. Youth overweight and obesity were classified according to the International Obesity Task Force age- and gender-specific BMI cut-offs. Results showed a moderate to strong tracking of BMI in females (r = .42-.65) and moderate tracking in males (r = .29-.53). From childhood to adulthood, 37% of males and 39% of females remained in the highest BMI quintile, and 38% of males and 47% of females remained in the lowest quintile. Overall, 83% of overweight or obese youth were also overweight or obese as adults, whereas 50% of normal weight youth were also normal weight adults. The chances of becoming an overweight or obese adult were 6.2 times greater for overweight or obese youth compared to their normal weight counterparts.

These studies show a positive relationship between overweight and obesity during childhood and overweight and obesity during adulthood. It is essential that healthy behaviors such as physical activity, which aid in preventing overweight and obesity, become an integral part of an individual's lifestyle in the early years.

Although evidence is not as strong as the tracking of obesity, studies have explored the relationship between physical activity in childhood and physical activity in adulthood (Telama et al. 2005). A 21-year longitudinal study by Telama et al. (2005) examined how physical activity in children and adolescents tracks into adulthood. Data was used from the Cardiovascular Risk in Young Finns Study which was collected in 1980 on youth aged 3, 6, 9, 12, 15, and 18 years. Measurements of the participants were repeated in 1983, 1986, 1989, 1992, and 2001. At the time of the last assessment, participants were 24, 27, 30, 33, 36, and 39 years of age. Telama et al. included all six age cohorts in the data analysis, but only included data from when the participants were ≥ 9 years of age.

Physical activity was measured using a short questionnaire, which assessed different aspects of physical activity. The questionnaires from 1983-1992 focused on frequency and intensity of activity, participation in sports, and school physical activity. The questionnaire administered in 2001 varied slightly from the previous years. Its focus was more related to adult activity and did not include questions about sports and school physical activity. Each answer was coded from 1 to 3 corresponding to intensity and frequency of activity (1-inactive or very low intensity; 2-moderate intensity or frequent activity; 3-frequent or vigorous activity). A physical activity index (PAI) was then computed for participants based on the sum of their coded responses. Cronbach's alpha was calculated as a measure of the internal consistency reliability. Reliability coefficients among females varied from .44 to .69 and from .49 to .76 among males in 1980. In 2001, reliability coefficients were higher and varied from .59 to .85 among females and from .74 to .85 among males.

Spearman's rank order correlation was used to examine tracking of physical activity. Coefficients of PAI were determined by gender and birth cohort for tracking intervals of 9 (1992-2001), 12 (1989-2001), 15 (1986-2001), 18 (1983-2001), and 21 (1980-2001) years. The 21-year tracking coefficients from youth to adulthood ranged from .33 to .44 in males and from .14 to .26 in females. On average, males had higher correlations than females for each of the tracking intervals.

Telama et al. (2005) used logistic regression analysis to analyze the effect of continuous physical activity, which was defined as remaining in the highest tertile of the PAI. Likewise, continuous physical inactivity was defined as remaining in the lowest tertile of the PAI. Odds ratios were computed comparing those who were continuously active to those who were continuously inactive in the same measurement. The outcome variable was those who were in the highest tertile of the PAI as adults in 2001. The two youngest age cohorts (9 and 12) and the two oldest age cohorts (15 and 18) were grouped together. Separate analyses were conducted to assess continuity over a 3 year period (1980-1983) and over a 6 year period (1980-1986). The odds ratios increased for males and females as the years of continuity increased. Odds ratios were also higher in the older cohort compared to the younger cohorts for the same continuity periods. Specifically, odds ratios for the younger cohort increased from 6.8 to 12.6 for males and 3.9 to 7.2 for females. Similarly, odds ratio for the older cohort increased from 11.8 to 19.2 for males and 4.4 to 6.1 for females. Overall, males had higher probabilities of continuing physical activity from childhood to adulthood. For example, males in the older cohort that were consistently active over 6 years were 19.2 times more likely to continue physical activity into adulthood compared to inactive males of the same cohort. As for females, there was a 6.1 greater chance of being active in adulthood for those who were continuously active over 6 years compared to their inactive counterparts. Telama et al. concluded that high levels of physical activity at ages 9 to 18 significantly predicted a high level of adult physical activity.

These findings reiterate the importance of developing an active lifestyle in childhood. Developing healthy behaviors (i.e., physical activity) early in life can impact future behaviors. With obesity rates increasing at such a dramatic rate, it is more important now than ever to decrease sedentary behaviors and increase physical activity levels in children. Children must be provided with opportunities that encourage a healthy, active lifestyle.

Importance of the School Environment on Physical Activity

The Surgeon General issued a report emphasizing the need for public and private sectors to commit to promoting physical activity (McKenzie & Kahan, 2008; USDHHS, 1996). Schools are a key setting to promote a healthy lifestyle and help reverse the current unhealthy lifestyles observed in children. Schools provide a safe environment with access to facilities and equipment needed to promote physical activity. For children whose physical activity levels are restricted due to factors such as unavailable resources and safety concerns (Pellegrini & Smith, 1998), schools may be the most desirable place to engage in physical activity.

Although the need for physical activity in schools is becoming more evident, the opportunities for participating in physical activity during school are decreasing. Much of the physical activity children engage in during school is attributed to physical education classes and recess. Due to budgetary constraints and the pressures to increase curricular time (Shephard, 1996), physical education is being sacrificed. The percentage of students participating in daily physical education classes decreased significantly from 42% in 1991 to 28% in 2003 (CDC, 2004).

A significant amount of the research related to physical activity in schools has been based on the physical education setting (Stone, McKenzie, Welk, & Booth, 1998). The School Health Policies and Programs Study (SHPPS) is a national survey designed to assess school health policies and programs. Lee, Burgeson, Fulton, and Spain (2007) published data from the 2006 survey and found few schools provided daily physical education, which was defined as physical education everyday for 150 minutes per week in elementary schools and 225 minutes per week in middle and high schools. Results showed approximately 4% of all elementary schools, 8% of all middle schools, and 2% of all high schools provide daily physical education. Furthermore, 31% of all elementary schools, 16% of middle schools, and 5% of high schools did not require any physical education.

For schools that offer physical education, it is not accurate to assume that students will achieve recommended amounts of physical activity during class. Nader (2003) recruited participants from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development to examine the frequency and intensity of activity of 814 third-grade children in physical education. The System for Observing Fitness Instruction Time (SOFIT) was used to obtain information on the activity levels of children and lesson context during physical education class. This study modified the original form of SOFIT by observing the activity of a single child rather than activity of all children in the class. Prerecorded audiotapes were used that sounded every 10 seconds to cue the data collectors when to observe and when to record the child's physical activity level and lesson context. Children's physical activity levels were recorded as follows: 1) lying down, 2) sitting, 3) standing, 4) walking, and 5) very active. Additionally, lesson context was coded as management, knowledge, fitness, skill practice, game play, or free play. Teachers also reported the total amount of minutes children spent in PE class per week.

Data obtained from the SOFIT observations were used to describe children's total time in the PE class in each of the lesson contexts and in each level of physical activity. This data were expressed as total minutes and as percentage of intervals observed. Time children spent in moderate-to-vigorous physical activity was calculated by summing the walking and very active categories. Overall, children accrued 4.8 very active and 11.9 MVPA minutes per PE lesson. These numbers are equivalent to 15% and 37% of lesson time, respectively. These results were similar to other studies that examined the amount of time children spent in MVPA during PE lessons (McKenzie et al., 2008). This falls short of the Healthy People 2010 objective that 50% of the physical education lesson should be spent in moderate-to-vigorous physical activity (USDHHS, 2000). It appears that children are not participating in sufficient amounts of physical activity during schools hours. However, it is still important that children engage in at least 60 minutes of physical activity daily (USDHHS, 2008).

Due to the declining rates of physical activity during school, Dale, Corbin, and Dale (2000) examined if children would compensate for restricted physical activity during the school day with increasing levels of physical activity after school. They hypothesized that children would engage in high levels of after-school activity when physical activity was limited during the school day. Their hypothesis was based on a biological basis for regulating physical activity in children. Rowland (1998) theorized that biological mechanisms control physical activity. In particular, it was speculated that physical activity provides the central nervous system with sensory information needed for arousal (Dale et al., 2000).

Dale et al. (2000) collected data on 78 third and fourth grade students. Physical activity was assessed using CSA accelerometers which were worn from 9:00 a.m. to 7:30 p.m. on four nonconsecutive school days. On two of these days the students participated in physical education class and outdoor recess. On the other two days the students did not participate in physical education class and were restricted to indoor recess in the school library. During all four days of data collection, children engaged in their normal after school activities.

Dependent samples *t*-tests were used to examine the average counts per minute obtained during school and after school on the active days versus the restricted days. As expected, children accumulated significantly more counts per minute during school on active days (366 ± 165 counts per min) compared to restricted days (129 ± 85 counts per min). However, it was shown that children do not compensate by increasing activity levels at home after a sedentary school day. Children actually spent more time being physically active after school on active days compared to restricted days. This study suggests that increasing physical activity levels during school may actually increase leisure-time physical activity, thus leading the students to a more active lifestyle.

The Centers for Disease Control and Prevention (CDC) conducted the Youth Media Campaign Longitudinal Survey, a nationally representative survey to assess the physical activity levels of children aged 9-13 years. Approximately 4,500 children and their parents were surveyed and it was found that 61.5% do not participate in organized physical activity outside of school and 22.6% do not participate in any leisure-time physical activity during nonschool hours (CDC, 2003). It appears that children are not getting the recommended amounts of physical activity during school, and many do not participate in sufficient amounts after school. A before school physical activity program may increase physical activity levels, thus helping children to attain the recommended amounts of physical activity.

Studies suggest engaging in physical activity before school can increase activity levels of the students (Cooper, Page, Foster, & Qahwaji, 2003; Sirard, Riner, McIver, & Pate, 2005; Tudor-Locke, Ainsworth, Adair, & Popkin, 2003); however, these studies are limited to active transport to school. Although these results appear to have a positive impact on physical activity, other conditions (e.g., travel distance, safety concerns) may not make active transport feasible for a large proportion of students. Cooper et al. objectively examined the physical activity patterns of elementary school children based on the mode of transportation to school. Accelerometers were worn for 7 days between 7:00 a.m. and 9:00 p.m. and a brief questionnaire was completed to determine the type of travel to and from school.

Analyses showed children who actively commuted to school were significantly more active (712.0 ± 206.7 counts per min) than those who traveled by car (629.0 ± 207.2 counts per min) and recorded more moderate-to-vigorous physical activity (i.e., > 3 METs). However, physical activity was not significantly different between the two groups on the weekend. The data were further analyzed to examine physical activity levels during specific times of the day. Those who actively commuted to school accumulated approximately 50% more moderate-to-vigorous intensity physical activity (MVPA) than car riders between 8:00 a.m. and 9:00 a.m. There were no differences in MVPA between the groups during school hours (9:00 a.m.-3:00 p.m.). Conversely, children who actively commuted to school accumulated more minutes in MVPA (82.8 ± 27.4 min) compared to the car riders (69.7 ± 28.4 min) after school (3:00 p.m.-9:00 p.m.). The overall results demonstrated that children who used an active mode of transportation to and from school were more physically active than those who were driven to school.

Although studies have found active commuting contributes to higher levels of physical activity (Cooper et al., 2003; Sirard et al., 2005; Tudor-Locke et al., 2003), fewer students are actively commuting to school now compared to past decades (CDC, 2008). Based on a national survey conducted by the U.S. Department of Transportation, active transport among youth aged 5-18 years declined from 42% in 1969 to 16% in 2001 (CDC, 2008). The reasons why there has been a decline in active transportation are important to consider.

Several researchers have examined various correlates (e.g., family, social, and environmental factors) of active commuting (Hume, Salmon, & Ball, 2007; Hume et al., 2009; Kerr et al., 2006; Timperio et al., 2006). Distance appears to be the strongest predictor of active commuting (Davison, Werder, & Lawson, 2008; McMillan, 2007; Merom, Tudor-Locke, Gauman, & Rissel, 2006). McMillan found that children in the U.S. were three times more likely to commute if they lived within 1 mile of the school compared to students who lived further away from the school. Timperio et al. found negative associations between the physical environment (i.e., no lights or crosswalks, busy roads) and active commuting to school. Although there is evidence that active transportation can be effective in increasing physical activity levels, many barriers to active commuting are present.

Overcoming some of the barriers (i.e., physical environment) of active commuting to school may be difficult. The previous studies show that before school may be an opportune time for children to engage in activity and help reach the recommended amounts of daily physical activity. Providing a program to children before school will allow the students to engage in physical activity without many of the barriers associated with active commuting.

Students spend most of their waking hours in the school environment, which makes it essential that schools provide opportunities for participation in physical activity. It is unfortunate that even as organizations and agencies, such as the CDC are recognizing the need for physical activity in schools, it appears that the levels of activity in schools are not increasing. Studies have shown that providing an environment conducive to physical activity can enhance physical activity levels (Sallis, Bauman, & Pratt, 1998; Sallis, Conway, Prochaska, McKenzie, Marshall, Brown, et al., 2001). Thus, physical activity interventions in schools may help to enhance the overall health and wellness of the students.

Cognitive Performance and Classroom Behavior

The Brain – Use It or Lose It

Many people speak of the positive benefits physical activity has on the body; however, the effect physical activity has on the brain may be more intriguing. Leading a physically active lifestyle can result in higher cognitive performance. In general, physical activity can help to: (a) optimize attention, alertness, and motivation, (b) prepare and encourage cells to bind together (the basis for organizing new information), and (c) fuel the development of new cells (Ratey, 2008).

The brain is a complex system, and many new developments have emerged linking the relationship between physical activity and brain health (Cotman & Engesser-Cesar, 2002; Dishman et al., 2006). Just as any bodily tissue needs enough blood supply to survive – so does the brain. The energy required for brain function is enormous, accounting for about 20 percent of the body's total energy usage (Raichle, 2006). Physical activity can help to increase the blood flow to the brain. In particular, increases in blood volume have been detected in the hippocampus, an area of the brain involved in memory processing and learning (Doering et al., 1998).

Physical activity also stimulates one of the brain's most powerful growth factors, Brain Derived Neurotrophic Factor (BDNF), which assists in the development of healthy tissue. BDNF, coined "Miracle-Gro" for the brain by one researcher, acts as a fertilizer-like protein that keeps existing neurons young and healthy, while encouraging the formation of new cells (Cotman & Berchtold, 2002; Medina, 2008; Ratey, 2006).

Previously held scientific beliefs that the brain is hardwired and one can only lose neurons once fully developed in adolescence has been shown not to be the case. Neurons do grow back, and physical activity is a contributing factor. This is important as the brain functions like muscles, growing with use, and shrinking with inactivity. As the research on the brain and physical activity has become more prevalent, studies have shown the effects of physical activity on cognitive and academic performance in the school environment.

Classroom Behavior

Although academic performance is not directly assessed in this study, academic/classroom behavior, which is assessed in this study, is a component of academic performance. A review study by the CDC (2009) examined the relationship between physical activity and academic performance, representing measures of academic achievement (e.g., grades, test scores), academic behavior (e.g., on-task behavior, attendance), and cognitive skills and attitudes (e.g., attention, concentration, mood). These measures were assessed in physical education, recess, and classroom-based physical activity contexts.

The authors of the review concluded that physical activity can positively impact cognitive skills and academic behavior, which both contribute to improved academic performance. From the 43 articles reviewed, 251 associations between physical activity and academic performance were measured. Over half (50.5%) of these associations were positive, whereas 48.5% of the associations showed no relationship. Only 4 (1.5%) of these associations tested were negative. This leads to the conclusion that physical activity does not appear to hinder academic performance, but may actually enhance it. This review only identified a few studies that focused on the association between physical activity and classroom behavior.

Jarrett, Maxwell, Dickerson, Hoge, Davies, and Yetley (1998) examined the effects of recess breaks on classroom behavior of 43 fourth grade students from two different classes. Prior to the study, students participated in physical education class 3 days per week, but did not engage in any school day physical activity on the other 2 days. Throughout the intervention each classroom incorporated a 15-20 minute recess period during one of the days the students did not attend physical education class.

Classroom behavior was observed on the 2 days the students did not attend physical education class. Classrooms were randomly assigned to have recess on one of these days, which varied each week. Therefore, the students were unaware of whether or not they were to have recess until just before it began. Data obtained from each recess day and nonrecess day (closest to the recess day) were used for data analysis. Behaviors were coded as: W (work), which referred to being on-task; F (fidgety), which included excessive movement, tapping, swinging arms or legs; and L (listless), which included not attending to the teacher, staring, having one's head on the desk.

Each student was observed for a 5 second interval and the behaviors were recorded. Behaviors were not mutually exclusive; therefore, more than one behavior may have been recorded within the 5 second interval. To calculate a score for each individual, a cumulative percentage for each behavior was found by summing the number of times the behavior occurred divided by the number of 5 second periods in which the child was observed during the six observation periods.

All students from the two classes were observed in the same natural classroom setting during science and mathematics; however, the time of day in which students were observed differed between the two classes. Although classes were taught science and mathematics by the same teacher, researchers were not able to control the types of teaching and learning that occurred before recess, after recess, or after no recess. Class A had mathematics and science from 9:30 – 11:15 a.m. On days when the children had recess, they took a break from 10:30-10:50 a.m. On both recess and nonrecess days children were observed from 10:00-10:25 a.m. and from 10:50-11:15 a.m. For each child in the class, separate scores were calculated for prerecess and postrecess time periods on recess and nonrecess days for the various behaviors. Class B had science and mathematics from 11:15 a.m.-12:00 noon and had a recess break from 11:20-11:40 a.m. Students were observed from 11:40 a.m.-12:00 noon on both recess and nonrecess days. Separate scores were calculated on recess and nonrecess days for work, fidgetiness, and listless. Due to scheduling of classes, Class B was unable to be observed prior to recess.

Jarrett et al. (1998) compared Class A children's prerecess behaviors on recess and nonrecess days with a repeated-measures multivariate analysis of variance (MANOVA). No differences were found between recess and nonrecess days. A repeated-measures MANOVA was also conducted to compare postrecess behaviors on recess and nonrecess days for children in both classes and results showed that the effect of recess was highly significant.

Specifically, Jarrett et al. (1998) found that children worked more and were less fidgety when they had a recess break. Without recess, students were on task 85% of the time and fidgety 16% of the time. With recess, students were on task 90% of the time and fidgety 7% of the time. There were no differences in listless behavior.

Students who benefited the most were compared to the other students. Jarrett et al. (1998) defined "benefited the most' on work or fidgetiness as being as least one standard error of the mean above the mean difference score on the variable. Mean differences of work behavior between recess days and nonrecess days were 5% with a standard error of 1.6%. Therefore, a 6.6% difference in on-task behavior would categorize the student as one who benefited the most. For fidgetiness behavior, there was a mean decrease of 9%, with a standard error of 1.6%. Consequently, children whose fidgetiness decreased at least 10.6% were considered to have benefited the most. Listless behavior was not included in this analysis because there were no differences in this behavior between recess and nonrecess days. Based on these criteria, 60% of the children benefited the most from recess by becoming more on task or less fidgety, or a combination of both.

These findings by Jarrett et al. (1998) showed that recess can have a positive effect on classroom behavior by increasing time-on-task and decreasing fidgetiness. It appears that after children had a break and engaged in some physical activity, they were able to concentrate and focus better.

Mahar et al. (2006) examined the effects of a classroom-based program (*Energizers*) on physical activity and on-task behavior. *Energizers* are short 10-minute activities which allow students an opportunity to participate in physical activity during instruction time. Participants were recruited from three classrooms in each grade level (K-4).

Physical activity was assessed using pedometers to examine differences in school day activity levels between students who participated in *Energizers* and students who did not participate in *Energizers*. Two classes from each grade level served as the intervention group and performed *Energizers* on a daily basis, whereas the remaining class in each grade level served as the control group. Pedometers were worn by the intervention group for 5 days from the start of the school day until the end of the school day. Differences in physical activity were determined based on number of steps taken before the *Energizers* activity began, after the *Energizers* activity was completed, and at the end of the school day for the intervention group. The control group recorded number of steps at the end of the school day. Independent groups *t*-tests were performed to determine whether average school day activity levels differed between the intervention group and the control group. Effect size was determined using Cohen's delta. Mahar et al. (2006) found a statistically significant difference between average daily in-school steps of the control group (4,805 ± 1,543) compared to the intervention group (5,587 ± 1,633). The size of the mean difference was moderate (*ES* = 0.49). During the *Energizers* activities, students in kindergarten, first, second, third, and fourth grade classes accumulated an average of 490 ± 152, 483 ± 268, 523 ± 337, 438 ± 137, and 595 ± 356 steps, respectively.

On-task behavior was assessed in this study using direct observation. Two randomly selected third grade classes and two randomly selected fourth grade classes were observed over a 12-week period. A multiple-baseline across-classrooms design was used, in which two classes had 4 weeks of baseline data collection before beginning the *Energizers* activities; and two classes had 8 weeks of baseline data collection before beginning the intervention. Each student was observed 1 day each week for 30 minutes prior to the *Energizers* activity and 30 minutes following the *Energizers* activity. During baseline, students were observed at the same times; however, *Energizers* activities were not performed. The observers took a break during the time period the *Energizers* would have been performed during the intervention period.

Observations of on-task behavior were conducted on 6 students per day during academic instruction. Observers listened to an audio recording indicating when to observe (10 second interval) the student and when to record the behavior (5 second interval). Behaviors were coded as on-task, motor off-task, noise off-task, or passive/other off-task. When analyzing the data, behaviors were referred to as either on-task or off-task. On-task referred to behaviors that followed the classroom rules and were appropriate in the school environment. Off-task behaviors were any behavior that was not on-task. After observing a student for 1 minute, observers rotated to the next student. This rotation was repeated 5 times, allowing the observers to record 20 observations per student.

Mean percentages of on-task behavior were found by dividing the number of on-task observation recordings by the total number of recorded behaviors. These percentages were found for prebreak and postbreak during the baseline period, and pre-*Energizers* and post-*Energizers* during the intervention period. Mahar et al. (2006) conducted a two-way ANOVA (time [preobservation vs. postobservation] x period [baseline vs. intervention]) to determine the differences in on-task behavior. A significant interaction between time and period was found. Fisher's LSD tests were performed to compare on-task behavior between (a) prebreak observation during baseline period vs. pre-*Energizers* observation during intervention period, (b) prebreak observation vs. postbreak observation during baseline period, and (c) pre-*Energizers* observation vs. post-*Energizers* observation during intervention period. There was no statistically significant difference in on-task behavior between prebreak during baseline period (71.3 ± 16.3%) and pre-*Energizers* during intervention period (70.9 ± 15.2%). There was also no statistically significant difference between prebreak and postbreak observations during baseline (71.3 ± 16.3% and 68.2 ± 14.5%, respectively). However, there was a statistically significant difference in on-task behavior between pre-*Energizers* (70.9 ± 15.2%) and post-*Energizers* (79.2 ± 11.4%). These results showed a moderate increase (*ES* = 0.60) in mean on-task behavior between the pre-*Energizers* and post-*Energizers* observations. Overall, these results concluded that participating in physical activity during academic instruction can have a positive effect on on-task behavior.

Jarrett et al. (1998) and Mahar et al. (2006) showed similar results that physical activity has a positive effect on classroom behavior, a component of academic performance. These conclusions are extremely important in providing support that physical activity does not have a negative effect on academic performance, but may actually enhance it.

Summary

The prevalence of obesity among children is on the rise. Health issues (e.g., hypertension, high cholesterol, type 2 diabetes) previously observed in adults are becoming more prevalent in children. Physical inactivity has been cited as a major contributor to the prevalence of obesity. Not only does physical activity have a positive effect on obesity, but it is also linked to other health-related and psychological benefits, such as increased memory and concentration.

Behaviors adopted at a young age can impact behaviors in the future. Therefore, it is important for children to adopt physically active lifestyles. The most recent physical activity guidelines state children should engage in at least 60 minutes of physical activity each day (USDHHS, 2008).

Children spend the majority of the day in school, placing an important role on schools to provide opportunities for children to be physically active. Unfortunately, these opportunities have been decreasing as more emphasis has been placed on academic coursework. Devoting time during the school day to physical education rather than academics may not hinder academic performance and may actually increase it (Van der Mars, 2006).

Studies related to active transport to school have shown that before school may be an opportune time for children to engage in physical activity (Cooper et al., 2003; Sirard et al., 2005). Schools have access to equipment and facilities to promote physical activity. Therefore, providing a before-school activity program may help to increase the overall health and wellness of the students.

CHAPTER 3: METHODS

Participants

Participants were recruited from one public elementary school (grade 3; four different classrooms) in eastern North Carolina. Approval was given from the local school district and principal of the school. The grade 3 teachers were recruited by the principal due to their high level of interest in the study. Informed consent forms were completed by the parents/guardians and assent forms were completed by the students prior to participation. A total of 35 students (20 females and 15 males) returned informed consent forms and participated in the study. Of these students, 89% were of minority status. Each classroom had 7-10 students participate in the study. This study was approved by the Institutional Review Board of East Carolina University and the local school district.

Intervention

Before School Activity Program

The *First-Class Activity Program* (*First-Class*) was implemented utilizing the HOPSports Training System to determine its impact on school day physical activity levels and on-task behavior. An A-B-A design was used to assess these differences. Baseline values of physical activity and on-task behavior were assessed (two classes per week) during the 2 weeks prior to the start of *First-Class*. Each week, participants from two grade 3 classes (i.e., 7-10 students per class) wore accelerometers during the school day (8:00 a.m. – 2:00 p.m.) and had on-task behavior observed during the first 30-45 minutes of academic instruction. All participants in the same class were assessed during the same week. After baseline values were established, HOPSports was set up in the multi-purpose room 30-mintues prior to the start of each school day (7:30 – 8:00 a.m.) for the following 8 weeks. Attendance was documented and students were able to participate anywhere from 5 to 30 minutes each day. During participation in the program, participants had physical activity and on-task behavior assessed for one week using similar procedures as the baseline assessments. In addition to wearing the accelerometer during regular school hours, children also wore it during *First-Class*. This allowed for evaluation of physical activity levels during the program, as well as during the school day. Physical activity and on-task behavior were assessed again for one week following the intervention. Figure 1 illustrates the timeline of the assessments. Height and weight were also measured and body mass index (BMI) was calculated during baseline data collection and during the week following the end of the program.

Aug 25-28	Aug 31 - Sep 4	Sep 7-11	Sep 14-18	Sept 21-25	Sept28-Oct 2	Oct 5-9	Oct 12-16	Oct 19-23	Oct 26-30	Nov 2-6	Nov 9-13	Nov 16-20	Nov30-Dec 4	Dec 7-11
					First-Class Activity Program									
Consent Forms			Baseline Data Collection				Intervention Data Collection						Post-intervention Data Collection	
			Class 1 Class 2	Class 3 Class 4			Class 1 Class 2	Class 3 Class 4					Class 1 Class 2	Class 3 Class 4

Figure 1. Timeline of physical activity and on-task behavior assessments.

HOPSports Training System

HOPSports is an interactive multi-media physical activity training system that utilizes DVR technology to engage large numbers of students in physical activity. The focus of this system is to create a fun and entertaining environment while improving physical activity levels and the overall health and wellness of youth. HOPSports provides a vast array of lessons appropriate for elementary, middle, and high school aged students. These activities consist of sport-specific skills, dance, and circuit training among others, and provide students with the opportunity to develop and enhance different motor skills. Equipment is provided by HOPSports to aid in many of the lessons. An unpublished study examined the effectiveness of HOPSports and found students to be significantly more active during physical education class on days when HOPSports was used compared to a traditional physical education class (West & Shores, 2007). Based on accelerometer data, students who participated in HOPSports engaged in moderate-to-vigorous physical activity (MVPA) 59% of the class time, whereas in traditional physical education students engaged in MVPA 38% of class time (West & Shores, 2007).

Measurement Procedures

Anthropometric Measurements

Height and weight were assessed during baseline data collection and during the last week of the program. Height was measured with a stadiometer (Seca model 214 Portable Stadiometer, Chiba City, Japan) and weight was measured with a portable scale (Health-o-Meter model 349KLX Medical Scale, Bridgeview, IL). BMI was determined by dividing weight in kilograms by height in meters squared.

Physical Activity Assessment

Physical activity was assessed using ActiGraph accelerometers (model GT1M, ActiGraph LLC, Pensacola, FL) to examine the level of physical activity during school. School day physical activity levels were compared between baseline, during participation in *First-Class*, and post-intervention. School day physical activity refers to activity accumulated during the time period of 8:00 a.m. to 2:00 p.m. Physical activity levels during *First-Class* were also determined. Previous research has shown ActiGraph accelerometers to be a valid measure of physical activity in children (Trost et al., 1998). Each student wore an accelerometer for 5 consecutive school days before *First-Class* began to collect baseline values, for 5 consecutive school days during participation in *First-Class*, and for 5 consecutive school days after *First-Class* ended. Accelerometers were placed on the student upon arrival at school (or upon arrival to *First-Class* during the intervention period) and removed at the end of the school day. Proper placement of the accelerometer was on the right hip in line with the midline of the thigh, attached to an elastic belt. Each student was given the same accelerometer during all assessments. The time the monitor was put on and taken off was recorded.

On-task Behavior Assessment

Direct observation was used to determine if on-task behavior differed between baseline, during participation in the *First-Class* intervention, and post-intervention. This observation method was similar to that used by Mahar et al. (2006). Two primary observers and one secondary observer were trained to observe on-task and off-task behavior. Primary observers were each responsible for the assessment of two classes. The observers assessed the same classes during all three measurement periods. The secondary observer functioned as the reliability observer and participated in 40% of the observations.

The observations took place during the first 30-45 minutes of academic instruction. Each grade 3 class (i.e., 7-10 students) was assessed for one week during baseline data collection, one week during participation in *First-Class*, and one week post-intervention. The observer randomly chose the order of the students to be observed and the teacher and students were unaware of which students were being observed.

Observers listened to a prerecorded audio file which indicated when to observe the student and when to record the behavior. Observations occurred during a 5 second interval, followed by a 5 second interval to record the behavior as being on-task or off-task. The same student was observed over a 1-minute period (a total of 6 observations) before the observer rotated to the next participant. Once each student was observed, the rotation repeated until each student was observed for a total of 3 minutes (18 observations).

Accelerometer Data Processing

Accelerometer data were downloaded at the end of each data collection week using the Actisoft Lifestyle Monitoring System Version 3.3.0. Due to the sporadic physical activity patterns in which children engage, an epoch of 5 seconds was used. This allowed the accelerometer to capture various intensities of physical activity more accurately. Accelerometer counts per minute were used in the following age-specific equation to determine MET value: METs = 2.757 + (0.0015 * counts·min $^{-1}$) – (0.08957 * age [years]) – (0.000038 * counts·min $^{-1}$ * age [years]) (Freedson et al., 1997). Pre-determined cut-points were used to categorize different intensity levels.

Outcome Measures

Physical Activity

Accelerometer cut-points were used to determine the amount of time spent in sedentary, light, moderate, and vigorous intensity activity throughout the school day and during *First-Class*. Sedentary time referred to minutes in which activity counts were less than 100 counts per minute. Light intensity activity was described as minutes with activity counts of 100 counts per minute or greater but less than the age-specific cut-points for moderate intensity activity. Moderate and vigorous intensity activity corresponded to MET values of ≥ 4, but < 7 and ≥ 7, respectively (Troiano et al., 2008). Moderate-to-vigorous intensity physical activity was calculated by summing minutes of moderate and vigorous intensity activity. The amount of time spent in each intensity level was expressed in minutes per day.

Classroom Behavior

Behavior was recorded as either on-task, motor off-task, noise off-task, or other or passive off-task behavior. Whole interval recording was used to code on-task behavior. That is, a student must be on-task during the entire interval for this behavior to be recorded as on-task. Partial interval recording was used to code off-task behavior. If off-task behavior was observed at any point during the interval, it was recorded as off-task. These categories of on-task and off-task behavior are mutually exclusive. The number of observations recorded for each category were divided by the total number of observations and multiplied by 100 to determine the percent of time each behavior was observed.

Reliability was calculated by comparing data interval by interval of both occurrence and nonoccurrence of on-task behavior. The number of observations recorded the same (either both on-task or both off-task) by both the primary and secondary observers were divided by the total number of observations and multiplied by 100 to get a percent of agreement.

On-task Behavior. On-task behavior includes verbal and motor behavior that follows the class rules and is appropriate to the learning situation. On-task behavior is defined with reference to both the rules of the classroom and the assigned academic activity given by the teacher. If a student is working on the appropriate academic activity and is obeying the rules of the classroom, then the student's behavior is recorded as being on-task. Examples of on-task behavior might include working quietly at one's desk, engaging in group games when appropriate, responding to teacher questions, demonstrating activity to others when expected to do so, and engaging in conversation during class discussion.

Motor Off-Task Behavior. Motor off-task behavior is any gross motor response that breaks the classroom rules and/or interrupts the learning situation. Gross motor behaviors may include getting or being out of one's seat, turning around at least 90°, running, walking around the room, and/or waving arms. Also noted as inappropriate gross motor behavior are behaviors generally labeled as aggressive, such as hitting, kicking, pushing, pinching, slapping, striking another person with objects, grabbing another's property, and throwing objects. Some motor behaviors may be inappropriate in certain classroom environments, while deemed appropriate in other classroom situations.

Noise Off-Task Behavior. Noise off-task behavior includes both verbal noise and object noise. Verbal noise is any oral response that breaks the class rules and/or interrupts the learning environment. This may include inappropriate talking, yelling, blurting out, whistling, humming, screaming, singing, and laughing. If a child responds to a teacher's questions or instruction, then the student is on-task. Further examples of verbal off-task behavior include blurting out an answer instead of raising one's hand (if this breaks class rules) and talking to a neighbor instead of working on assigned tasks. Object noise is any audible noise resulting from any behavior on the part of the child that may cause other children to be off-task. This includes behaviors such as slamming books, kicking furniture, or tapping a desk.

Other or Passive Off-Task Behavior. Other or passive off-task behavior refers to times when there is no student interaction or when the student is not participating when he or she is expected to be involved. This category includes behaviors such as daydreaming and staring into space. For a student to be classified in this category, he or she must be engaged in no gross motor or verbal activity. Although uncommon, there may be a time when doing nothing is appropriate, for example, when an assignment is completed and nothing has been assigned. This category also includes minor motor behaviors, such as thumb sucking, fingernail biting, fiddling with hair, finger twiddling, chewing on a pencil or other object, or playing with one's pencil when this is not appropriate. These behaviors are only categorized as off-task when it is apparent that a student's attention is not directed toward the student's learning work. If, however, the student is engaged in appropriate activities while he or she exhibits these small motor behaviors, then his or her behavior is on-task.

Data Analysis

SPSS 17.0 was used for data analysis. Total minutes and percent of time spent in sedentary, light, moderate, vigorous, and moderate-to-vigorous intensity activity during *First-Class* and throughout the school day were calculated. Mean percentages of on-task behavior during baseline, intervention, and post-intervention data collection were also calculated. Repeated measures analyses of variance (ANOVA) were conducted to examine differences in physical activity and on-task behavior between the baseline period, participation in *First-Class*, and post-intervention. Effect sizes (*ES*) were calculated using Cohen's delta to estimate the size of the mean differences (Cohen, 1998). Paired *t*-tests were used to examine the differences in physical activity and on-task behavior between days students attended *First-Class* and days students did not attend *First-Class.*

CHAPTER 4: RESULTS

A total of 35 students returned informed consent forms. However, 8 of these students did not attend the *First-Class Activity Program* during the data collection period. Therefore, results are based on students (n = 27) who attended *First-Class* on at least one day during the intervention data collection period. On average, students attended the program 3.1 ± 1.4 days per week and spent 18.3 ± 5.3 minutes at *First-Class* each day. The mean age of the participants was 8.2 ± 0.5 years. Height and weight of the students were measured during baseline (134.9 ± 7.1 cm; 35.2 ± 9.9 kg) and post-intervention (136.1 ± 7.4 cm; 35.8 ± 10.2 kg). No significant difference ($p > .05$) in BMI was found between baseline (19.2 ± 4.0 kg/m^2) and post-intervention (19.1 ± 4.0 kg/m^2).

Intervention

Table 1 contains descriptive data for physical activity levels during *First-Class*. Time spent in sedentary behavior (Sed), and in light (LPA), moderate (MPA), vigorous (VPA), and moderate-to-vigorous intensity physical activity (MVPA) was calculated for each day during the data collection period. Additionally, a weighted average was calculated for each intensity level. Students spent an average of 46.4% of the total time at *First-Class* in moderate-to-vigorous physical activity.

School Day Physical Activity

The mean values for physical activity during the school day at each time period (i.e., baseline, intervention, post-intervention) are displayed in Table 2. Table 2 presents school day physical activity (excluding activity engaged in during *First-Class*) during the intervention period in two categories: one which provides data for all of the days during the data collection period, and one which provides data for only the days the students attended the intervention. A repeated measures ANOVA was conducted between baseline, intervention (days attended), and post-intervention for each intensity level. These analyses showed no significant differences at any of the intensity levels. Significance levels ranged from 0.5 to 1.0. There were also no significant differences when comparing baseline, intervention (all days), and post-intervention.

Of the 27 students who attended *First-Class* on at least one day, 18 of them did not attend the program on all 5 days during the data collection period. Therefore, paired *t*-tests were performed to compare school day physical activity levels for the days the students attended the program versus the days the students did not attend the program. These data are presented in Table 3. There were no statistically significant differences ($p > .05$) in time spent at any intensity of activity during the school day (not including time spent at *First-Class*) on the days the students attended the intervention compared to the days the students did not attend the intervention.

Table 1
Amount and Percent of Time Students Spent at Various Intensity Levels during *First -Class*

Variable	**Day 1** (M ± SD)	**Day 2** (M ± SD)	**Day 3** (M ± SD)	**Day 4** (M ± SD)	**Day 5** (M ± SD)	**Weighted Average** (M ± SD)
Sed time (min)	4.4 ± 1.6	3.1 ± 1.8	3.8 ± 1.2	3.5 ± 1.6	3.1 ± 1.6	3.4 ± 1.6
% total time in Sed	20.5 ± 6.8	16.6 ± 7.6	18.5 ± 6.2	17.4 ± 7.1	15.4 ± 6.6	17.3 ± 6.9
LPA (min)	8.4 ± 2.5	6.7 ± 3.1	7.9 ± 3.7	7.7 ± 3.0	7.2 ± 2.2	7.5 ± 2.9
% total time in LPA	38.0 ± 4.7	35.7 ± 9.7	35.7 ± 12.7	36.8 ± 8.6	36.1 ± 6.7	36.3 ± 8.5
MPA (min)	6.5 ± 1.7	5.2 ± 1.9	5.3 ± 2.1	5.5 ± 2.0	5.0 ± 1.4	5.4 ± 1.8
% total time in MPA	30.0 ± 4.8	29.2 ± 8.3	23.9 ± 5.1	26.2 ± 5.1	25.6 ± 6.0	26.8 ± 6.0
VPA (min)	2.6 ± 1.2	3.3 ± 1.9	4.8 ± 3.0	3.9 ± 2.0	4.4 ± 1.3	3.9 ± 1.8
% total time in VPA	11.5 ± 4.2	18.5 ± 8.9	21.8 ± 11.3	19.6 ± 9.8	23.0 ± 7.1	19.6 ± 8.4
MVPA (min)	9.1 ± 2.7	8.4 ± 3.1	10.1 ± 4.5	9.4 ± 3.1	9.5 ± 1.7	9.3 ± 2.9
% total time in MVPA	41.5 ± 6.5	47.7 ± 13.1	45.8 ± 13.6	45.8 ± 10.3	48.6 ± 7.4	46.4 ± 10.1
N	**10**	**17**	**12**	**16**	**21**	

Note: Sed = sedentary behavior; LPA = light intensity physical activity; MPA = moderate intensity physical activity; VPA = vigorous intensity physical activity; MVPA = moderate-to-vigorous intensity physical activity. The Weighted Average was weighted by the number of participants that attended the program each day.

Table 2
Amount and Percent of Time Students (*n* = 27) Spent at Various Intensity Levels during the School Day

Variable	**Baseline** (Mean ± SD)	**Intervention (all days)** (Mean ± SD)	**Intervention (days attended)** (Mean ± SD)	**Post-intervention** (Mean ± SD)
Sed time (min)	252.8 ± 18.9	251.9 ± 19.7	253.0 ± 19.6	253.2 ± 22.5
% total time in Sed	70.2 ± 5.2	70.0 ± 5.5	70.3 ± 5.4	70.3 ± 6.3
LPA (min)	73.3 ± 12.5	75.1 ± 14.0	73.8 ± 14.2	74.5 ± 15.5
% total time in LPA	20.3 ± 3.5	20.8 ± 3.9	20.5 ± 4.0	20.7 ± 4.3
MPA (min)	25.2 ± 6.4	24.9 ± 5.7	24.8 ± 5.9	24.0 ± 6.4
% total time in MPA	7.0 ± 1.8	6.9 ± 1.6	6.9 ± 1.6	6.7 ± 1.6
VPA (min)	8.7 ± 3.7	8.0 ± 3.8	8.4 ± 3.8	8.4 ± 3.7
% total time in VPA	2.4 ± 1.0	2.2 ± 1.0	2.3 ± 1.1	2.3 ± 1.0
MVPA (min)	33.9 ± 9.2	33.0 ± 8.6	33.2 ± 8.5	32.4 ± 9.6
% total time in MVPA	9.4 ± 2.6	9.2 ± 2.4	9.2 ± 2.4	9.0 ± 2.7

Note: Sed = sedentary behavior; LPA = light intensity physical activity; MPA = moderate intensity physical activity; VPA = vigorous intensity physical activity; MVPA = moderate-to-vigorous intensity physical activity; all days refers to the entire week of data collection during the intervention period; days attended refers to days the students were at *First-Class* and participated in ≥ 5 minutes of at least moderate intensity activity.

Table 3
Time during School Day (Excluding Time Spent at *First*-*Class*) Students Spent at Various Intensity Levels (n = 18) on Days Students Attended *First-Class* Compared to Days Students Did Not Attend *First-Class*

Variable	**Days Attended** (Mean ± SD)	**Days Did Not Attend** (Mean ± SD)	***p*-value**	***ES***
Sed time (min)	252.0 ± 18.7	251.9 ± 18.9	.98	0.01
% total time in Sed	70.0 ± 5.2	70.0 ± 5.3		
LPA (min)	74.2 ± 14.7	76.6 ± 14.1	.40	0.16
% total time in LPA	20.6 ± 4.1	21.3 ± 3.9		
MPA (min)	25.2 ± 5.3	24.3 ± 5.8	.61	0.16
% total time in MPA	7.0 ± 1.5	6.7 ± 1.6		
VPA (min)	8.6 ± 3.9	7.3 ± 3.7	.25	0.33
% total time in VPA	2.4± 1.1	2.0 ± 1.0		
MVPA (min)	33.8 ± 7.7	31.6 ± 8.4	.41	0.27
% total time in MVPA	9.4 ± 2.1	8.8 ± 2.3		

Note: Sed = sedentary behavior; LPA = light intensity physical activity; MPA = moderate intensity physical activity; VPA = vigorous intensity physical activity; MVPA = moderate-to-vigorous intensity physical activity; Days Attended refers to days the students attended *First Class* and engaged in ≥ 5 minutes of moderate-to-vigorous intensity physical activity; Days Did Not Attend refers to days students did not attend *First Class* or participated in < 5 minutes of moderate-to-vigorous intensity physical activity during *First Class*.

On-task Behavior

On-task behavior was assessed by two primary observers and a secondary observer, who was present during 40% of the observations. The observations of the primary and secondary observers on the same students were used to calculate percentage of agreement. The percentage of overall agreement for on-task and off-task behavior was 89.1% (range = 81.7 to 96.3).

Table 4 contains descriptive data for the mean percentages of on-task behavior of students during baseline, intervention, and post-intervention periods. Mean percentages of on-task behavior during the intervention period are displayed for the entire intervention data collection period; as well as only for the days the students attended *First-Class*. On-task behavior of students improved by approximately 13% during the intervention period (74.6%) compared to baseline values (61.4%). Furthermore, on days students participated in *First-Class*, on-task behavior increased by almost 18% in relation to baseline data. The mean percentage of on-task behavior during the post-intervention data collection period (64.3%) was within 3% of baseline values (61.4%). A repeated measures ANOVA was conducted [$F_{(2,52)} = 12.4$, $p < .01$] to examine the differences in mean percentages of on-task behavior during baseline, intervention (days attended) and post-intervention. Furthermore, post-hoc tests using Fisher's LSD were performed to evaluate the three comparisons of on-task behavior (baseline vs. intervention; intervention vs. post-intervention; and baseline vs. post-intervention). Significant differences were found between the baseline vs. intervention comparison ($p < .01$) and the intervention vs. post-intervention comparison ($p < .01$). For both of these comparisons, the mean differences were large (*ES* = 1.17 and 0.95, respectively). There was no significant difference between baseline vs. post-intervention ($p = .43$) and the mean difference was small (*ES* = 0.18).

Table 4
Mean Percentages of On-task Behavior of Students (*n* = 27) during Baseline, Intervention, and Post-intervention Data Collection.

Variable	**Baseline** (Mean ± SD)	**Intervention (total intervention period)** (Mean ± SD)	**Intervention (days attended)** (Mean ± SD)	**Post-intervention** (Mean ± SD)
On-task Behavior	61.4 ± 15.8	74.6 ± 12.9	79.3 ± 14.7	64.3 ± 16.7

Note: Intervention (total intervention period) refers to the entire week of data collection; Intervention (days attended) refers to days the students attended *First-Class* and engaged in ≥ 5 minutes of moderate-to-vigorous intensity physical activity.

A paired *t*-test was conducted to determine mean differences for the percentages of on-task behavior of students ($n = 18$) on days students attended *First-Class* compared to days they did not attend *First-Class*. These data are displayed in Table 5. On-task behavior was 11% higher on the days the students attended *First-Class* compared to the days the students did not attend *First-Class*. This comparison failed to reach statistical significant (p =.07), which may have been due to the small sample size used in the analysis. However, the effect size (i.e., Cohen's delta) was moderate to large (*ES* = 0.65).

Table 5
Percentages of On-task Behavior of Students ($n = 18$) on the Days They Attended *First-Class* Compared to the Days They Did Not Attend *First-Class*

Variable	**Days Attended** (Mean ± SD)	**Days Did Not Attend** (Mean ± SD)	***p*-value**	***ES***
% On-task Behavior	79.4 ± 16.3	68.4 ± 17.7	.07	0.65

Note: Days Attended refers to days the students attended *First-Class* and participated in ≥ 5 minutes of moderate-to-vigorous intensity physical activity; Days Did Not Attend refers to days the students were not present at *First-Class* or participated in < 5 minutes of moderate-to-vigorous intensity activity during the program.

CHAPTER 5: DISCUSSION

A review of literature revealed that few studies have examined the effects of physical activity on classroom behavior in elementary school children. Furthermore, no studies were found that examined the effects of a before school physical activity program on classroom behavior. Therefore, the purpose of the present study was to evaluate the effect of a before school physical activity program on elementary school-aged children's physical activity levels during the school day and on on-task behavior during academic instruction time.

Physical Activity

In the present study, physical activity levels of elementary school-aged children in grade 3 were measured during the *First-Class* program (7:30 – 8:00 a.m.) and also throughout the school day (8:00 a.m. – 2:00 p.m.). Because students arrived at *First-Class* at different times, results were presented as percent of total time spent at different intensity levels based on accelerometer data. Percent of total time spent in moderate-to-vigorous physical activity (MVPA) during *First-Class* ranged from 41.5% to 48.6%, with a weighted average of 46.4%. This percentage appears to be greater than time spent in MVPA during physical education class, although we recognize that the goals of a before school program differ from goals of a physical education class. Recommendations set forth by Healthy People 2010 state children should engage in MVPA at least 50% of class time (USDHHS, 2002). Results from previous studies showed that children spend an average of 10 to 40% of physical education class time in MVPA (Burgeson, Wechsler, Brener, Young, & Spain, 2001; Simons-Morton, Taylor, Snider, & Huang, 1993). Not only does it appear children are not engaging in adequate amounts of MVPA during physical education class, but also an alarming number of schools do not provide daily physical education class. Lee et al. (2007) published data from the School Health Policies and Programs

Study (SHPPS), a national survey designed to assess school health policies and programs, and found only approximately 4% of all elementary schools, 8% of all middle schools, and 2% of all high schools provide daily physical education. Daily physical education was defined, based on the recommendations from the National Association for Sport and Physical Education (NASPE), as physical education everyday for 150 minutes per week in elementary schools and 225 minutes per week in middle and high schools. Furthermore, 31% of all elementary schools, 16% of middle schools, and 5% of high schools did not require any physical education. The need to provide additional opportunities for children to engage in physical activity during school hours is evident based on the SHPPS data.

Although children in this study engaged in considerable amounts of moderate-to-vigorous physical activity before the start of the school day, children did not compensate for this increase in physical activity by engaging in less activity throughout the course of the school day. Percent of time spent in MVPA during the school day increased slightly (8.8% to 9.4%), although not significantly ($p > .05$), on days the children attended *First-Class* compared to days children did not attend *First-Class* during the intervention. Similar results were found by Mahar et al. (2006), who implemented *Energizers*, a classroom-based physical activity program. In this study, effects of the *Energizers* activities on physical activity were compared between an intervention group and a control group. The researchers found from pedometer data that steps accumulated during the school day (not including the *Energizers* activities) were slightly higher for the intervention group than the control group. Additionally, Dale, Corbin, and Dale (2000) examined if children would compensate for restricted physical activity during the school day with increasing levels of physical activity after school. Results from this study showed that children did not compensate in activity levels at home after a sedentary school day. Furthermore, findings revealed that children were more physically active after school on active school days compared to sedentary school days. Together, these studies provide examples that additional physical activity opportunities offered to children during the school day will not decrease activity levels later in the day, but may actually increase activity.

Data from this study also show the percent of time spent in various physical activity behaviors during the school day. Children spent the majority of the school day (70%) in sedentary behavior and only 9.2% (33 minutes) of the school day in MVPA. On average, children spent an additional 9 minutes in MVPA during *First-Class*. Each week, children could engage in an additional 45 minutes of MVPA by participating in *First-Class*. This would account for 30% of the total recommended amount (150 minutes) of structured school day physical activity per week.

A strength of the present study was the use of accelerometers to assess physical activity. This allowed calculation of the amount of time spent at various intensity levels based on activity counts and predetermined cut-points. Physical activity guidelines state the need to participate in physical activity at a moderate-to-vigorous intensity level to receive significant health-related benefits. Accelerometer data are useful to determine whether or not individuals meet physical activity recommendations.

This present study suggests that a before school activity program is beneficial in helping children reach the recommended amounts of daily physical activity. It is important to note that this before school activity program was designed to complement recess and physical education classes, not to be used as a substitute for such activities.

On-Task Behavior

In the present study, on-task behavior was assessed on students during baseline, intervention, and post-intervention. A 13% increase (*ES* = 1.17, p = <.01) in mean on-task behavior was found between the baseline and intervention periods. Additionally, mean on-task behavior during post-intervention data collection was within 3% of baseline values. This suggests that *First-Class* had an impact on classroom behavior, and the improvement in on-task behavior during the intervention was not merely related to the increased exposure to the classroom environment or to the increased knowledge of teacher expectations.

Some students did not attend *First-Class* every day during the intervention. Of the 35 students who returned consent forms, 8 students did not attend *First-Class* during the intervention and 9 students attended on all days they were present at school. Therefore, analyses were also conducted on the remaining 18 students to compare on-task behavior on days students attended *First*-Class to days they did not attend the program during the intervention. This comparison best represents the effects we can expect when children attend the intervention. These results showed on-task behavior to be 10.5% higher (*ES* = 0.65) on the days students attended *First-Class*. This relationship of physical activity to classroom behavior does not appear to have a carry-over effect, but rather an immediate effect. Based on results from this study, there does not appear to be a carry-over effect from day to day. However, we are not sure of the lasting effects physical activity may have on classroom behavior as the students in this study were observed during the first 30 minutes following the *First-Class* program. Moreover, the amount of physical activity needed to improve classroom behavior is also uncertain. The average amount of time spent in MVPA during *First-Class* was 9.3 minutes, corresponding with a 10.5% increase in on-task behavior. Previous studies have also found positive effects of physical activity on classroom behavior, but have focused on recess or classroom-based physical activities during the school day (Jarrett et al., 1998; Mahar et al., 2006). Programs before school and activity breaks throughout the school day may be beneficial in contributing to increased physical activity levels and on-task behavior.

A limitation of the present study is that observers knew whether the students were present at *First-Class*. However, observers had no knowledge of whether the students engaged in at least 5 minutes of MVPA during the program; the inclusion criteria to be considered as attending *First-Class*. All observers were well trained in observation techniques and reliability between the primary and secondary observers was high. Average percentage of agreement for on-task behavior was 89%. This leads us to believe that observers were unbiased to the *First-Class* condition. This study used an A-B-A design. The inclusion of another invention period (A-B-A-B) may have aided in the interpretation of the findings. However, an A-B-A-B design was not possible in this study due to the time and setting limitations.

Results from the present study provide an important message to teachers and administrators. A program such as *First-Class* may not only improve classroom behavior, but may ultimately improve academic performance. A recent review by the CDC (2009) examined the effects of physical activity on academic performance, representing measures of academic achievement (e.g., grades, test scores), academic behavior (e.g., on-task behavior, attendance), and cognitive skills and attitudes (e.g., attention, concentration, mood). From the 43 articles reviewed, 251 associations between physical activity and academic performance were measured. Overall, 50.5% of these associations were positive, 48.5% showed no relationship, and only 1.5% were negative. This leads to the conclusion that physical activity does not appear to hinder academic performance, but may actually enhance it.

In conclusion, the *First-Class* program had positive effects on physical activity and classroom behavior in elementary school-aged children. Children did not compensate for physical activity levels during the school day on days they attended *First-Class.* Additionally, children had higher percentages of on-task behavior on days they attended *First-Class* compared to days they did not attend *First-Class*. This is the first study to demonstrate the effects of a before school program on physical activity and on-task behavior. Before school programs do not cut into academic time and give children an opportunity to become more physically active and improve their overall health and wellness. Physical activity before school may also be beneficial in preparing the student to learn, as evidenced by increased on-task behavior during the first 30 minutes of the school day. A before school activity program is recommended for teachers who want to increase physical activity and/or improve classroom behavior in their students.

Future Directions and Recommendations

Physical activity was assessed in the present study with accelerometers, which provide an indication of intensity levels. For the purpose of this study, accelerometers were used to report the amount of moderate-to-vigorous physical activity accumulated during *First-Class* and throughout the school day. Additionally, intensity levels were used to classify students as attending *First-Class*. Future research could use the accelerometer data to determine if there is a dose-response relationship between physical activity levels and classroom behavior.

Additional research is also needed to evaluate the effectiveness of a before school physical activity program on on-task behavior and academic performance. Although classroom behavior can contribute to academic performance, other factors such as academic achievement (e.g., standardized test score, grades) or cognitive skills (e.g., attention/concentration, memory) should be directly assessed. Evidence that physical activity positively affects academic performance will provide a stronger rationale for school systems to enhance the environment and adopt policy to increase physical activity during the school day.

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APPENDIX

University and Medical Center Institutional Review Board
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600 Moye Boulevard • Old Health Sciences Library, Room 1L-09 • Greenville, NC 27834
Office **252-744-2914** • Fax **252-744-2284** • **www.ecu.edu/irb**
Chair and Director of Biomedical IRB: L. Wiley Nifong, MD
Chair and Director of Behavioral and Social Science IRB: Susan L. McCammon, PhD

TO: Matthew Mahar, EdD, Dept. of EXSS, ECU

FROM: UMCIRB

DATE: August 18, 2009

RE: Expedited Category Research Study

TITLE: "Effects of a Before School Activity Program on School Day Physical Activity and On-task Behavior"

UMCIRB #09-0626

This research study has undergone review and approval using expedited review on 8/17/09. This research study is eligible for review under an expedited category because it is a collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.) Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual. The Chairperson (or designee) deemed this **unfunded** study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **8/17/09** to **8/16/10**. The approval includes the following items:

- Internal Processing Form (received 8/13/09)
- Pitt Co. Schools Approval
- Informed Consent: Parent (dated 8/12/09)

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.