A ZERO-HOUR PHYSICAL ACTIVITY PROGRAM'S BENEFIT ON ACADEMIC ACHIEVEMENT IN ELEMENTARY AGED SCHOOL CHILDREN

by

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ABSTRACT

With childhood obesity on the rise and the need for American children to be academically successful compared to peer nations, it is imperative that physical activity become part of the typical school day for all elementary aged school children. There is an understanding that physical activity not only benefits physical fitness and health, but that it positively affects children's academic achievement. With only one-half of American children meeting the CDC's recommendation of 60 minutes daily, the physical and cognitive effects of inactivity have been widespread and undeniable.

When children engage in physical activity prior to the school day, their bodies will undergo physiological changes in regards to heart rate and increased blood flow to the brain leading to an increase in attention, focus, and positive mood thereby ultimately improving academic achievement. This quasi-experimental design studied 26 participants (13 intervention, 13 control; 3-5th grade) enrolled in an extended school program. Resting heart rates, PACER tests, and reading and math AimsWeb scores were collected before and after the exercise intervention consisting of 35-45 minutes of zero hour physical activity, 4 days a week for 5 weeks was implemented.

The results from the study were assessed using two one-way between-groups analysis of covariance that compared the effectiveness of the physical activity intervention designed to improve academic achievement for both math and reading. After adjusting for pre-intervention scores, there was a significant difference in reading test scores for the zero hour physical activity intervention group F (1, 23) =6.157, p = .021 but not duplicated with math test scores F (1, 23) =.252, p=.621. A large effect size

was also seen for the intervention's reading scores with Cohen's d =.73 for the intervention group as compared to d=.48 for the control group.

Physical activity prior to the school day does positively affect academic achievement. Even the smallest positive significance should be interpreted as a triumph and certainly outweighs the potential risks of continuing down the path of physical inactivity. Educational administrators and teachers should consider the large body of evidence regarding the influence of physical activity on children's ability to succeed in the classroom.

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CHAPTER I

INTRODUCTION

An active mind cannot exist in an inactive body. – George S. Patton

In 2012, 34 countries' children participated in the Programme for International Student Assessment (PISA) (National Center for Educational Statistics, 2012). This assessment is given to 15 year old students every three years and examines proficiency in math, reading, and science. American children ranked 27th in math, 17th in reading, and 20th in science with no significant change since 2003. As a result of the somewhat humiliating performance exhibited by American children, politicians and school administrators collaborated to find ways to combat the educational concerns. Suggestions such as spending more focused class time on these core subjects through eliminating or reducing fine arts, physical education, and recess were among the few options. As well, longer school days, more financial support, and more stringent evaluations of teachers were advocated by parents and politicians. Coincidentally, out of 27 modernized countries, children from the United States rank in the lower half in terms of length and frequency of weekly physical activity. Perhaps the real problem with academic achievement lies in the disparity between the amounts of physical activity students engage in throughout the school day (National Center for Educational Statistics, 2012).

Humans evolved to engage in frequent and prolonged bouts of physical activity (Lieberman, 2014). Long ago, we were hunters and gatherers using physical activity as our mode of survival. We were constantly searching for our next meal which was only obtained through using our bodies to run, jump, throw, catch, etc. However, hundreds of years later, food is no longer a scarce resource; our bodies do not have to engage in physical activity to obtain our next meal. Instead physical activity is no longer “required” for us to physically sustain ourselves. In fact, due to food being so readily available and the majority of the population being physically inactive, obesity is a wide scale problem (Ratey & Hagerman, 2008). As well, since the majority of Americans have cut out physical activity, we have also seen an increase in many emotional, spiritual, and behavioral problems in children and adults. Time and again research has clearly proven physical activity not only benefits individuals physically but also in a variety of other ways including cognitively, emotionally, spiritually, and behaviorally. Knowing the benefits of physical activity, it is hard to fathom why so many schools fail to recognize the importance of daily physical activity during the school day (Ratey & Hagerman, 2008).

The concept of the mind and body working together is not a new idea among physical educators and researchers studying physical activity. Educators and researchers strongly believe students must engage in physical activity for effective and efficient cognition. Many studies have been performed to justify the ever-growing need for physical activity and physical education in schools supporting the notion that physical activity is imperative to enhance academic achievement (Chaddock, et al., 2012; Castelli, D.M., Hillman, C.H., Buck, S.M., & Erwin, H.E., 2007; Coe, D.P., Pivarnik, J.M., Womack, C.J., Reeves, M.J., & Malina, R.M., 2006; Hillman, et al., 2009; Ratey & Hagerman, 2008; Sibley & Etnier, 2003).

An overwhelming amount of evidence suggests that physical activity benefits students' overall health. For example, increasing physical activity levels helps to improve physical fitness, reduce the risk of common physical pathologies (Strong et al., 2005), as well as, improve psychological well-being like self-esteem, depression, and anxiety (Ratey & Hagerman, 2008). With all of these positive attributes associated with physical activity and because schools are where children spend a vast majority of their time, it is logical for schools to be an agent and proponent of physical activity, often taking the form as physical education. One must concede that physical educators are in the business of not only providing physical training but also providing mental training for developing children (Sibley & Etnier, 2003).

Physical activity in schools

Although there are many different channels for students to pursue physical activity most are still falling short of the national recommendation. The Centers for Disease Control and Prevention (CDC) ("How Much Physical Activity," 2015) recommends at least 60 minutes of moderate to vigorous physical activity for children daily. Most commonly this can be met by school aged children by participating in a 30 minute physical education class and then engaging in 30 minutes of free play or recess. If students do not receive physical activity during the school day, many do not have the opportunity to meet the guidelines due to parents' work schedule, financial restraints, or safety of the physical environment in which the student lives.

The Institute of Medicine has recognized the need for physical activity in schools (Cook et al., 2013). According to the Institute of Medicine, 48-69% of children do not attend a physical education class in the average week (Cook et al., 2013). According to the Centers for Disease Control and Prevention, only 4% of elementary schools, 8% of middle schools, and 2% of high schools provide daily PE for the entire school year (U.S. Department of Health and Human Services, 2010). In fact, 44% of school administrators have made a cut in physical education to allow for more time on reading and math to meet the mandates of the No Child Left Behind Act. Today's school aged child is spending a minimum of seven or more hours a day at school due to parental obligations and work schedules. This situates schools to be in a prime position to influence children by mandating physical activity. Regardless of families' socioeconomic background and ability to provide transportation, monetary support for extra-curricular activities, or physical environment, schools are common ground that can reach an enormous number of children (Educating the Student Body, 2013).

Physical activity's impact on childhood obesity

According to the CDC (2015), childhood obesity rates have tripled from one generation ago. Seventeen percent of all children and adolescents in the United States are considered obese ("How much physical activity", 2015) while nearly 11% of children age 2-19 are classified as severely obese (London, 2011). The concept of childhood obesity being on the rise is no surprise since only 18% of 9-12th grade students met the national guidelines to enhance health and weight control (U.S. Department of Health and Human Sciences, 2010). Based on these statistics and schools being where students spend most of their day, it is easy to recognize why they are falling short of the recommendation.

Concurrently, there are several other factors that are contributing to the obesity crisis. The number of fast food choices that are relatively inexpensive compared to the cost of healthy food choices becomes a quandary for many families. In today's modern age, computers, video games, and television are often activities that students turn to for entertainment purposes. Without proper supervision, students may be encouraged to stay inside rather than participating in physical activity outside. Such activities usually require very little brain activity and promote a sedentary lifestyle.

Physical activity and mental functioning

Aerobically fit children exhibit higher academic achievement scores and superior cognitive performance when compared to less fit children (Hillman et al., 2009; Ratey & Hagerman, 2008). Beyond combatting childhood obesity, exercise scientists and neurobiologists have agreed that physical activity favorably influences mental functioning that is key to cognitive development (Telford et al., 2012). Physical activity affects key brain functions, like concentration and memory, and contributes to intellectual and academic benefits that may have long- term positive effects on life and the learning process (Castelli et al., 2007; Rosewater, 2009).

Most studies show that there is a positive link between physical activity and academic achievement on standardized tests; however, there are a few that detected no effect (Coe et al, 2006; Dwyer, T., Coonan, W.E., Leitch, D.R., Hetzel, B.S., and Baghurst, R.A., 1983). However, Coe and colleagues (2006) did find that students had higher grades associated with exercise. Several studies have shown positive cognitive function from engaging in moderate to vigorous physical activity even if only for a 20 minute bout. What does this mean for school aged children? Quite simply, students that participate in consistent, daily physical activity that is of moderate intensity are more inclined to perform optimally in their given environment.

Physical activity's effect on stress, depression, anxiety, self-esteem

According to Sattelmair and Ratey (2009), a student's academic performance is influenced by things like learning, memory, concentration and mood. All of these are proposed to improve by simply engaging in physical activity. Physical activity is also credited with improving mental health and self-esteem (Chomitz et al., 2009). Other problems that can affect school performance like stress, anxiety, and depression have proven to be alleviated. Even students diagnosed with attention deficit hyperactivity disorder (ADHD) can expect healthy cognitive results through strenuous physical play. Quite simply, people that are engaging in movements inevitably stimulate their brain to respond and react accordingly (Ratey & Hagerman, 2008). Stress, anxiety, depression, ability to attend, and self-esteem all influence how one would perform academically. If exercise can benefit the body is so many different ways physically, emotionally and psychologically, it makes sense that academics would benefit in turn.

Due to the gradual decrease of physical activity over the last 30 years, a significant health burden has been placed on society. With only one-half of American children meeting the recommended guideline, the effect of inactivity has been characterized as being equivalent to a terrorist threat (Ratey & Sattelmair, 2012). However, until society changes their opinion regarding the importance of physical activity and buys into the concept that mind and body work together as one, researchers and physical educators have a long battle ahead in order to create a paradigm shift within our nation. A complete overhaul in our culture is required before we can start to reap the enormous amount of benefits physical activity can provide.

Study context

Given the overwhelming evidence of physical activity's benefits, a "zero hour", or before school, a physical activity program was instituted at an elementary school whose focus is leadership. Known as the Leadership school, this public city school uses the Leader in Me philosophy by integrating the teaching, modeling, and practicing of skills to help develop a culture of leadership. Stephen Covey's Seven Habits of Highly Effective People is the principle in which they focus all activities of the school. Due to their pursuit of excellence in regards to academics and leadership, this city school that is immersed in a culture of leadership has been identified to be the ideal setting for such an innovative program. If children are given the tools and experience personally the significance physical activity can have on their lives and others, they will be more likely to become role models and proponents of physical activity.

Students ages 7-12 enrolled in the extended school program were recruited to participate in a five-week physical activity program. Children were randomly assigned based on the order in which they returned their signed parental permission slips. All students were given a number based on the order the slips were turned in. If the student submitted their permission slip as an even number, they participated in the zero hour activity; if they were given an odd number based on their order, they remained in the traditional activities of the extended school program involving reading, playing on the computers, arts and crafts, etc. We recruited approximately twenty-two students to participate. Eleven of those were participants in physical activity Monday through Thursday mornings while the remaining 11 were in the traditional program. College students from a nearby university helped devise and lead age appropriate activities to keep students' heart rates elevated for 35-40 minutes. Activities included jump rope activities, a variety of cone and ladder drills, team sport drills including basketball and soccer, and running games.

Research design

A design study was chosen to address the research question and determine if in fact the program would produce any effect for participants. The extended school program presents the children with two options. Children whose parents returned permission slips were either placed in the traditional non-intervention program (non-participants) or placed in the physical activity intervention program (participants) based on the order slips were returned. Both options coincide with one another. Students were given the option to drop out of the physical activity intervention at any time. Researchers collected data on benchmark math and reading test scores that were significant for comparison between the intervention and control groups prior to the intervention and immediately after the intervention. Age, pre- and post- intervention heights and weights, pre- and post-PACER test scores, and pre- and post- resting heart rates were also collected from each group. Once data was collected, a t-test was run and determined that the groups' pre-intervention test scores were significantly different. Therefore, a two way repeated measures ANCOVA analyses (pre- and post-; intervention and control) was performed to assess the program's outcomes on participants' reading and math achievement scores and resting heart rates.

Research question

Regardless of the accumulated evidence, there still seems to be some misunderstanding of the relation of physical activity to students' academic achievement in elementary classrooms (Sibley & Etnier, 2003). The purpose of this study is to examine the purported effects of a five-week physical activity program on participating students' academic achievement.

1. Does a 5-week, 4-day per week, 35-45minute per day early morning physical activity program for elementary school students positively affect their math and reading standardized test scores?

CHAPTER II

LITERATURE REVIEW

Researchers are increasingly becoming aware that physical activity does not just impact children's cardiovascular system or body composition, but also affects the neurological system in a variety of ways. It is believed that the neurological benefits of physical activity include improved cognition, depression and attention while decreased stress and anxiety. Regardless of the numerous studies that have been performed to date, there still seems to be some misunderstanding of physical activity's relevance and its significance on academic achievement in elementary-aged children specifically (Sibley & Etnier, 2003). In the 1950s and 1960s several studies were performed to support the mind-body connection (Jacobs, 2001) validating physical educators' beliefs in the holistic approach in that the whole child needs to be addressed and educated at school. The concept caught on in the 1970s and physical education became a vital part of the daily curriculum due in part to the previous studies that justified its relevance. Gradually physical education became widely accepted for the physical benefits rather than the cognitive benefits (Sibley and Etnier, 2003). Unfortunately, the need to justify physical activity's relevance has returned. According to the Institute of Medicine (2013), 48-69% of children who attend school do not attend a physical education class in the average week. Now more than ever, it is the responsibility of the researcher, physical educators and proponents of physical activity to impress upon schools and communities that maintaining a healthy fitness level by engaging in regular, consistent physical activity can and does have an instrumental effect on a student's academic achievement. Today, it is a necessity to demonstrate that physical activity performed throughout the school day is undeniably linked to how a student performs in the classroom (Wittenberg, 2012). Once this is obvious to not only researchers but the general public, physical activity will return to the academic curriculum and be seen as an important component to the educational process.

An overwhelming amount of evidence suggests that physical activity benefits students' overall health. For example, increasing the duration and degree of students' physical activity helps to improve physical fitness and reduce the risk of common physical pathologies, such as obesity, hypertension, and diabetes (Strong et al., 2005). Additionally, increased physical activity has been shown to improve psychological well-being including traits such as self-esteem, depression, and anxiety (Ratey & Hagerman, 2008) which will be addressed in depth later. With all of these positive attributes associated with physical activity and because schools are where children spend a vast majority of their time, it is logical for schools to be an agent and proponent of physical activity, often taking the form of physical education. This chapter will explore this topic first by documenting the harmful outcomes that result from daily physical *in*activity, and then proceed with an examination of how a novel approach to physical education may addresses such outcomes.

Physical activity in schools

Although there are many different channels for students to pursue physical activity, most parents and communities assume students are participating in physical education or activity throughout the school day. Surprisingly most children are falling short of the Centers for Disease Control and Prevention recommendation of at least 60 minutes of moderate to vigorous daily physical activity (U.S. Department of Health and Human Sciences, 2010). Tufts University recently researched the activity patterns of children both in and out of school and compared them to the national guidelines. Sampling over 450 Massachusetts schoolchildren, they found a meager 15% met the prescribed guidelines with girls and overweight/obese children participating in the least amount of physical activity (Hubbard, 2015). People commonly believe this recommendation can be met by school-aged children by participating in a 30-minute physical education class and then engaging in 30 minutes of free play or recess. The reality is if students do not receive physical activity during the school day, many do not have the opportunity to meet the guidelines due to parents' work schedule, lack of access to parks and green space, financial constraints, and/or safety of the physical environment in which the student lives. The Institute of Medicine has recognized the need for physical activity in schools after being identified as the pivotal point for obesity prevention due to the long duration in which students attend school (Cook et al., 2013). "In an increasingly sedentary world, schools provide the best opportunity for a population-based approach for increasing physical activity among the nation's youth" (Cook et al., 2013, p. 2).

Today's school aged child is spending a minimum of seven or more hours a day at school due to parental obligations and work schedules placing schools in a prime position to influence children by mandating physical activity. Regardless of families' socioeconomic background and ability to provide transportation, monetary support for extra-curricular activities, or physical environment, schools are common ground that can reach an enormous number of children (Cook et al., 2013). Only those that are homeschooled are the exception.

It might be assumed that students are afforded many opportunities to participate in physical activity during a long school day. However, the actual statistics are surprising. According to the Centers for Disease Control and Prevention, only 4% of elementary schools, 8% of middle schools, and 2% of high schools provide daily physical education for the entire school year (U.S. Department of Health and Human Sciences, 2010). In fact, 44% of school administrators have made cuts in physical education to allow for more time on reading and math instruction to meet the mandates of the No Child Left Behind Act in 2001 (Cook et al., 2013).

Not only has physical education suffered cuts, but concurrently there is a trend to eliminate recess in an effort to spend more time preparing for standardized testing. According to the CDC (2014), only 57% of school districts mandated a scheduled recess in 2007. This well intentioned desire to allow for more “in-class learning” rather than “play time” only leads to more physically unfit, obese children that in turn have increased anxiety, stress, and depression. According to the most recent trends, childhood obesity, emotional, and behavioral concerns in children are on the rise. Although there may be many contributing factors to these concerns in children, one might suggest that physical inactivity plays a role. Media has placed a spotlight on childhood obesity and has recognized it as a national concern.

Childhood obesity

As of 2014, 12.7 million students or 17% of 2-19 year olds are classified as being obese ("How much physical activity", 2015) while in 2012, it was reported that one third of students met the criteria as being either obese or overweight. Seventy percent of obese students exhibit at least one factor of cardiovascular disease such as high blood pressure and/or cholesterol. Other significant health concerns associated with physical inactivity in youth include high blood glucose levels, bone and joint problems, and an increased likelihood of becoming an obese adult increasing the chance of further health conditions, including cancer ("How much physical activity", 2015).

While obesity rates have continued to rise steadily since the 1980s, Americans saw obesity become prevalent in the 1990s. Increasing physical inactivity rates can be attributed to transportation conveniences, larger portions served at restaurants, and more screen time ("Exercise Can Help", 2016). As well, a decrease in daily physical education beginning in the 1980s through 2000s contributed to an increase in childhood obesity only to be compounded when the No Child Left Behind Act was put into effect (Trost & van der Mars, 2010).

No Child Left Behind was a well-intentioned law that was passed in 2001 to ensure that all children receive a high quality education thereby closing the gap between students that were successful in school and those that were not due in part perhaps to disabilities, living in poverty, having English as a second language, among other factors (U.S. Department of Education, 2005). According to Cizek (1998), students and school administrators use standardized testing to obtain valuable information that is difficult to assess otherwise. For years these tests have been employed to measure what students have learned throughout their school year. Although standardized tests remain a topic of debate within the American education and political systems, achievement tests make up the majority of standardized tests used for promotion purposes and improvement within the educational system. Federal aid is granted to those schools that see consistent improvement in tests scores holding educators and administrators accountable. Therefore, standardized testing is a huge motivator for students and teachers alike (Cizek, 1998).

Even though the purpose behind such the act is commendable, the focus of education changed from a holistic approach to one strictly focused on academic performance. Despite all of the possible positive connections, PE is being cut across the country (Wingfield, 2011). Some administrators cite the cuts are due to tight budgets while others suggests that emphasis on standardized testing has led to the increased need for time spent in the classroom preparing for such tests. Due to the No Child Left Behind Act, schools and teachers live in fear of their students performing badly (Murnane & Papay, 2010; Walker, 2015). Federal aid to schools that perform well has substantiated this idea.

After this mindset change towards education, physical inactivity and childhood obesity has received a great deal of attention from the media and health organizations. Obesity rates are highest amongst wealthy countries that do not encourage walking or bicycling to get to school or work, and jobs that are considered low-activity. Obesity rates in children are on the rise because fewer and fewer families can afford to be single income households. As a result, children often have less parental supervision and spend more time indoors during their free time for safety reasons. This leads to them engage in activities that are sedentary in nature like watching television, playing video games, or using the computer. The American Academy of Pediatrics estimates that on average children spend seven hours a day on phones or computers, in front of the TV, or using other electronic devices (“Media and Children Communication”, 2016).

As a result of sedentary lifestyles, the number of calories burned on a daily basis is significantly less than the cheap, high caloric consumption choices most people make. In addition since parents are often the decision makers in regards to food choices and preparation, children are subjected to the healthy and unhealthy selections made by their parents. Although other factors such as size, genes, and age play into our daily caloric expenditure, the one aspect that we can control is our level of physical activity. Physical activity not only increases one’s energy expenditure, but it helps to maintain energy balance. Through participation in physical activity the increased muscle mass causes the body to burn more energy to sustain that mass both at rest and with activity. Consequently, more energy is expended throughout the day (Brown et al., 2013). Oppositely, one who consumes more calories than what they burn through thermogenesis, metabolism, and physical activity find themselves gaining weight leading to obesity if not altered.

Students that lead a healthy lifestyle and control their weight are less likely to be afflicted by chronic diseases that are increasing from year to year. Chronic diseases such as heart disease, stroke, diabetes, high blood pressure, osteoporosis, and cancers are widespread and rampant across the world due to physical inactivity. In fact, 20% to 50%

of newly diagnosed type 2 diabetes cases are found in youth and linked to the childhood obesity epidemic (Dabelea et al., 2014). "The tendency for excess fatness to persist from childhood and adolescence into adulthood, coupled with the strong association between obesity and chronic disease, has caused great concern for future obesity levels and the health of youth and adults alike" (Cook et al., 2013, p. 123). These chronic conditions are causing a global health crisis as insurance rates and medical expenses continue to rise.

The benefit that physical activity provides goes clearly beyond the size or shape of our bodies. Our physical health and mental health are equally as important and can accrue considerable positive influences through physical activity. There is evidence to suggest that those students with higher body mass indexes are predisposed to suffer from depression (Brown et al., 2013). Since physical activity is a prescription for combatting obesity and associated diseases, it stands to reason that there is dual benefit in regards to mental health issues.

Media tends to focus on childhood obesity rates that continue to be on the rise, but mental health concerns are sizable and equally disturbing. Approximately 20% of school aged children have a diagnosable mental health disorder (Cook et al., 2013) with depression being the most prevalently diagnosed (Brown et al., 2013). Certainly not all mental health issues can be combatted by engaging in physical activity, but a child's overall mental health status does play a significant role in their academic performance. "Students suffering from depression, anxiety, mood disorders, and emotional disturbances perform more poorly in school, exhibit more behavioral and disciplinary problems, and have poorer attendance relative to mentally healthy children" (Cook et al., 2013, p. 132). Vail noted (2006) that regular exercise has the potential to alleviate stress, anxiety, and depression—problems that can affect school performance—boosting self-esteem. By providing adequate amounts of physical activity throughout the school day, schools exhibit interest in both the physical and mental well-being of children.

What is the mind-body connection?

Dreher (2003) describes how modern medicine often tries to separate the body into two entities; a physical body and a mind. However, it is becoming more evident than ever that our minds including our emotions, learned behaviors, and thoughts exert tremendous influence over our physical condition. Connection would tend to imply that two separate entities are intertwined or linked. However, the mind and body are not separate from one another but united. In fact, neuroscientists and researchers have found no real division between the mind and body; instead a network of communication that exists throughout all systems of the body, demonstrating a universal language effecting multiple levels of the mind and body (Brower, 2006; Dreher, 2003).

Due to the mind-body connection, it can be expected that exercise is not only vital to keeping the body physically fit, but also mentally fit. When one exercises their fatigue levels drop, and they become more alert and better able to concentrate. How does this happen? The body releases endorphins which are often referred to as the body's natural painkiller. When endorphins are released the body feels more energized, more focused on tasks, body rhythms become normalized, and overall mental well-being is improved according to the Anxiety and Depression Association of America ("Physical Activity

Reduces Stress", 2016). In fact, a mood-enhancement effect takes places even after as little as 5 minutes of physical activity.

Depression

One of the most common mood disorders is depression which can be defined as pessimism, sadness, incompetence or despair brought about by natural constitution, hormones, and lack of self-confidence or inferiority (Aliabadi, Zobairy, and Zobairy, 2013) that is self-pertuating and reoccurring (Otto, 2011). Physical activity helps to combat depression by "stimulating the brainstem and giving us more energy, passion, interest, and motivation" (Ratey & Hagerman, 2008, p. 135). When children or adults are depressed, it is very challenging to ask them to start moving their bodies; one might describe depression as the absence of moving entirely. However, when they do, it is an accomplishment in itself. Physiologically, exercise adjusts the release of various chemicals thereby maintaining psychological equilibrium and in turn diverting negative feelings. When endorphins are released flooding the central nervous system, a sense of calm and improved mood occurs. In fact, if one is not physically active, irritability, anxiety, and restlessness can creep in due to the low levels of endorphins in the system (Cook et al., 2013). Psychologically, physical activity can improve depression by providing social interactions and through improving self-efficacy. Often people tend to choose to participate in physical activity with others for accountability purposes or to establish a sense of connectedness, also referred to as social integration (Otto, 2011). Self-efficacy is a person's belief that they can achieve or accomplish a task. Typically social interaction and support will improve self-efficacy and adherence to exercise. In turn, satisfaction and even feelings associated with success are achieved improving symptoms associated with mood (Kravitz, 2011). In fact, even those that find exercise inherently unpleasant reap the immediate positive mood swing once their workout is complete. Being able to complete a challenging task is proof that one can help themselves perpetuating an increase in self-esteem and self-worth (Ratey & Hagerman, 2008).

In addition, physical activity can serve as a distraction from negative thoughts and emotions. Rather than focusing on worries or concerns, thoughts are interrupted by engaging in some sort of demanding physical task. Through physical activity, one can temporarily focus on something else breaking the negative thought cycle. Exercise can be a motivator and can help to re-energize an individual.

Several studies have been performed to demonstrate the effectiveness of physical activity in relation to depression. Brown and colleagues (2013) performed a meta-analysis to determine the relevance of physical activity as a means of treatment and prevention of depression. They noted that depression had substantial influence on cognitive function and academic performance. The authors reviewed nine high quality studies to find physical activity having a small, but significant treatment effect on children aged 5-19. They speculated that neurobiological mechanisms (endorphins) and psychosocial mechanisms (improved self-worth) were the rationale for their positive results (Brown et al., 2013).

A study conducted in Australia by Kremer et al. (2014) looked at the relationship between physical activity, leisure time screen use, and depression. The results supported the notion that those students meeting the recommended daily physical activity guidelines demonstrated fewer depressive symptoms that those students that did not. The survey used highlighted questions involving activity participated in during school hours as well as after school. After controlling for age, gender, socioeconomic status, and location, Kremer et al. (2014) demonstrated that those children who engaged in physical activity and less screen time exhibited lesser depressive symptoms. The significance signaled the authors to call for further activity during the school day whether it was outside of class time at school or being extremely active during physical education. Another practical implication from this study was the importance of diversifying activities offered to promote the participation of students thereby leading to a potential decrease in depressive symptoms (Kremer et al., 2014).

Rothon et al. (2010) surveyed 11 to 14 year old adolescents from the United Kingdom to determine if physical activity prevented and or decreased depressive symptoms. The authors found an inverse relationship between the two variables decreasing depressive symptoms by 8% through increasing boys' and girls' physical activity by as little as one hour per week.

Even though the Rothon study found an inverse relationship between physical activity and depressive symptoms, the association between the two variables is uncertain. It is more likely that there is a bi-directional relationship; physical activity may improve mental health or people are more physically active when they are in good mental health (Cook et al., 2013).

However, it is well established that as children age, there is a trend for students, particularly females, to participate in less physical activity. This decline in activity often is parallel to an increase in depressive symptoms. In 2015, the National Institute of Mental Health found that 17.3% of adolescent females experienced a depressive episode as compared to 5.7% of adolescent males ("Major Depression" 2015). For this reason it is imperative to at least try to seek physical activity as a possible treatment and protective mechanism to ward off depression in children and adolescents (”Major Depression," 2015).

Literature suggests that depression has significantly impact on a child in a variety of ways. Not only can a depressed child have impairments in social situations, but they can see cognitive and academic decline as well. This would obviously affect their ability to learn in the classroom and performance on assessments (Brown et al., 2013).

Anxiety

Anxiety is a reaction to stress while stress is a response to a threat in any given situation (ADAA, 2016). Typically anxiety is characterized by excessive worry, avoidance, and feeling keyed up or distracted (Otto, 2011). When children are engaged in more vigorous physical activity, they are less likely to suffer from anxiety (Gosmann, 2015). In fact, those that participate in chronic physical activity are less likely to suffer from several psychological symptoms, while sedentary behavior is often a risk factor. The theory is that as exercise increases so does heart rate and breathing increase similar to those symptoms associated with an anxiety attack. If one is engaging in regular physical activity, the body's recognition of exercise symptoms improves and the realization is made that fear of an anxiety attack is unnecessary. Also, "physical activity lowers the resting tension in the muscles….if the body is calm, the brain is less prone to worry"

(Gosmann, 2015, p. 91-92). If we can decrease anxiety in children, they will be more relaxed and able to perform optimally when given a challenge in the classroom.

Stress

Stress can be defined as the brain's response to any demand or challenge. Stress is a necessity of life and can be positive or negative; chronic or acute. However, if stress persists over an extended period of time, the effects can be quite harmful and lead to chronic illnesses.

As stress invades the system, the brain sets off a cascade of hormones that focus the body and stimulate the fight or flight response. The neurotransmitters release norepinephrine and dopamine helping to arouse one's attention and sharpen their alertness. Another key player controlling stress is cortisol. Once it is released during the stress response a few consequences can follow. "A little bit (of stress) helps wire in memories; too much suppresses them; and an overload can erode the connections between neurons and destroy memories" (Ratey & Hagerman, 2008, p. 67). Obviously just the prescribed amount is needed for the body to recognize that the stress is not always negative, but prepares the body to perform optimally on whatever task lies ahead.

Exercise is a way to control the emotional and physical characteristics associated with stress. Being that exercise itself is a stressor, it forces your body to adapt to demands placed upon it (Otto, 2011). Ratey and Hagerman (2008) state that exercise causes brain activity to occur leaving by-products that can damage cells. However, the body's natural repair mechanism leaves cells that are more resilient for future challenges. "Neurons get broken down and built up just like muscles. This is how exercise forces the body and mind to adapt" (Ratey & Hagerman, 2008, p. 60).

The stress of exercise is predictable and controllable. If we engage in regular aerobic activity, it enables us to handle more stress by raising the threshold it takes to activate or increase our heart rate and stress hormones. Mild stress brought about through exercise activates the production of certain proteins to prevent cell damage and disease while simultaneously producing endorphins that allow us to feel good. These endorphins stabilize our mood by enabling us to reach a certain level of calmness, shedding tension our bodies may be storing, and allowing us to focus on a single task more efficiently. With newly found enthusiasm and vigor, a child could face challenges, and lessen their feelings of being overwhelmed by responsibility through a single bout of exercise. This has significant impact on how children perceive stress freeing up their ability to focus on activities in the classroom.

Attention

Besides affording us the ability to adapt to stressful situations, physical activity plays a role in attention. Attention is "the ability to inhibit interest in unimportant stimuli and motor impulses" (Ratey & Hagerman, 2008, p. 150). Inhibition involves several neuropsychological functions like working memory and self-regulation that are also essential for successfully performing academic tasks in a classroom setting. If physical activity can be demonstrated to improve one's inhibition then in turn it can improve self-regulation leading to an increase in academic performance (Verret, 2012).

Attention deficit hyperactivity disorder (ADHD) was officially defined in 1980 as a dysfunction of the brain's attention center which is found in the prefrontal and frontal regions of the brain (Gapin, 2011). The prefrontal cortex has many responsibilities, including being responsible for controlling arousal, motivation, reward, movement, and executive functioning. It helps us to eliminate distractions allowing us to cope with multiple problems at once. The prefrontal cortex helps regulate our behavior as well as dealing with working memory. Working memory is a system for holding, managing, and transferring information required to carry out complex cognitive tasks such as learning, reasoning, and comprehension (Pickering, 2006) and is needed when there is a delay of a reward. Someone with ADHD tends to procrastinate because they find it hard to keep track of time. If one cannot stay on task, then they are never able to focus long enough to process a task at hand leading to procrastination (Ratey & Hagerman, 2008).

Today we know that the attention system is regulated by two chemicals: dopamine and norepinephrine. Dopamine's primary job is to signal the reward system. This is crucial because the reward center must be stimulated sufficiently to signal the prefrontal cortex that attention needs to be paid. Without the reward center being activated, the brain is unable to be "turned on" and attention is not achieved. The reward center is a "cluster of dopamine neurons responsible for doling out pleasure or satisfaction signals providing the necessary drive or motivation to focus" (Ratey & Hagerman, 2008, p. 142). What stimulates one's reward center in order to capture the brain's attention, does not necessary activate the next person's reward center (Ratey & Hagerman, 2008).

Approximately 2.5 million American schoolchildren (Pontifex et al., 2013) and 5.3% of the world population are diagnosed with ADHD (Kamp, 2014). Symptoms that are commonly exhibited resulting in diagnosis include fidgeting, doodling, impatience, overreacting, and quickness to anger (Ratey & Hagerman, 2008), while the three main characteristics expressed consistently in association with this disorder are inattention, hyperactivity, and impulsivity (Verret, 2012; Ratey & Hagerman, 2008). On occasion hyperactivity can present as someone hyper-focusing on a subject to the point of obsession. In other words, they become so focused on one task that they cannot attend on demand to a more important task (Ratey &Hagerman, 2008).

With such a large percentage of American children being diagnosed with ADHD, there is no wonder why studying the effects of physical activity on attention should be of interest. This is especially true due to academics being a main focus during developmental years. The most proven and effective treatments currently used for the 3-7% of American school aged children diagnosed with ADHD include medications and behavioral training for parents, teachers, and peers (Ziereis, 2015). Even so, it has been speculated that physical activity can also prove to be a worthy treatment. Both animal and human studies have suggested that physical activity affects behavior and cognition although not enough studies have been performed to prove this suspicion held by many parents, teachers, and health care professionals (Verret, 2012). Teachers have found their students to be much calmer following recess because exercise is believed to 'burn energy' (Ratey & Hagerman, 2008). In reality, the prefrontal cortex has been "turned on" and a student is prepared to attend. When exercise is performed, it increases the amount of dopamine and norepinephrine, two chemicals found in ADHD medications. Once they are in the system, they lead to growth of new receptors in specific locations in the brain causing a smooth shift of attention and a decrease in the tendency to react out of proportion (Ratey & Hagerman, 2008).

Dopamine, norepinephrine, and other hormones released during physical activity alter memory leading to increased cognitive functioning. It has been found that complex activities, such as aerobic dance and martial arts, are able to activate several areas of the brain including the cerebellum, prefrontal cortex, and brainstem all comprising the web-like attention system. The ability of the cerebellum to regulate information is through the presence of dopamine. The significance of this is that the cerebellum's primary functions are to deal with coordination of movement and the management of the flow of information regulating the brain's systems. In turn, the ability to move effectively requires one's attention system to be in sync. Therefore, movement and attention are linked together for appropriate function (Ratey & Hagerman, 2008). If there is too much or too little dopamine, attention will become altered, and one of two things will happen: either attention is unable to be paid or the individual becomes consumed by the task demanded (Ratey & Hagerman, 2008).

This dynamic was examined by Morand (2004) who looked at 8-11 year old boys with ADHD. He proposed that through engaging in martial art activities twice a week during school hours, several maladaptive behaviors would decrease such as poor academic and behavioral performance. Specifically he examined behaviors such as completion of homework, following classroom rules, inappropriate callouts, inappropriately leaving the seat in class, improved academic performance, and improved classroom preparation. Morand (2004) found behaviors and performance to improve when it came to finishing more homework, preparedness for class, improvement in grades, and fewer rules broken after participating in the 12-week study.

Silva et al. (2015) performed a study comparing adolescents identified with ADHD and those without. He had both groups participate in a relay race of sorts in order to increase their heart rate within a target zone. Immediately following the physical activity they were to play and computer game that required critical thinking skills. It was determined that those with ADHD did show improvement with their attention for about 5 minutes immediately following intense physical activity. The rationale is that during intense physical activity, the release of serotonin, norepinephrine, and dopamine cause excitement. Once those chemicals return to normal levels, normal attention and focus is resumed. This is beneficial to those with ADHD because it allows their levels to balance out and increase their ability to attend (Silva et al., 2015).

For years it has been suggested that children grow out of their diagnosis of ADHD. It is no coincidence that by one's early twenties the prefrontal cortex matures. Once prefrontal cortex maturation is achieved, the ability to inhibit distracting or unnecessary impulses occurs (Ratey & Hagerman, 2008).

Even today, one might speculate that a larger number of adults have difficulty paying attention. In a world with constant overstimulation from the multiple electronic devices and gadgets we possess, it is easy to understand why the majority of us might be easily distracted from time to time and not able to give full attention to a specific task at hand. In particular, we are so used to multi-tasking using several devices that we are constantly receiving stimulating information in which to process. As we continue to lead hectic lifestyles and allow ourselves to be flooded with information from computers, phones, and gaming devices, we become less able to attend to a given source of information. We lose patience and seek out other ways to feed our need to attend to many different sources. The use of electronic or hand held devices exacerbate ADHD symptoms. Weiss et al. (2011) states that some of the negative behaviors that increase with a rise in time spent playing on the internet include responding quickly, the need for an immediate reward, impulsivity, and hyperfocusing.

Regardless whether a student has been diagnosed with ADHD, attention is needed for successful academic performance. In order to achieve good cognition, it is imperative that the brain be turned on, and we are able to attend to the task at hand. Physical activity helps to regulate necessary chemicals in the brain to trigger one's attention. Once attention is gained, behavior is altered and one is more prepared for learning to occur leading to successful cognitive performance. Ratey and Hagerman (2008) state, "Exercise is the single most powerful tool you have for proper brain function" (p. 245). The next task is finding a type of exercise that is enjoyable, allows you to work up a sweat, and can be committed to on a daily basis.

Stress, anxiety, depression, ability to attend, and self-esteem all influence how students perform academically. If exercise can benefit the body in so many different ways physically, emotionally and psychologically, it makes sense that academics would benefit in turn.

Executive functioning

There are many explanations as to how physical activity effects executive function or the ability to control and coordinate cognitive functions such as critical thinking, learning, and decision making (Engelhardt et al, 2016). For optimal cognitive function, several elements are needed. An extremely important factor in being able to focus and control one's actions has to do with filtering out irrelevant environmental information. Chaddock et al. (2012) refers to this as cognitive inhibition. Second, cognitive flexibility is the ability to use information and adapt it to certain situations. Lastly, working memory is imperative to temporarily store and manage information while learning and responding to cognitive challenges (Chaddock et al., 2012). All of these cognitive operations are imperative for academic achievement and success whether on standardized tests or in real world situations.

A potential relationship of fitness to cognitive functioning could be explained through physiological and psychological mechanisms. For example, "physical activity stimulates neural development, enhances circulation, increases blood flow to the brain, and raises levels of norepinephrine and endorphins—which collectively may decrease stress, improve mood, stimulate a calming effect after exercise, and as a result possibly improve academic performance" (Wingfield, 2011, p. 1). This theory directly supports the mind-body concept.

Ratey and Hagerman (2008) believes our brain to be an adaptable organ that can hypertrophy or atrophy much like a muscle. Through physical activity neurotransmitters are kept in balance and brain derived neurotropic factors (BDNF) "improve the function of neurons, encourage their growth, and strengthen and protects against the natural process of cell death" (Ratey & Hagerman, 2008, p.40). In other words, it acts as a Miracle Grow for the brain (Ratey & Hagerman, 2008).

Is there time for physical education?

Numerous studies refute the notion that physical education harms academic achievement and in fact, may have a modest favorable effect on achievement (Carlson et al., 2008). Sibley and Etnier (2003) stated, "these results are important because the extra time spent in physical education has associated physical benefits and the use of school time for physical education as opposed to academic subjects resulted in either improvements or no change in academic performance"(p. 244). Sallis et al. (1999) concurred when they found the most valuable information gained from their study was that replacing a core academic class and replacing it with physical education did not adversely affect overall achievement. In fact, Shephard et al. (1997) found replacing 240 minutes per week of academic class time with increased physical education led to higher standardized math scores. Schools striving to meet the national health standards of daily physical activity should not fear it negatively affecting their students' academic achievement. Time and time again the belief that physical education is taking time away from what some school officials deem "more important" core classes is an unacceptable reason for reducing or eliminating physical education program (Carlson et al., 2008). The seemingly thoughtless and effortless way in which school administrators and politicians dismiss physical education as a relatively cheap and easy way to encourage healthy physical and mental behaviors perpetuates the message to parents, teachers and students that students' physical fitness and general well- being is not important and has no bearing on academic performance (Wingfield, 2011). In fact, I would challenge that many politicians and school administrators have turned a blind eye to the evidence and enormous amount of literature supporting their most important responsibility as educators—to produce physically and mentally healthy students that can contribute positively to society.

Studies supporting physical activity in school

A study performed in California used the Fitness Gram to assess students' fitness (aerobic capacity, body composition, flexibility, trunk strength, and upper body strength) and how it correlated to students' SAT scores. Those who were fit or met more of the fitness standards scored higher in both math and reading SAT scores than those unfit counterparts. A statistically significant improvement was found academically as each additional physical fitness standard was met for both reading and math. Grissom (2005) also found a relationship between fitness and academic achievement consistent across gender and socioeconomic divisions. He used the National School Lunch program as an indicator of socioeconomic status, and found generally that children of higher socioeconomic status achieved higher physical fitness and academic achievement scores when compared to the lower socioeconomic peers. However, in both groups it was noted that the higher they performed on the physical fitness test, the higher their academic achievement, inferring that physical fitness can affect how a student performs academically regardless of their financial situation (Grissom, 2005).

Remarkably, Coe (2006) discovered that when children were engaged in as little as 19 minutes of vigorous physical activity there was a positive association with academic performance. Hillman et al. (2009) concurred when they found with only a light to moderate single 20-minute bout of exercise cognitive performance increased.

Chomitz et al. (2009) also found a positive relationship between physical fitness and academic achievement specifically in Math and English in 4th, 6th, 7th, and 8th grade students. Castelli et al. (2007) observed similar results when field tests of physical fitness were positively related to academic performance in math and reading in 3rd and 5th grade students.

In another study performed by Castelli and Hillman (2007), it was discovered that 8-10 year old students' total fitness positively correlated with academic achievement measured by the Illinois standardized test. The researchers also noted that the higher the students' body mass index, the lower their academic test scores. This would lead one to believe that the healthier the student, the more academically successful (Vail, 2006). A similar study performed in the Northeast found that as the number of fitness tests passed increased so to be their odds of passing the state achievement test in the areas of English and Math. Likewise, a study performed in Quebec, Canada found that one hour per day of additional physical education was significantly related to improvements in standardized Math test scores for elementary aged children (Chomitz et al., 2009).

Sibley and Etnier (2003) conducted a meta-analysis of 44 studies to determine if there was a correlation between physical activity and cognitive performance. The authors reviewed all English language studies written prior to January 2002 that pertained to physical activity and its relationship to cognition or academic performance. Perceptual skills, intelligence quotient, achievement, verbal tests, mathematics tests, academic readiness were all found to improve among school aged children with physical activity.

Based on what appears to be unquestionable benefits associated with physical activity, it would seem that school administrators and politicians would pay attention to such results. In addition, because many school administrators and politicians may not be well versed on the specifics of physical activity and its effects, it might behoove them to obtain viewpoints from physical educators directly.

Physical educators' views on PE and academics

Physical educators understand the ramifications of physical inactivity and are strong proponents of physical education in schools. The Society of Health and Physical Educators (SHAPE) recommends that elementary aged children should spend 150 minutes per week attending a physical education class while middle and high school aged children receive 225 minutes per week all year ("Physical Education Guidelines", 2014). McCullick et al. (2012) found that only six states mandated 150 minutes per week of physical education for elementary aged students. They stressed that there is a strong misconception between physical activity and physical education. Many schools feel that they are meeting the 30 minutes of physical activity per day recommendation by granting students recess. However, recess does not meet the rigors of a regularly scheduled physical education class. In order to reap the physical and mental benefits of physical activity, most research suggests a student must be engaging in moderate to vigorous activity for at least 150 minutes per week for elementary aged children; recess does not guarantee such intensity.

Most physical educators are passionate and relentless about wanting to educate the public about the injustice they feel students receive with the limited amount of time spent in physical education. Their frustration stems from not only the lack of time spent in physical education but also the lack of physical activity students receive when teachers resort to cancelling recess or limiting recess. Teachers who feel their students are falling behind or not grasping a concept, might use recess time for remediation or review rather than allowing the children to expend some perhaps pent up energy. Again, those few short minutes engaging in physical activity might be just the required prescription needed to focus and engage in a mentally challenging concept.

Due to the ambiguity in state school based physical education policies, physical educators are calling for a mandated number of days and minutes per week students should be engaging in physical education. Many other states are currently seeking to mandate tougher physical education standards (McCullick et al., 2012).

The difference between physical activity and physical education

Even though there is some overlap in the terminology, physical activity and physical education should not be used interchangeably. Physical activity can be achieved through a student simply moving their bodies. Physical activities can include a wide variety of things like dancing, chasing lightning bugs, playing tag, or jumping rope. These are activities that a student can do in a variety of settings to expend energy, improve coordination, and to stress muscles and bones. However physical education has some similarities in how it affects the physical body but it does more than just that. Physical education impacts are long term health and lifestyle by incorporating instruction regarding health, nutrition, fitness, and spiritual well-being. The knowledge gained through physical education allows the students to understand the importance of physical activity throughout the lifespan and on overall physical, mental, and spiritual health.

The concept of physical activity providing holistic benefits has been described above. It is undisputable that physical activity overwhelmingly has positive rewards and is imperative to remaining healthy. Sattelmair & Ratey (2009) pointedly suggested, "Movement is essential not only to the health of students but to the very goal of schools: educating students" (p. 235). If parents, educators, and administrators are truly seeking to provide an educational environment, they must pursue an environment that engages students consistently throughout the day in some type of physical activity.

Due to the current research that supports the notion that exercise improves cognition and academic performance, physical activity absolutely must be mandated (Sattelmair & Ratey, 2009). Sattelmair and Ratey (2009) call for improving the amount and quality of physical education offered. Some researchers believe that traditionally physical education has failed students by not engaging them in intense enough activity to attain the proposed benefits. Even though physical activity is correlated with improved academic performance, if physical education does not require students to perform at a sufficient level of activity, optimal academic performance will not be achieved (Sattelmair & Ratey, 2009).

Ratey and Hagerman (2008) believe that exercise prior to academic challenges "sparks biological changes that encourage brain cells to bind to one another. For the brain to learn, these connections must be made" (p. 10). Exercise is able to create an environment that is most suitable for the brain to learn. By putting students in a state of heightened awareness, their brains are most “awake” to absorb new information.

Regardless of whether or not physical education is mandated daily, it is imperative that multiple bouts of physical activity need to be interspersed throughout the day for students to meet the national guidelines. Ideally, all students would receive physical education on a daily basis for at least 45 minutes. As well, if it could be scheduled early during a zero hour period or one of the first class periods of the day it would be best for optimal function. Mandatory recess, brief physical activity bouts throughout the school day, and physical activity opportunities within extended school programs would also help contribute to the overall recommended 60 minutes. Every time these bouts of physical activity are introduced during the school day, the significant neurological and physical benefits would “wake up the brain” potentially leading to a positive response to academic challenges.

Conclusion

There are countless physical and psychological benefits resulting from physical activity. Mandated physical education courses are one way to ensure that students are getting regular physical activity thereby impacting up to 56 million children attending schools in the United States. Since it is mandatory for students to attend and participate in all subjects whether they are considered core or special areas, students participating regularly in physical education would increase their physical activity levels. Based on this conclusion, it can be assumed that the more time children spend in physical activity, the higher their academic achievement would be. Substantial evidence supports that physical and mental process influences one another. If current research continues in to find positive correlations between physical activity and academic performance, then physical education should be considered a core class rather than an extracurricular class. (Vail, 2006).

Based on all the research, parents, educators, students, and administrators could all benefit by seeking new ways or interventions to promote movement, sparking a change in the American mentality. In doing so, they could improve the cognitive performance of their student simply by increasing their aerobic capacity. "By promoting fun physical activity of a proper dose during the school day, children may not only optimize academic potential but learn and practice healthier lifestyle habits, reduce health risks associated with obesity, and develop a foundation of knowledge and practice that will benefit them through adulthood" (Wittenberg, 2012, p. 2306). If this statement is accurate, not only are we producing students that will be best equip to handle the rigors of academic life and work but produce students that are healthy enough to contribute to society. It is imperative to provide continuous support for the ever-increasing need for physical activity in schools. Due to the growing pressures placed on students and teachers to perform well on standardized exams, it is necessary to prove that consistent physical activity not only leads to physical benefits, but academic improvement. It is vital to enlighten administrators and politicians of the cognitive benefits physical activity provides since that is what drives education today.

“When policy makers need to make difficult decisions about where to spend public funds and administrators need to make decisions about where to focus resources in a climate of academic accountability, a proven relationship between physical fitness and academic achievement could be used as an argument to support, retain, and perhaps even improve physical education programs" (Grissom, 2005, p. 2).

CHAPTER III

METHODOLOGY

Given the established relationship between physical activity, neurological function, and academic achievement, the present study investigated the extent to which a physical activity intervention might positively affect elementary students' academic performance. After describing the study context, this chapter details the intervention, measures, and data analysis techniques used to assess the research question.

Study context

The study centers around a zero hour (i.e., prior to the school day) physical activity program at a public elementary school in a mid-sized city (pop. ~115,000) in the southeastern United States. Known as the Leadership School, this public city school uses the Leader in Me philosophy by integrating the teaching, modeling, and practicing of skills to develop a culture of leadership amongst students and educators. Stephen Covey's Seven Habits of Highly Effective People is the text that guides all of the leadership-related activities of the school. Due to the holistic nature of Covey's curriculum, this city school was identified as being an ideal setting for an innovative physical activity program. School administrators believe that if students are given the tools and have experienced the significance physical activity can have on their life, they will be more likely to become proponents of physical activity for their family and peers.

Participants

Due to the highly constrained nature of school curriculums and class instruction, the study's intervention took place in the Leadership School's Extended School Program

(ESP), and specifically in its morning program that occurs prior to the official start of the school day. As such, participants were recruited from the 80 students who participate in the school's ESP during the morning hours on a regular basis. Recruitment took place via flyers and face-to-face interactions at early morning drop off. Participating parents were asked to sign a consent form to allow their student to participate in the research study. Students were then assigned to the traditional program or the zero hour physical activity program based on the order in which consent forms were received. Each student was also asked to sign an assent form and record their age. Demographic data was available for the Leadership School overall, though not specifically within the ESP. Of the 379 students attending the Leadership School, 62% receive free or reduced lunches with a racial demographic of 13% Hispanic, 24% African American, 49% Caucasian, and 13% two or more races. Only students aged 7-12 enrolled in the extended learning program were invited to participate in the five-week physical activity program. Twenty-six third, fourth, and fifth grade students agreed to consistently participate in the program, Monday through Thursday mornings from 7:25 until 8:10am.

Program design

The program was designed to facilitate relatively low-skilled physical activities that elevated students' heart rates for 35-45 minutes. Beginning at approximately 7:25, students were welcomed and activities began. A wide variety of activities were used but most popular were those including jump rope games, cone and ladder drills, team sport drills including basketball and soccer, rotating callisthenic stations, and obstacle course games. Activities concluded around 8:05 so that students could prepare for the initial school bell. Participation was facilitated by school staff members, the researchers, and several undergraduate students from a nearby university. The undergraduate students all underwent a semester long independent study to plan and practice the facilitation of activities, choose age appropriate activities, and consider the risk and liability of such a program. The program ran Monday through Thursday for a total of 5 weeks during the Spring semester. This allowed the researcher to obtain the AimsWeb test scores prior to the initiation of the program for comparison to the end of the year scores at the conclusion of the program.

Research design

A quasi-experimental group design was employed to examine if in fact the intervention had an effect on participants' academic performance. The participants were split into two groups--an intervention group, i.e., those participating in the physical activity program, and a control group, i.e., those not participating in the program. As discussed above, both the intervention and control groups were comprised of 13 students from an already established extended school program and in the third, fourth, or fifth grades.

Measures

Prior to the implementation of the physical activity program, several measures were taken before the beginning of the school day during the extended school program's regular meeting time. All students' heights were recorded through use of a tape measure in inches. Weight was collected using a Health-o-meter standard scale and measured in pounds. Students then sat quietly to obtain a resting heart rate for 60 seconds. Lastly, a

PACER test was administered pre and post program to assess each student's physical fitness level.

The PACER (Progressive Aerobic Cardiovascular Endurance Run) or beep test was used to determine the student's fitness level. This test is typically used for younger ages for a variety of reasons. One reason it is effective is because it is fun for students versus running a mile on the track (Nova Southeastern University Pacer Manual, 2017). They can challenge themselves and compete with other students during its completion. The test allows them to rest briefly if they are able to keep up with the pace required giving them a sense of accomplishment and motivation. Also due to the design, those less fit or who typically finish last actually finish first unlike many other physical activities. The rationale behind performing the PACER test is to encourage students to have fun while learning how to pace oneself.

PACER test scores had been completed previous to the intervention as part of the students' physical education class in the fall and winter. The researcher collected both sets of scores and performed the PACER test at the conclusion of the intervention to assess whether a change in fitness level occurred.

Acquisition of pre- and post-AimsWeb math and reading test scores were significant for comparing the intervention and control groups. AimsWeb is used to identify students at risk, monitor their progression, and determine response to intervention. The scores from such tests are reported at the student, class, grade, and national levels. These were obtained from the principal for confidentiality reasons at the conclusion of the physical activity program.

Analysis

Once the data was reviewed for missing values, it was input into SPSS. An ANCOVA(pre- and post-; 13 intervention students and 13 control students) was performed to compare mean differences between the interaction and control groups related to the changes in their AimsWeb test scores at time one and time two.

Due to the subjects all being selected from those enrolled in the school's extended school program and the inability to truly randomly select students, it was determined that the ANCOVA would be the most beneficial. ANCOVA analysis is used when a pre-test/post-test experimental design is implemented. In this case, the dependent variable is the post-test score and the independent variable is the physical activity group versus the traditional extended school program. Test scores were attained at the conclusion of the study, making controlling for an even distribution of pre-test scores impossible. As well, even if the pre-test scores had been gathered in advance, then the random selection process would have been tainted. Since the study itself had some limitations in regards to control, researchers were able to statistically control for the variation between the two groups of students. Using the ANCOVA allowed for the pre-test scores to be statistically controlled for and become the covariate. A Pearson's correlation was computed to assess the relationship between the post-intervention resting heart rate and the post-intervention AimsWeb reading scores.

CHAPTER IV

RESULTS

Two one-way between-groups analysis of covariance were conducted to compare the effectiveness of the physical activity intervention designed to improve academic achievement for both math and reading. The independent variable was the zero hour physical activity program versus the traditional extended school program, and the dependent variable consisted of math and reading AimsWeb scores administered after the intervention was completed. Participants' scores on the pre-intervention administration of the math and reading AimsWeb exam were used as the covariate in this analysis.

After adjusting for pre-intervention scores, there was a significant difference in reading for the zero hour physical activity intervention group F (1, 23) =6.157, p = .021. Tables 1 and 2 contain descriptive statistics for reading performance (DV) and multiple comparisons or test scores. An alpha of .05 was used for all analyses. The ANCOVA saw a significant effect size in reading scores with those students involved in the intervention group as compared to the control group. Cohen's d statistics were calculated for the reading scores with d=.73 for the intervention group and d=.48 for the control group solidifying the significance.

Tables 1 and 2 also provides descriptive statistics for math performance and multiple comparisons or test scores. The ANCOVA did not find any significant differences between the intervention and control group F (1, 23) =.252, p=.621.

Table 1.

Descriptive Statistics for Reading and Math and Multiple Comparisons (pre-test scores)

Variable	Intervention		Control	
Reading	Mean	*SD*	Mean	*SD*
rT1	99.0	42.3	94.3	43.7
rT2	124.3	50.9	105.9	48.9
Adj. M/Std. Error	121.6	3.7	108.5	3.7
Math	Mean	*SD*	Mean	*SD*
mT1	13.3	6.1	7.4	3.4
mT2	14.2	5.8	8.9	5.1
Adj. M/Std. Error	14.2	5.8	8.9	5.1

Based on estimated marginal means

*The mean difference is significant for reading at the .05 level.

Table 2.

Sidak Comparisons on Reading and Math Adjusted for Multiple Comparisons (pre-test scores)

Reading		Mean Difference	95% CI	
(I)	(J)	(I-J)	Lower Bound	Upper Bound
Intervention	Control	13.1*	2.1	24.0

Math		Mean Difference	95% CI	
(I)	(J)	(I-J)	Lower Bound	Upper Bound
Intervention	Control	.9	-2.9	4.8

Based on estimated marginal means

*The mean difference is significant for Reading at the .05 level.

Heart rates and PACER tests were also examined to determine if any changes occurred due to the physical activity intervention. PACER scores were not significantly different between the two groups. However, there was a significant change of heart rate for the intervention group. A Cohen's score of d=.75 was demonstrated by those children participating in the early morning physical activity program whereas the control had a score of d=.3.

Beyond there being a significant change in both heart rates and reading scores for the intervention group, the average change in these two variables should also be mentioned. The average change of heart rate in the intervention group from trial 1 to trial 2 was 7.6 bpm while only 1.1 bpm in the control group. The average change of reading scores for the intervention group from trial 1 to trial 2 was 25 while only an 11.6 change was found in the control group.

A Pearson's correlation was used to assess the relationship between the post-intervention resting heart rates and post-intervention test scores for both reading and math. There was a positive correlation between post-intervention reading scores and resting heart rate, r=.16, p=.43. A positive correlation was also found between post-intervention math scores and resting heart rate, r=.12, p=.57.

CHAPTER V

DISCUSSION

According to the data analysis, both groups improved their math and reading scores. However, using the ANCOVA to control for the baseline reading scores, there was only a significant difference for reading in the intervention group. Unfortunately, there was no significant difference in math. In addition to there being a statistical significance for reading, the effect size was quite large, indicating a practically, meaningful difference between the two groups.

Heart rates did show a large change in effect size for the intervention group. This demonstrates that even physical activity over a 5 week period made an improvement in the students' fitness levels. Heart rate is a simple indicator of physical fitness, health, and predictor of longevity (Kravetz, 2014). In children an average resting heart rate of 60-130 is normal (Schreiber, 2011). Resting heart rates that are low imply efficient heart function. Regular or consistent aerobic exercise leads to the heart not having to work as hard to supply oxygen throughout the body. Those children that have lower resting heart rates and are considered to be physically fit are going to reap the physical, emotional, and academic benefits explored previously. It can be implied that due to an improvement in physical fitness, there might be an association with the improvement in reading scores. The average change in the heart rates found in the intervention group when compared to the control group was larger. As well the average change in reading scores also was larger in the intervention group when compared to the control group. So in this study it is suggested that the greater the improvement in the heart rate, the more likely it was to see improvement in reading scores.

Based upon the analysis and existing research, one could conclude that during the five week period that the students participated in physical activity prior to the school day the binding of brain cells and vital connections made facilitating a more beneficial state for learning to take place. Based on previous research, one could assume that the students were relatively alert, energized, and prepared to absorb new information. Additionally, their mood and well-being may have been elevated due to the release of endorphins.

Just as Ratey & Hagerman (2008) have reiterated, physical activity increases circulation throughout the body and releases several important neurotransmitters. Fatigue levels drop arousing the brain and releasing epinephrine into the system producing a calming effect, increasing concentration, improving attention and mood while lowering stress. Endorphins energize the body and provide overall mental well-being. These chemicals “turn on” the brain as a result of physical activity and impacts key brain functions like concentration and memory. These positive effects contribute to one’s life-long learning (Castelli et al., 2007; Rosewater, 2009).

The significance of the mind-body connection must be impressed upon principals and administrators. If one keeps the body physically fit, the mind is more likely to follow. Therefore even the smallest positive significance should be interpreted as a triumph and certainly outweighs the potential risks of continuing down the path of physical inactivity. As well, an early introduction to the benefits of physical activity could lead to lifelong participation and lowering a student's potential for chronic health issues associated with obesity.

As stated previously, Castelli et al. (2007) have done repetitive studies to demonstrate the relationship between physical fitness and academic achievement. They were able to find global improvement in total academic achievement including both math and reading success. They, too, found the results to be small, but positive nevertheless.

Similarly, another quasi-experiment performed in Texas using third and fourth grade students found those children who participated in more physical activity breaks throughout the day and who performed moderately to vigorously during physical education were more inclined to perform better in Math and Reading on standardized tests. In addition, the most compelling information was found in those children with emotional or behavioral problems; they demonstrated the greatest improvement (Maynard. E.J., Coonan, W.E., Worsley, A., Dwyer, T., & Baghurst, P.A, 1987).

Even though the ANCOVA only found significant difference in the reading scores, there is some question as to whether or not there was any clinical significance to administrators and educators. After a previous pilot study, conversations with the principal and behavioral specialist were enlightening. They were very much aware of the literature and effects of physical activity on academic achievement, and both commented on the seemingly happier disposition of the students. Not only was their outlook toward school more positive, but they also appeared more ready for the school day to begin. There were fewer discipline issued reported during those few weeks that students were participating in early morning physical activity, presumably because they were more engaged and focused on the tasks asked of them during school hours. All of these changes in emotional disposition and behaviors commented on by the administrator and teacher would certainly lead to an increased likelihood of learning and improved academic performance.

Pearson's correlation measures the strength of the association and based on that, there was no statistical significance in the correlation scores which would mean that both move in the same direction linearly but there is very little correlation between them. There is a positive relationship seeing that they both saw improvements but the relationship is weak. In general those children that performed well in reading should also perform well in math; those children that perform poorly in reading should typically perform poorly in math. Overall as reading scores improved, so too did the heart rates but we can't say that one caused the other.

Obviously, it is beyond the scope of this study to determine exactly how physical activity affected the students individually, but earlier studies would suggest several positive possibilities. Previously mentioned was the number of psychological benefits including mental well-being of students being significantly impacted. It could be suggested that students' mood and fatigue levels improved leading to better attention and concentration.

All in all, the study does support the current literature. It does suggest a correlation between physical activity and reading achievement. There are many possibilities as to why an improvement in math was not observed, but results from this study do suggest that physical activity had no negative effect on the participants. Finally, besides its effect on academic achievement, fitness improvements were made leading to positive effects on the physical well-being of the children.

Limitations

Although the current study did not show similar results for increasing math achievement, there are some possible explanations. Once scores were collected from the principal, it became obvious that when observing the raw math scores the intervention group had a mean score that was significantly inflated in comparison to the control group for test one. The inflation caused concerns that there might be a possible limit in their ability to achieve. This inflation in scores again reinforced the decision to use an ANCOVA and the pre-test scores to serve as a covariate since they possibly could have confounded or influenced the outcome studied. These initial scores left less room for improvement for the intervention group as compared to the control group. As well, a covariate by definition is observed rather than manipulated which in this case was discerned after obtaining scores.

Perhaps most surprising was the decrease found in PACER scores for both groups. The initial PACER scores were done in the students' physical education class prior to the intervention. The second PACER scores were performed by the researcher. It is hypothesized that the dynamics of the test caused there to be a decrease in performance. Students may not have given full effort for a variety of reasons: lack of encouragement provided by a familiar physical educator who had invested in their education all year long, no associated grade or pressure to perform, lack of interest or self-motivation to perform their best, among other potential causes.

Compliance to the program also was an issue. Students from time to time would express a disinterest or dislike for certain scheduled activities. This would lead to a lack of effort, poor attitude, or complete non-compliance until another activity was initiated. Through prodding students would sometimes begrudgingly continue participation but with a lackluster performance.

Lastly, prior to the study it was questioned as to whether or not a large enough sample size could be obtained. However, through further research a smaller group of participants was consistent with similar studies. In fact, according to Fedewa and Ahn's (2011) meta-analysis groups of 10-30 students participating in physical activity saw greater improvements with regards to mental and intellectual benefits than those in smaller or larger groups. This supports the notion that class sizes similar to ours are more beneficial than extremely small or large class sizes.

CHAPTER VI

IMPLICATIONS FOR FUTURE RESEARCH

The implication of this research is that students participating in physical activity prior to the beginning of the school day are more likely to perform better on reading tests. However, it is unclear as to why math scores did not see a similar result. Generally speaking a zero hour physical activity period does prove to have positive benefits on the mind and body of elementary aged children. As demonstrated in this study, the benefits outweigh the costs and can contribute to the health of a child in a variety of ways beyond academic performance. Even if a zero hour physical activity cannot be implemented within the school day, the benefit from increased physical activity throughout the day and prior to academically challenging subjects serves children well. However, many questions still persist that require further exploration.

If this study were to be repeated based upon the association found between physical activity and reading, it would be interesting to find out exactly when those students in the intervention group had reading and math instruction throughout the day. Research suggests that physical activity immediately before an academically challenging subject turns the student's brain on leading to better attention and performance (Ratey & Hagerman, 2008). Perhaps the students involved in the intervention group went directly from the zero hour physical activity to a reading class. In turn, math may have been instructed later in the day and subsequently more time may have passed from students being engaged in physical activity and having an elevated heart rate. A long interval would potentially cause less than optimal blood flow and brain stimulation leading to poor student attention and focus. The importance of this interval suggests that it might be beneficial to periodically take breaks throughout the day to participate in activities that elevate a student's heart rate and an increase in blood flow leading to a greater awareness in the classroom.

Future studies should address several potential variables besides which courses immediately follow activity. Travlos (2010) supports that when children participate in physical education in the morning or midday they demonstrate greater cognitive improvement than towards the end of the day. This may become a scheduling nightmare for administrators, but might be worth the effort considering the outcomes.

Other variables or concerns needing further clarification and scrutiny include physical activity intensity, duration, and use of the PACER test. In this case, physical activity intensity was not accounted for but it would be interesting to determine what kind of intensity is required in order to see academic benefits. A zero hour physical activity program in Naperville, Illinois, boasts the substantial improvements they have seen since 2005 based upon students performing moderate to vigorous physical activity for 20 minutes prior to being immediately dismissed to their most challenging course. This translates to a target heart rate of 145-175 bpm for a 20-minute period for high school aged students. The ideal intensity and time required to see improvements is yet to be decided (PBS, 2011). Additionally, many studies support that vigorous physical activity has larger effects on academic performance compared to lower intensity activities (Carlson et al, 2008; Castelli et al, 2007).

Not only is it necessary to determine what intensity is required to influence academic achievement, but so too is it imperative to determine the minimum time required to engage in physical activity to see improved test scores. Hillman et al (2009) found that children who walked for as little as 20 minutes prior to being given test questions performed better on reading comprehension than their peers who sat for a similar length of time. It also was determined that those who were active also were more likely to read above grade level (Hillman et al, 2009). Moreover, Tomporowski (2003) found that a single bout of exercise influenced a child's attention and memory. It would appear that even a single 20 minute bout of exercise would influence many brain functions that lead to learning and academic performance.

Furthermore, the PACER test scores were appalling and were not an accurate reflection of what the students could perform. In the future some kind of incentive may need to be given to ensure that students put full effort into the task. Only those students that were self-motivated and possessed a competitive nature seemed inclined to give an optimal performance.

Lastly, since the AimsWeb test is given three times a year, the truest representation and significance may be seen through observing all three scores. If a zero hour physical activity program could be implemented throughout the entire school year, an even greater improvement in those engaging in year around early morning physical activity compared to their peers might be observed. Perhaps improved scores would be demonstrated throughout the entire year with the greatest effect scores to be seen at the conclusion of the school year revealing the effects of chronic exercise.

This study found that the students who participated in physical activity prior to the school day saw increased academic success on reading test scores. This should enlighten administrators and educators on the importance physical activity and the role it plays in education. Although this study only lasted for 5 weeks, the results demonstrated were chronic in nature. Simply stated, positive benefits have been seen after only one dose of physical activity last 20 minutes of moderate to vigorous physical activity. Imagine the potential benefits demonstrated if a similar program was implemented year-long. If the mission of the school is to help students achieve academic success and further nurture their developing brains, physical activity is imperative. As well, it contributes to the body of literature encouraging more public awareness and emphasizing the significance physical activity plays in elementary aged children.

At this time there are many unanswered questions regarding the intensity and minimal amount of time required to see improvement in academic performance. However, moderate physical activity even for as little as 20-30 minutes before the school day does show changes in reading. The population of those students involved in the study may have been less likely to participate in any other physical activity throughout the day other than what they received at school due to financial restraints, parent work schedules, etc. Therefore, if children can participate in a zero hour physical activity period or have physical education early in the day, the positive benefits will carry over throughout the day in the classroom.

Pursuing how often children are participating in physical education on a weekly basis to determine if there is a relationship to academic achievement should be continued.

As well, comparing academic improvement between traditional versus new physical education programs being implemented in areas across the country should be observed.

Lastly, children with ADHD are seeing tremendous benefit from participating in physical activity. With the many distractions in today's world, more and more children can be expected to be diagnosed. If effects from this disorder can be minimized or deterred by participating in physical activity, the use of medications would decline and children perform/behave better at school and at home. This concept is in agreement with the current study and ultimately affecting this population's academic achievement.

Based on the research and this study, it would be recommended that students participate in physical activity several times throughout the course of the day. Obviously bouts of 20-30 minutes of moderate to vigorous (60-80% of maximal heart rate) physical activity is ideal but even small bursts would provide the "spark" needed to enhance learning by increasing circulation and neurotransmitter release. If students were participating in a zero hour physical activity period or physical education, at least 20 minutes of moderate to vigorous physical activity through some means (bike, treadmill, dancing, aerobics, etc.) would be recommended before immediately attending their most challenging course. Even if students were unable to attend a zero hour physical activity period or participate in early morning physical education, teachers could employ a physical activity break periodically throughout the day including activities such as jumping jacks, squats, push-ups, sit-ups. After lunch, simply encouraging students to run and climb on the playground would prepare them to attend and focus on information the latter portion of the day.

This study reiterates the benefit that physical activity provides the optimal environment for learning. Brains are “sparked” and ready to soak up new information. With continued support from this study and others similar in nature, it undoubtedly places pressure on administrators and educators to re-appropriate resources, time, and effort. As well it should give teachers further impetus to use physical activity throughout the day as they are held accountable for the academic improvements of their students.

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APPENDIX

APPENDIX A: IRB Approval Letter

IRB

INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Thursday, March 16, 2017

Investigator(s): Kristi Phillips (PI) and Rudy Dunlap (FA)
Investigator(s') Email(s): *kristi.phillips@mtsu.edu; rudy.dunlap@mtsu.edu*
Department: Health and Human Performance

Study Title: ***Academic outcomes associated with an early morning physical activity***
Protocol ID: **16-2025**

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category *(4) Collection of data through noninvasive procedures* A summary of the IRB action and other particulars in regard to this protocol application is tabulated as shown below:

IRB Action	APPROVED for one year
Date of expiration	**10/24/2017**
Sample Size	80 (EIGHTY)
Participant Pool	**Minors**
Exceptions	NONE
Restrictions	**Subpart D applies - vulnerable subjects (MINORS) - Mandatory parental consent (active) and child assent**

Comments	This approval template was generated during continuing review (CR) and subsequently revised on 03.16.2017

This protocol can be continued for up to THREE years (**10/24/2018**) by obtaining a continuation approval prior to **10/24/2017**. Refer to the following schedule to plan your annual project reports and be aware that you may not receive a separate reminder to complete your continuing reviews. Failure in obtaining an approval for continuation will automatically result in cancellation of this protocol. Moreover, the completion of this study MUST be notified to the Office of Compliance by filing a final report in order to close-out the protocol.

Continuing Review Schedule:

Reporting Period	Requisition Deadline	IRB Comments
First year report	9/24/2016	Continuing review has been conducted in accordance with Expedited category 8. Thirty (30) participants have already been enrolled. The review finds the protocol to be in good standing
Second year report	9/24/2017	INCOMPLETE
Final report	9/24/2018	INCOMPLETE

Post-approval Amendments:

Date	Amendment	IRB Comments

10.27.2015	Add Michelle Finney as a co-investigator.	
10.22.2015	Add Jonathan Griffith as a co-investigator.	
11.03.2016	Request to interview the school's Principal (a behavioral specialist) and a few teachers is permitted (Amendment request was made during CR).	
03.16.2017	1. Request to enroll participants to serve as control is approved - these minor participants would only complete the pre- and post-test procedures but would not be involved in other physical activities of this protocol. 2. Students from Discovery School's extended program are approved to be enrolled in the study (permission letter on file). 3. Updated parental consent and child assent forms are approved 4. Request to collect certain demographics information is granted. 5. Administration of the PACER test is approved	

The investigator(s) indicated in this notification should read and abide by all of the post-approval conditions imposed with this approval. Refer to the post-approval guidelines posted in the MTSU IRB's website. Any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918 within 48 hours of the incident. Amendments to this protocol must be approved by the IRB. Inclusion of new researchers must also be approved by the Office of Compliance before they begin to work on the project.

All of the research-related records, which include signed consent forms, investigator information and other documents related to the study, must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data storage must be maintained for at least three (3) years after study completion. Subsequently, the researcher may destroy the data in a manner that maintains confidentiality and anonymity. IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University
Email: irb_information@mtsu.edu (for questions)
irb_submissions@mtsu.edu (for documents)