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Does Physical Fitness Predict the Reading Achievement of Fifth-Grade Students? The Interaction with Gender

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the Reading Achievement of Fifth-Grade Students?

The Interaction with Gender

by

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ABSTRACT

States across the nation are facing pressure to meet standards for high stakes testing which is resulting in a decrease in the amount of time allotted to physical education (Ennis, 2006). Although the U.S. Department of Health and Human Services (2008) recommends children engage in 60 minutes or more of physical activity a day, on average, children only receive 30 minutes per day of aerobic exercise (Epstein et al., 2001). Despite this decrease in physical activity, research has shown that physical activity is associated with academic achievement (Ardoy et al., 2013). In addition, physical activity is positively related to physical fitness (Rowlands, Eston, & Ingledew, 1999), which has also been shown to have a positive relationship with academic achievement (Castelli, Hillman, Buck, & Erwin, 2007). This study is the first to look at how gender moderates the relationship between physical fitness and reading achievement.

Secondary data analyses were conducted with a total of 74, fifth-grade youth. All participants took the Fitnessgram (Plowman & Meredith, 2013) and Discovery Education (Discovery Education, 2014). The Fitnessgram is a standardized measure of physical fitness and activity levels used in schools. It is comprised of the Pacer (a measure of aerobic fitness), curl-ups, trunklift, flexed arm hang, and backsaver sit-and-reach. Discovery Education is a standardized, criterion-referenced assessment that measures students' academic achievement in reading. The data were analyzed using regression analyses in order to determine the extent to which physical fitness predicts academic achievement and the extent to which gender moderates this relationship.

No measure of physical fitness (i.e., Pacer, curl-ups, trunklift, flexed arm hang, and backsaver sit-and-reach) significantly predicted academic achievement. In addition, gender did not significantly moderate any of the relationships. However, the small sample size utilized in this study limited the ability to detect an interaction. When all physical fitness components were included as predictors of academic achievement, the model accounted for less than 4% of the variability in academic achievement. The limitations, implications of findings, and directions for future research are discussed.

CHAPTER ONE:

INTRODUCTION

The push to meet national standards for high-stakes testing in reading and mathematics is being felt by states across the country. As a result of this pressure, there is a reduction in the emphasis placed on subjects such as physical education (Ennis, 2006). Budget cuts have taken away physical education resources (Morgan & Hansen, 2008), some districts offer physical education online (Daum & Buschner, 2012), and general education teachers have replaced physical education specialists (Lee et al., 2012). However, recent programs such as the initiative launched by Michelle Obama called *Let's Move!* (Let's Move, n.d.) and the National Football League's *Play 60* (NFL Rush, 2014) suggest a national interest in promoting children's physical activity. The U.S. Department of Health and Human Services (2008) recommends that children engage in 60 minutes or more of physical activity a day, and research has documented the health benefits associated with physical activity including a decreased risk for obesity (Holmes, Eisenmann, Ekkekakis, & Gentile, 2008) and Type II diabetes (Ball & McCargar, 2003; Reinehr, 2005). Despite these more recent initiatives, on average, children only receive 30 minutes per day of aerobic exercise (Epstein et al., 2001).

The fact that children are not meeting the recommendation for physical activity has contributed to obesity becoming one of the most widespread childhood diseases (Ogden, Carroll, Kit, & Flegal, 2014). A review of longitudinal studies reported that children who were overweight were twice as likely to become overweight as adults compared to normal-weight children (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008). A health complication associated with obesity is Type II diabetes (Ball & McCargar, 2003). A recently published study reported that the incidence of Type II diabetes in 10 to 19-year-old youth increased from 0.34 per 1000 in 2001 to 0.46 per 1000 in 2009, representing a 35% increase (Dabelea et al., 2014). Research points to reduced physical activity as a contributing factor in the childhood obesity epidemic (Holmes, Eisenmann, Ekkekakis, & Gentile, 2008). Moreover, recommendations for preventing or managing Type II diabetes include that children and adolescents should engage in aerobic exercise for 40-60 minutes per day in addition to strength training (Tompkins, Soros, Sothern, & Vargas, 2009). Physical activity is also beneficial for managing other physical health conditions such as juvenile idiopathic arthritis (Tucker et al., 2014), cystic fibrosis (Hommerding et al., 2015), and Duchenne muscular dystrophy (Elliott, Davidson, Davies, & Truby, 2015). Thus, the importance of physical activity in maintaining one's health is emphasized throughout the literature.

Not only does physical activity improve one's physical health, it has been found to improve a variety of mental functions as indicated by scores of intelligence (Ardoy et al., 2013), executive functions (Davis et al., 2007; Wu et al., 2011), and academic achievement (Ardoy et al., 2013; Davis et al., 2007). Sibley and Etnier (2003) and Fedewa and Ahn (2011) conducted meta-analyses on the effect of physical activity on cognitive functioning in children aged 4-18 and 5-16, respectively. Both studies found that the influence of physical activity on IQ resulted in effect sizes of 0.32 (Fedewa & Ahn, 2011) and 0.34 (Sibley & Etnier, 2003). An experimental study by Ardoy and colleagues (2013) also found that increased duration and intensity of physical education resulted in improved cognitive performance as measured by the Spanish Overall and Factorial Intelligence Test (IGF-M; Yuste-Hernández, 2001).

When looking specifically at executive functions, Verburgh, Königs, Scherder, and Oosterlaan (2013) conducted a meta-analysis and found an overall effect size of 0.52 for the effect of physical exercise on executive function domains (i.e., inhibition/interference control, working memory, set-shifting, cognitive flexibility, contextual memory, and planning) in individuals aged 6-35 years. The effect size for preadolescents (6-12 years of age) was 0.57, adolescents (13-17 years of age) was 0.52, and young adults (18-35 years of age) was 0.54 (Verburgh et al., 2013). Castelli and colleagues (2011) found that an after-school fitness program resulted in significant improvements in areas of executive functions spanning the domains of attention, memory, and mental flexibility in a group of youth with an average age of 8.79 years. Researchers have found improvements in response inhibition in youth with an average age of 9.6 years (Hillman et al., 2009), as well as executive functions as measured by the Cognitive Assessment System in overweight youth aged 7 to 11 years (Davis et al., 2011).

Of paramount interest to educators is the relationship between physical activity and physical fitness with academic achievement. Physical activity is "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen, Powell, & Christenson, 1985, p. 127). Whereas physical fitness is "a set of attributes that people have or achieve...the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies" (Caspersen et al., 1985, p. 128). Most often, academic achievement is measured by state standardized tests making it difficult to replicate the findings across states. Nonetheless, several studies have employed physical activity interventions and found positive effects on academic achievement (e.g., Ardoy et al., 2013; Davis et al., 2011; Hillman et al., 2009; Donnelly & Lambourne, 2011; Kirk, Vizcarra, Looney, & Kirk, 2013). When looking at physical fitness, higher academic achievement scores were associated with greater total fitness (Castelli, Hillman, Buck, & Erwin, 2007). Additional studies have found correlations between fitness and achievement to vary depending on the measure of fitness. Bass and colleagues (2013) found the strongest correlation between aerobic fitness and achievement followed by muscular endurance in a sample of middle school students. Similarly, Wittberg, Northrup, and Cottrell (2009) found fifth graders' aerobic fitness to be correlated with all measures of academic achievement, whereas students with greater upper body strength scored higher in math and students with greater flexibility scored higher in math and science. Taken together, this research suggests that there is relationship between academic achievement and physical fitness.

Statement of the Problem

The educational community needs more evidence to make conclusions about the importance of physical fitness. The current body of literature pertaining to physical fitness and academic achievement has focused mainly on correlational data (e.g., Castelli, Hillman, Buck, & Erwin, 2007). This literature demonstrates that various components of physical fitness (i.e., flexibility, aerobic capacity, muscular strength) are correlated with various measures of academic achievement. Additionally, researchers have looked at differences in mean scores for students who met fitness test standards and those who did not meet standards (e.g., Wittberg et al., 2009). However, it remains unknown the extent to which various components of physical fitness predict academic achievement. Additionally, previous research has looked at the relationships between physical fitness and academic achievement separately for boys and girls. This research has found differences in the extent to which aerobic capacity related to academic achievement for boys and girls (Wittberg et al., 2010). Bass and colleagues (2013) also found differing correlations between Fitnessgram components and academic tests for boys and girls. However, no studies have looked at how gender moderates the relationship between physical fitness and academic achievement. By showing that physical fitness predicts academic achievement educators can take a more holistic approach when teaching students by incorporating physical activity in order to promote specific components of fitness. Knowing how gender moderates the relationship will also provide further insight into physical fitness goals for males and females.

Purpose of the Current Study

The purpose of the current study was to determine which components of physical fitness predict academic achievement and the extent to which gender moderates these relationships. Specifically, this study utilized data from a sample of fifth grade students. Determining this relationship has implications not only for practice but for policy as well. Although the Federal government is making a strong effort to increase physical activity in schools, the same zeal across individual states is not apparent (Sallis et al., 2012), as states continue to cut funds related to physical education (Morgan & Hansen, 2008) and do not enforce physical education standards (National Association for Sport and Physical Education, 2012). As such, it is important that educational stakeholders at the state level understand how physical fitness relates to academic achievement. If components of physical fitness predict academic achievement, states may be more likely to allocate time, money, and resources on physical education in schools in order to increase physical fitness.

Research Questions

The specific research questions that this study addressed were:

1. To what extent do components of physical fitness as measured by the Fitnessgram predict academic achievement as measured by the Discovery Education assessment?
2. To what extent does gender moderate the aforementioned relationship?

Importance of the Current Study to School Psychology

The National Association of School Psychologists (NASP; 2010) set forth a *Model for Comprehensive and Integrated School Psychological Services*. The model outlines that school psychologists engage in student-level services such as interventions and instructional support to develop academic skills, as well as interventions and mental health services to develop social and life skills (NASP, 2010). By understanding the relationship between physical fitness and academic achievement, school psychologists can aim to increase various components of physical fitness as a possible intervention to use along with strategies aimed at specific academic skills. The model also specifies that school psychologists engage in systems-level services such as school-wide practices to promote learning (NASP, 2010). Increasing physical fitness can serve as a school-wide practice via physical education. By understanding the extent to which physical fitness predicts academic achievement, the field of school psychology can move toward incorporating practices aimed at increasing physical fitness to help improve students' academic achievement. Additionally, a better understanding of the importance of physical fitness for academic achievement will further the field of school psychology by offering additional avenues through which to intervene when students have academic difficulties.

In addition to informing interventions, this study has the potential to promote policy change. In a survey administered to school districts in the winter and spring of 2011, the Center on Education Policy (2012) found that 84% of schools anticipated experiencing funding decreases in 2011-2012 compared to 70% who experienced decreases in 2010-2011. Of importance for physical education was that 68% of districts with funding decreases in 2010-2011 cut teaching positions in subjects other than the core academic subjects, with physical education being one of them. Fifty-five percent of districts expecting to experience budget cuts during the

2011-2012 school year planned to follow suit. In addition, 64% of districts anticipating budget cuts in 2011-2012 planned to reduce funds toward materials and equipment with 43% of them eliminating extracurricular programs and activities. Physical education teachers, equipment, as well as extracurricular programs and activities are all essential aspects of promoting the physical fitness of students. Moreover, according to the “Shape of the Nation Report” published in 2012 by the National Association for Sport and Physical Education (NASPE), 74.5% of states mandate physical education but only 31.4% specify a minimum of minutes required per week or per day. Only three states (i.e., New Jersey, Louisiana, and Florida) require the recommended 150 minutes per week for elementary school physical education, although the time is not strictly enforced. When looking at the district-level, findings from the 2012 School Health Policies and Practices Study (SHPPS) found that 93.6% of districts had a policy stating that elementary schools will teach physical education. If physical fitness predicts academic achievement, it could provide the impetus for educational stakeholders to inform policy and increase the amount of physical education required in schools.

Contributions to the Literature

The focus of the current study was to broaden the literature by determining the extent to which various components of physical fitness predicted academic achievement. This was the first study to use the Discovery Education as the measure of academic achievement. This measure is used in Alabama, California, District of Columbia, Florida, Illinois, Kentucky, Missouri, Mississippi, North Carolina, New York, Ohio, South Carolina, Tennessee, Virginia, and Wisconsin (Discovery Education, n.d.). Whereas previous studies used measures of academic achievement specific to their state, this study explored the relationship between fitness and achievement that can be replicated across a number of states. Additionally, this study investigated the extent to which gender moderated the relationship between physical fitness and academic achievement. It has been shown that boys and girls differ on some physical fitness components so it is important to further explore how this influences the relationship between fitness and achievement.

Definition of Key Terms

Physical fitness. Physical fitness is “a set of attributes that people have or achieve...the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies” (Caspersen, Powell, & Christenson, 1985, p. 128). Health-related components of physical fitness include cardiorespiratory endurance, muscular endurance, muscular strength, body composition, and flexibility (Caspersen, Powell, & Christenson, 1985).

Fitnessgram. The Fitnessgram (Human Kinetics, 2014) is a standardized measure of physical fitness and activity levels used in schools. The program measures body composition, aerobic capacity, muscular strength, muscular endurance, and flexibility through various exercises that do not require skill or agility. Students are categorized as Healthy Fitness Zone (HFZ) if they pass the test by meeting a certain age-level expectation or Needs Improvement Zone (NIZ) if they do not pass the test.

CHAPTER TWO:

REVIEW OF THE LITERATURE

This chapter outlines the current knowledge base of physical activity through a discussion of its history in schools, current physical education standards, barriers to implementation, health benefits, cognitive benefits, and relationship with academic achievement. Relevant literature pertaining to these topics is reviewed to provide support for the current study.

Physical Education and Physical Activity in the Schools

History. The importance of physical activity and physical education can be traced back to as early as 776 B.C. beginning with the Greeks (Lumpkin, 2005). It was during the Homeric Era that the "Greek Ideal" was introduced, which emphasized both mental and physical power. The Greeks believed that physical training was essential for both men and women in order to prepare them for their roles in society. Women participated in gymnastics, wrestling, swimming, and horseback riding in order to better prepare themselves for bearing children; whereas, men engaged in running, swimming, hunting, wrestling, and boxing to train for the military. During the Athenian era, boys attended one school for academics and another for physical training. The Greek ideals, athletics, and school practices set the stage for physical education and sports throughout history (Lumpkin, 2005).

During the Renaissance, the Reformation, and the Age of Enlightenment, many leaders emerged who helped to shape the discipline of physical education, one of those being John Locke. John Locke's phrase "a sound mind in a sound body," written in *Some Thoughts*

Concerning Education (1772) helped to draw attention to physical health and discipline in the late 1600s. In 1893, Thomas Wood introduced the idea of developing the whole child by having children engage in various physical activities, an idea which later became known as educating *through* the physical (Tomporowski, Lambourne, & Okumura, 2011). With the help of Rosalind Cassidy, the idea of education *through* the physical continued to grow throughout the nineteenth century (Lumpkin, 2005). The premise was that physical activity would help children attain not only fitness goals but also social, intellectual, and emotional goals (Ennis, 2006).

Lumpkin (2005) argues it was not until the early twentieth century that the focus shifted away from education *through* the physical to education *of* the physical. Charles McCoy instilled the belief that the goal of physical education should be solely to teach fitness and sports skills. When the United States entered World Wars I and II, the emphasis on fitness was made even stronger in order to prepare young men for enlistment in the military. However, during peacetime very little stress was placed on fitness in the educational curriculum (Lumpkin, 2005).

The shift back to education *through* the physical began during Dwight Eisenhower's reign as president when he established the President's Council on Youth Fitness and promoted a minimum of 15 minutes of vigorous activity a day. Throughout the 1960s and 70s the prominence of leisure time physical activity, sports participation, and marathons took hold.

In 1994, Shape of America joined with Cooper Institute to create Physical Best, a program of physical education that aimed at helping students develop a healthy and fit life (Lumpkin, 2005). The program incorporates a fitness assessment component called Fitnessgram, which assesses aerobic capacity, body composition and muscle strength, endurance, and flexibility through a variety of activities. The Fitnessgram is used today in elementary, middle, and high schools, across all grade levels, and by researchers in order to assess the fitness of youth in the United States.

Measuring physical fitness. Although assessments became more widely used to measure the fitness of youth in the United States, students in grades 9-12 still failed to achieve the fitness goals outlined in *Healthy People 2010* (Lumpkin, 2005). The vision of Healthy People is to have "a society in which all people live long, healthy lives" (U.S. Department of Health and Human Services, 2010, p. 1). In order to obtain this vision, Healthy People set forth objectives that strive to improve the health of Americans (U.S. Department of Health and Human Services, 2010). For example, *Healthy People 2010's* target for vigorous physical activity in students in grades 9-12 was 85%, a 20% increase from the baseline of 65% in 1999 (U.S. Department of Health and Human Services, 2012). The data collected during the final year indicated that this goal was not met. In fact, there was only a 3% increase in the amount of vigorous physical activity for students in grades 9-12 (U.S. Department of Health and Human Services, 2012). In the most recent iteration of Healthy People, *Healthy People 2020* aims to increase the proportion of adolescents who meet guidelines for muscle-strengthening and aerobic physical activity, although there are currently no data to evaluate progress toward these goals (U.S. Department of Health and Human Services, 2014).

In addition to their goals pertaining to fitness, *Healthy People 2020* also set goals to increase the number of states that require regularly scheduled recess and daily participation in school physical education for all students (U.S. Department of Health and Human Services, 2014). According to the "Shape of the Nation Report" published in 2012 by the National Association for Sport and Physical Education (NASPE), 74.5% of states mandate physical education but only 31.4% specify a minimum number of minutes per week or per day. Of importance is that only three states (i.e., New Jersey, Louisiana, and Florida) require the recommended 150 minutes per week for elementary school physical education, although the time is not strictly enforced. When looking at the district-level, findings from the 2012 School Health Policies and Practices Study (SHPPS) found that 93.6% of districts had a policy stating that elementary schools will teach physical education. These results represent a significant increase from 82.6% of districts in the 2000 SHPPS results (NASPE, 2012). Although there are data to suggest an improvement in policies regarding physical education, the 2006 SHPPS results indicated that only 3.8% of elementary schools require *daily* physical education for all students (NASPE, 2012), which is below the goal set by *Healthy People 2020* of 4.2% of elementary schools (U.S. Department of Health and Human Services, 2014).

Physical education standards. In one of the most seminal papers written about the role of physical education, Sallis and McKenzie (1991) took the position that physical education needs to be a public health program preparing children for a lifetime of regular physical activity by teaching activity-planning and movement skills. Until individuals come to terms with the public health risk of physical inactivity (e.g., greater likelihood of cardiovascular disease), the United States will not see drastic changes in the implementation of physical education. Since the paper was written, many changes have in fact occurred that have influenced the perception of physical activity and the role of physical education.

One of those changes is that many associations and agencies have since set forth guidelines as to the amount of physical activity in which children should engage (Sallis et al., 2012). The Centers for Disease Control and Prevention (CDC, 2011) recommends that children and adolescents engage in at least 60 minutes of physical activity per day. Similarly, the American Heart Association (AHA; 2013) recommends 60 minutes of moderate to vigorous physical activity (e.g., brisk walking) each day. The U.S. Department of Health and Human Services published the *2008 Physical Activity Guidelines for Americans* (2008), which suggests 60 minutes of age appropriate physical activity each day. Noteworthy is all of the recommendations seem to follow a similar trend: at least an hour a day of some sort of physical activity. With children spending more time in school than anywhere else besides their home, physical education provided in the school seems to be a logical solution for children to meet these recommendations (Sallis & McKenzie, 1991).

The paper published by Sallis and McKenzie (1991) served as an impetus for Shape of America to adopt the goal of preparing youth for a lifetime of physical activity. The goal of physical education identified by Shape of America is “to develop physically literate individuals who have the knowledge, skills and confidence to enjoy a lifetime of healthful physical activity” (2013b, p. 1). The organization further created the five National Standards for Physical Education in order to define a physically literate individual. It is expected that the physically literate individual:

1. Demonstrate competency in a variety of motor skills and movement patterns;
2. Apply knowledge of concepts, principles, strategies and tactics related to movement and performance;
3. Demonstrate the knowledge and skills to achieve and maintain a health-enhancing level of physical activity and fitness;
4. Exhibit responsible personal and social behavior that respects self and others;
5. Recognize the value of physical activity for health, enjoyment, challenge, self-expression and/or social interaction (Shape of America, 2013).

Although the National Standards have laid out what it means to be a physically literate child, it is still at the discretion of the states and individual school districts to adopt and enforce such standards. The National Standards only serve as a guide for which states and districts can create their own standards. Furthermore, how rigorously schools adhere to physical education standards and how successfully they are implemented remain issues in the realm of physical education and physical activity promotion in the schools.

Barriers to implementation. States are being pushed to meet national standards for high-stakes testing in reading and mathematics while simultaneously having to reduce their emphasis on physical education (Ennis, 2006) Budgetary cuts are taking away physical education resources (Morgan & Hansen, 2008), physical education is being offered online (Daum & Buschner, 2012), and physical education specialists are being replaced with general education teachers (NASPE, 2012). In addition, despite monetary support and advocating for physical activity from the Federal government, the states, which ultimately have the final decision when it comes to education, still lag behind.

Budget Cuts. In a survey administered to school districts in the winter and spring of 2011, the Center on Education Policy (2012) found that 84% of schools anticipated funding decreases in 2011-2012 compared to 70% who experienced decreases in 2010-2011. Of importance for physical education was that 68% of districts with funding decreases in 2010-2011 cut teaching positions in subjects other than the core academic subjects, physical education being one of them. Fifty-five percent of districts expecting budget cuts during the 2011-2012 school year planned to follow suit. In addition, 64% of districts anticipating budget cuts in 2011-2012 planned to reduce funds toward materials and equipment with 43% of them eliminating extracurricular programs and activities. Physical education teachers, equipment, as well as extracurricular programs and activities are all essential aspects of increasing the physical activity of students. When districts make cuts in these areas they seem to be sending the implicit message that physical activity is not a priority of their school culture (Carson et al., 2014). In addition, teachers perceive these cuts as one of the top three barriers to implementing physical education (Morgan & Hansen, 2008).

Virtual Physical Education. In the findings reported by the National Association for Sport and Physical Education (2012), 59% of states allow physical education credits to be earned virtually. Furthermore, only 17 of these 30 states require that trained, state-certified physical education teachers teach the virtual courses. Daum and Buschner (2012) surveyed 32 teachers who taught virtual high school physical education. Seventy-eight percent of the teachers reported that the course did take into account the national standards; however, most of the programs focused on the cognitive and health-related fitness domains and failed to address the affective and psychomotor domains. In addition, only nine of the courses met the NASPE (2012) recommendation of 225 minutes of physical education per week, with six requiring no physical activity at all. Many of the teachers raised concerns regarding how honest the students were when reporting their amount of physical activity. In order to address this concern, Mohnsen (2012) suggested that students video record themselves engaging in specific motor tasks as well as wear heart rate monitors and upload the data to the teacher. However, the teachers in the study conducted by Daum and Buschner (2012) noted that technological troubles in regards to having students upload heart rate monitor data were a barrier to the successful implementation of the class. Although this descriptive study was based on the results of only 32 teachers, it offers initial insight into some of the areas of concern surrounding virtual physical education. Due to the paucity of systematic research concerning virtual physical education, its efficacy remains unknown. Proponents of virtual physical education believe that it offers students, who might have otherwise not enjoyed participating in traditional physical education for many different reasons (e.g., lack of confidence performing the skills, not wanting to participate in the middle of the day), the opportunity to engage in physical activity in a more private setting (Mosier, 2012). In addition, Rhea (2011) believes that virtual physical education should be used as a supplement to, rather than a replacement of, traditional physical education in order to increase student's physical activity. Despite both negative and positive viewpoints when it comes to virtual physical education, more research needs to be conducted before online physical education becomes even more widespread.

Certified physical education teachers. One of the consequences of cutting certified physical education teachers is that general education teachers have to assume the responsibility of teaching physical education. Approximately 68.6% of states allow general education elementary school teachers to teach physical education. However, even though states define the guidelines, the individual school districts are responsible for their implementation and develop policies of their own. In a nationwide survey of school districts, 75.2% of districts implemented a policy requiring that physical education teachers earn a degree in physical education or a related field, such as exercise science. Furthermore, New York is the only state that requires a licensed physical educator to serve as the coordinator of physical education (NASPE, 2012).

Evidence from a number of studies shows that physical education taught by certified physical education teachers results in better student outcomes than when taught by general education teachers. Sallis and colleagues (1999) sought to investigate the effects of a health-related physical education program on student achievement and time spent in physical education. The program specifically targeted the promotion of physical activity during and after school.

During school, the physical education classes taught specific skills and allowed the students to engage in high levels of activity. The classroom-based portion of the program taught behavior change skills in order to increase physical activity outside of school. The classes were taught a minimum of three days per week and lasted approximately 30 minutes (i.e., 15 minutes for physical activity and 15 minutes for classroom-based education). Seven elementary schools serving children in grades kindergarten through fifth were randomly assigned to one of three conditions. In the first condition, certified physical education teachers were trained in the program, implemented it, and received supervision from researchers who developed the program. In another condition, general education teachers were trained in the program, implemented it, and received follow-up support. The control condition consisted of schools following their usual physical education program. The results indicated students spent more time in physical education classes as well as self-management classes compared to the control condition (Sallis et al., 1999). In addition, when looking at academic outcomes, those students who participated in the program taught by specialists experienced an increase in Reading score, as measured by the Metropolitan Achievement Tests (Psychological Testing Corporation, 1990), whereas this same score declined for students in the control condition. The students taught by trained general education teachers declined significantly less on the Language test compared to those students in the control condition (Sallis et al., 1999).

In a related study, researchers compared the physical fitness scores of Slovenian students taught physical education by a physical education specialist to students taught physical education by a general education teacher (Starc & Strel, 2012). Seventy-one classes (n = 950) received physical education from physical education specialists and 75 classes (n = 994) received physical education from general education teachers. Both the specialists and generalists implemented the same physical education curriculum. The SLOFIT test battery (Strel et al., 1997) was used to measure students' fitness. The SLOFIT includes tests for eight different motor abilities (i.e., arm-plate tapping, standing long jump, polygon backwards, sit-ups, standing reach touch, bent arm hang, 60-meter run, and 600-meter run). The results revealed that students who received physical education from specialists experienced significantly greater fitness benefits compared to those who received physical education from generalists. Specifically, those in the specialist condition had significantly higher scores for the standing long jump, 60-meter run, and flexibility (Starc & Strel, 2012).

Not only do studies indicate that students experience better outcomes, but general education teachers often feel inadequately prepared to teach physical education, despite their acknowledgment of its importance (DeCorby et al., 2005). In a systematic review of barriers to implementing physical education, teachers reported lack of opportunities to attend professional development in physical education, as well as lack of expertise and qualifications, as two of the biggest barriers (Morgan & Hansen, 2008). Teachers also reported not teaching certain physical education standards (e.g., gymnastics) because they did not want to see their students get hurt as a result of their lack of knowledge (Morgan & Hansen, 2008). The current body of research in this area suggests general education teachers are not prepared to teach physical education and that certified physical education specialists need to instruct the students to increase the likelihood of positive outcomes.

State and federal support. Although there are many barriers and challenges facing the implementation of physical education and the adoption of a school culture valuing physical activity, it is important for educational stakeholders to realize the benefits physical activity provides for students as they develop both physically and mentally.

The Federal government has consistently provided support for an emphasis on healthful practices in schools. Currently, the Centers for Disease Control and Prevention (CDC) supports 16 national nongovernmental organizations as well as numerous state education agencies in order to promote child and adolescent health (CDC, 2013). The National Programs to Improve the Health and Educational Outcomes of Young People and National Organizations for Chronic Disease Prevention and Health Promotion are two of the grants funded by the CDC that aim to encourage healthy environments (CDC, 2013). In 2001, the U.S. Department of Education administered the Carol M. Physical Education Program (PEP) as part of Title X of the Elementary and Secondary Act of 1965 (Lee, Burgeson, Fulton, & Spain, 2007). The U.S. Department of Education (2014) writes that the program's goal is to "initiate, expand, or enhance physical education programs, including after-school programs, for students in kindergarten through 12th grade" (Carol M. White Physical Education Program, p. 1). In 2014, the U.S. Department of Education provided 67 grants to implement PEP (U.S. Department of Education, 2014). The Children Nutrition and Special Supplemental Food Program for Women, Infants, and Children Reauthorization Act was passed in 2004 requiring the implementation of wellness policies and providing a technical assistance and guidance plan to help create school environments that promote healthy eating and physical activity (Lee et al., 2007; USDA, 2013). In President Obama's 2008 campaign, he promoted the collaboration with schools in order to increase physical activity and signed the first ever Task Force on Physical Activity in 2010 to make this possible (Domestic Policy Council, 2010). In the "One Year Progress Report" it was reported that there had been a shift toward promoting activities that build physical activity habits by promoting the Presidential Active Lifestyle Award. The report also included the goal of helping over one million Americans achieve an Active Lifestyle Award (Domestic Policy

Council, 2011). Although there is a strong effort being made by the Federal government to increase physical activity in schools, the same level of commitment from the states is not as apparent (Sallis et al., 2012). This is exemplified in the previous sections that discuss budget cuts, lack of mandated physical education, and an overall lack of school culture promoting physical activity.

Relationship Between Physical Education, Physical Activity, and Physical Fitness

As previously noted, the goal of physical education is to prepare youth for a lifetime of physical activity. Strong and colleagues (2005) suggest the recommended 60 minutes of physical activity per day can be achieved at school through physical education, recess, sports, and before and after school programs. Implementing the SPARK physical education program resulted in students receiving between 30 to 40 minutes of moderate to vigorous physical activity (Sallis et al., 1997).

In order to assess the relationship between physical activity and physical fitness, 34 children ages 8 to 10 years wore an accelerometer and pedometer around the waist for an average of 5 days (Rowlands, Eston, & Ingledew, 1999). Additionally, the students wore a heart rate telemeter for one weekday to measure minute-by-minute heart rate. The children's fitness was measured using a maximal treadmill test in which the child runs on a treadmill with increasing speed and grade until maximal volitional effort was attained. The results found a significant positive relationship between physical activity levels (i.e., accelerometry and pedometry) and fitness for the whole group and for girls alone but not for boys alone. There were no significant correlations between heart rate and fitness. Because physical activity has been found to increase physical fitness, and physical activity is related to academic achievement, it is important to also look at the relationship between physical fitness and academic achievement. Taken together, these studies suggest that physical education is a venue to increase physical activity and there is a strong relationship between physical activity and physical fitness.

Benefits of Physical Activity

Health benefits. Recently, there has been an increase in the promotion for children to engage in physical activity with such programs as the initiative launched by Michelle Obama called *Let's Move!* (Let's Move, n.d.) and the National Football League's *Play 60* (NFL Rush, 2015). The U.S. Department of Health and Human Services (2008) recommends that children engage in 60 minutes or more of physical activity a day; however, on average, children are only receiving 30 minutes per day of aerobic exercise (Epstein et al., 2001). The health benefits associated with physical activity have been well documented and include a decreased risk for obesity and Type II diabetes.

Obesity. From NBC's popular show "The Biggest Loser" tackling childhood obesity to the front cover of the American Psychological Association's *Monitor on Psychology* (2012) displaying a picture of an obese child, concern and awareness of childhood obesity is growing just as rapidly as the disease itself. Childhood obesity is one of the most widespread childhood diseases, and the prevalence of obesity has increased dramatically from 7% in 1980 to 16.9% of all children and adolescents aged 2 to 19 years in 2012 (Ogden, Carroll, Kit, & Flegal, 2014). This number almost doubles to 31.8% when overweight children are also taken into account along with obese children (Ogden et al., 2014). One of the reasons for the obesity epidemic is reduced physical activity (Holmes, Eisenmann, Ekkekakis, & Gentile, 2008). From obesity stems numerous medical complications such as Type II diabetes (Ball & McCargar, 2003; Reinehr, 2005) and increased risk for cardiovascular disease (Ball & McCargar, 2003; Ice, Murphy, Cottrell, & Neal, 2011). In a systematic review of longitudinal studies assessing the persistence of childhood and adolescent overweight, it was reported that children who were overweight were twice as likely to become overweight as adults compared to normal-weight children (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008). The percentage of overweight adolescents becoming overweight adults was even greater than the percentages of overweight children becoming overweight as adults, ranging from 24% to 90% across the reviewed studies (Singh et al., 2008).

Diabetes. Childhood obesity is a risk factor for developing other health problems such as Type II diabetes (Ball & McCargar, 2003; Reinehr, 2005), which is characterized by one's inability to utilize insulin, resulting in insulin resistance (American Diabetes Association, 2014; Reaven, 1988). Recommendations for preventing or managing Type II diabetes include that children and adolescents should engage in aerobic exercise for 40-60 minutes per day in addition to strength training (Tompkins, Soros, Sothern, & Vargas, 2009). This recommendation is consistent with those set forth by the U.S. Department of Health and Human Services (2008).

A study of 79 obese children aged 7 to 11 years was conducted that measured the effects of a physical activity intervention on insulin sensitivity (Ferguson, 1999). The participants were randomly placed into two groups: 1) exercise training for four months followed by no exercise training for the subsequent four months, or 2) no exercise training for four months followed by exercise training for the subsequent four months. The training took place five days per week and lasted a total of 40 minutes each session. Participants' plasma insulin concentrations, plasma glucose concentrations, and percentage body fat as measured by a dual-energy x-ray absorptiometry, were taken during baseline, after four months, and again after eight months. The participants in Group 1 experienced decreased plasma insulin concentrations during the exercise training and a rebound after the exercise program ended. Similarly, Group 2 experienced increased plasma insulin concentrations initially, followed by decreased plasma insulin concentrations during the exercise program. No changes in plasma glucose concentration were observed during the study. The participants experienced greater insulin sensitivity during the exercise program as evidenced by the findings regarding plasma insulin and plasma glucose concentrations. The participants also showed a decrease in percentage of body fat after the exercise program. These results suggest that regular exercise may decrease body fat, which then decreases the risk for developing Type II diabetes (Ferguson, 1999).

These results are consistent with a study of 15 obese and overweight girls between the ages of 9 and 15 years who completed a 12-week aerobic exercise intervention (Nassis et al., 2005). The intervention occurred three days per week and each session lasted 40 minutes. During each session, participants warmed up for the first 10 minutes, engaged in 25 minutes of physical training games, and ended with a five minute cool down. Some of the warm up activities included running and jumping rope, whereas the physical training games included basketball and volleyball. Prior to starting the intervention, participants completed a two-hour oral glucose tolerance test, had their body weight measured, and had their body composition measured using a dual-energy x-ray absorptiometry. The same procedure was followed after the 12-week intervention. The results indicated that participants experienced increased insulin sensitivity. Additionally, the participants experienced changes in neither body fat nor body weight, suggesting that aerobic exercise alone, without caloric restriction, may be sufficient to improve one’s risk for Type II diabetes (Nassis et al., 2005).

The recommendations put forth by Tompkins and colleagues (2009) suggest strength training in addition to aerobic exercise. In a randomized controlled study, the effects of aerobic versus resistance exercise on insulin sensitivity were observed without having participants limit their caloric intake (Lee et al., 2012). Forty-five obese adolescent boys were randomly assigned to one of three groups: 1) aerobic exercise three days per week for 60 minutes per session, 2) resistance exercise three days per week for 60 minutes per session, or 3) no exercise, control condition. Adolescents in both the aerobic and resistance exercise groups experienced a decrease in total body fat as measured by a dual-energy x-ray absorptiometry. Only those in the resistance exercise group experienced increased insulin sensitivity as measured by an oral glucose tolerance test, suggesting that strength training is another important aspect of physical activity that helps to decrease the risk of Type II diabetes (Lee et al., 2012).

Considering these reviewed studies, it becomes unclear whether physical activity *alone* is enough to increase insulin sensitivity. In a review of the literature, Lee and Kim (2013) concluded that there were too few randomized controlled studies to come to any definitive conclusions regarding the exact mechanism (i.e., increased physical activity or decreased body fat) through which an increase in insulin sensitivity occurs. However, they concluded that physical activity does in fact produce health benefits that mitigate the risk for Type II diabetes (Lee & Kim, 2013).

Cognitive benefits. It is common knowledge among researchers and laypeople alike that physical activity provides numerous benefits to one's overall health; however, what is less well known by the general public are the benefits physical activity has on mental functioning. A meta-analysis by Sibley and Etnier (2003) examined a number of potential moderator variables in the physical activity-cognition relationship. Physical activity included resistance training, aerobic training, perceptual-motor, and physical education programs. One of the moderator variables was the type of cognitive assessment (i.e., perceptual skills, IQ, achievement, verbal tests, math tests, developmental level/academic readiness, and other). The category of "other" constituted creativity, concentration, and cross-disciplinary assessments. The results indicated that the effect sizes for all types of cognitive assessment except memory were significantly greater than zero, suggesting that physical activity has an effect on various aspects of cognition. The largest effect sizes were seen for perceptual skills, other (e.g., creativity), tests of developmental level, IQ, and academic achievement, respectively. Physical activity had the smallest effect on assessments that measured verbal and math skills (Sibley & Etnier, 2003). A more recent meta-analysis conducted by Fedewa and Ahn (2011) found different results. These researchers looked at the effect of physical activity on similar cognitive outcomes as Sibley and Etnier (2003; i.e., total achievement, reading, mathematics, language arts/English, science, other). Physical activity was defined similarly in this meta-analysis in that studies included resistance/circuit training, aerobic training, physical education programs, and perceptual-motor training. The effect of physical activity was largest for math achievement, followed by IQ and reading achievement (Fedewa & Ahn, 2011). Fedewa and Ahn (2011) included 15 more studies compared to Sibley and Etnier (2003) and employed both random- and mixed-effects models in their statistical analyses. These two major differences may explain the discrepant results of these two meta-analyses. Nevertheless, the discrepancies highlight the fact that physical activity has numerous benefits on cognitive capabilities and that future research needs to be conducted to identify the areas of cognition that are most affected by physical activity.

Intelligence quotient. One of the measures of cognitive abilities used in the literature is a measure of IQ. As previously noted, Sibley and Etnier (2003) and Fedewa and Ahn (2011) found that the effect of physical activity on IQ resulted in effect sizes of 0.34 and 0.39, respectively. This finding has been reported in other studies as well.

In an experimental study, three classes ($N = 67$) of 12- to 14-year old adolescents from a South-East Spanish high school were randomly assigned to participate in one of three conditions that each lasted four months (Ardoy et al., 2013). The class assigned to the control group (CG) participated in their regular physical education class, which was held twice a week for 55 minutes each class. The first experimental condition (EC1) increased the number of physical education classes to four times per week while keeping the duration of 55 minutes per class the same. The second experimental condition (EC2) increased both the number and intensity of physical education classes. This group received physical education four times a week for 55 minutes per class at an increased intensity, which involved activities that increased participants' heart rate above 120 beats per minute (bpm). The mean heart rate of the adolescents in EC2 was significantly higher than the mean heart rate for EC1 and CG, confirming that this condition was more intense. The results indicated that cognitive performance, as measured by the medium version of the Spanish Overall and Factorial Intelligence Test (IGF-M; Yuste-Hernández, 2001), improved significantly for adolescents who were assigned to EC2 compared to those assigned to EC1 and CG. There were no differences between EC1 and CG (Ardoy et al., 2013). The researchers who conducted the academic achievement assessments were blind to the condition in which the student was randomized adding strength to the research design. However, analyses did not take into account the nesting of the data. Classes were randomized to experimental conditions thus extraneous variables such as classroom teacher, classroom environment, and peer relationships were not controlled. Randomizing students to conditions instead of classrooms would have strengthened this study.

Executive functions. Executive functions are also of interest as an aspect of cognition that benefits from physical activity. Research conducted with geriatric populations suggests that aerobic exercise has beneficial effects on executive functioning (e.g., selective attention, working memory span, and inhibition of automatic responses; Churchill et al. 2002; Guiney & Machado, 2013; Hall, Smith, & Keele, 2001).

Wu et al. (2011) conducted a study to determine the developmental trajectories of various aspects of executive functioning, namely shifting, working memory, and inhibition. One-hundred and sixty-seven, 7- to 14- year old Chinese children completed tasks that assessed the aspects of executive functioning of interest to the researchers. The results indicated that various aspects of executive functioning improved across the ages of 7-12 and then reached a plateau (i.e., shifting, inhibition, working memory); whereas, other skills developed around the age of 9 and continued to improve into early adolescence (i.e., selective attention). By integrating the research on the effects of exercise on executive functioning and the developmental trajectories of executive functioning, Davis et al. (2007) proposed that exercise might be especially beneficial to school age children because they are exhibiting rapid growth in executive functioning during this time. The limited amount of research conducted with school age children makes it hard to draw such firm conclusions with this particular population (Guiney & Machado, 2013). However, there is evidence suggesting that physical activity does improve various aspects of children's executive controls for example, memory, response inhibition, and sustained attention (Kamijo et al., 2011).

In a recent meta-analysis, researchers sought to determine the effects of acute physical exercise and chronic physical exercise on executive function domains (i.e., inhibition/interference control, working memory, set-shifting, cognitive flexibility, contextual memory, and planning; Verburgh, Königs, Scherder, & Oosterlaan, 2013). Acute physical exercise refers to a short bout of exercise; whereas, chronic exercise refers to an exercise program that occurs over a longer period, usually several weeks. An overall effect size of 0.52

was found for the effects of acute physical exercise on executive function domains This finding is in contrast to a non-significant effect size of 0.14 for the effects of chronic physical activity on executive function domains (Vergurgh et al., 2013). However, this finding should be interpreted with caution, as only five studies of chronic physical activity were included.

Castelli and colleagues (2011) sought to explore the effects of a fitness program on tasks that required varying amounts of executive control, spanning the domains of attention, memory, and/or mental flexibility. In order to accomplish this, 59 participants with a mean age of 8.79 years completed pre- and post-measures using the Stroop-Color-Word Test (Golden, 1978) and the Comprehensive Trail Making Tests (Reynolds, 2002). For the Stroop-Color-Word Tests, participants named the color of congruent color-word pairs (e.g., the word blue written in blue ink) and incongruent color-word pairs (e.g., the word green written in red ink). The Comprehensive Trail Making Tests had participants connect dots in numerical and alphabetical order as fast as possible. During the physical activity intervention, participants received education in a health-related subject (e.g., nutrition) and then engaged in 40 minutes of physical activity. The results indicated that students showed significant improvements on all versions of the Stroop-Color-Word Test and Comprehensive Trail Making Tests post-physical activity intervention, providing evidence for the benefits of physical activity of executive functions. Similarly, Buck, Hilman, and Castelli (2008) found that physical fitness, as indicated by the number of laps completed on the PACER subtest of the Fitnessgram, was positively correlated with performance on three versions of the Stroop-Color-Word Test in a sample of 74 children between 7 and 12 years of age. Each version of the Stroop-Color-Word Test Children's Version (Golden, Freshwater, & Golden, 2003) required different amounts of executive control. In the first version, participants saw color words (e.g., blue, green) written in black ink and were required to read aloud the word. The second version had participants say the ink color of a list of "XXXX." The last version consisted of incongruent color-word pairs and the participants had to say the name of the color of the ink.

Response inhibition has also been another aspect of executive function examined in the literature. The modified flanker task (Eriksen & Eriksen, 1974) is often used to measure this aspect of executive function. During this task, participants have to identify the direction of the middle arrow on congruent (e.g., <<<<<) or incongruent (e.g., <<><<) trials (Hillman et al., 2009). Twenty participants with a mean age of 9.6 participated in the study. Following a bout of treadmill walking, participants had greater response accuracy compared to when they participated in a resting, control condition (Hillman et al., 2009). Similar results were found in regards to physical fitness (Chaddock et al., 2012). Nine- and 10-year-old participants had their maximal oxygen uptake measured while running on a treadmill. Those participants whose maximal oxygen uptake fell above the 70^{th} percentile according to normative data from Shvartz and Reibold (1990) were classified as higher-fit, and those who fell below the 30^{th} percentile were classified as lower fit. Participants who were more physically fit (7 boys, 7 girls) had higher accuracy on the flanker task both during an initial testing session and during a one-year follow up compared to lower fit participants (8 boys, 10 girls). Additionally, participants who were more fit had shorter reaction times on the task at the follow-up test compared to lower fit participants (Chaddock et al., 2012).

In an attempt to show that exercise has its strongest effects on aspects of executive functioning compared to general cognition, Davis and colleagues (2011) conducted a randomized, controlled trial with 171 overweight 7- to 11- year olds. Children were stratified by race and gender. The children participated in either a 20-minute (low-dose), 40-minute (high-dose), or a non-exercise control program for 13 weeks. The participants completed the Cognitive Assessment System (CAS; Naglieri & Das, 1997), which measures one's ability to generate strategies and apply a plan (i.e., Planning), one's ability to focus on a task while simultaneously ignoring irrelevant stimuli (i.e., Attention), one's ability to integrate verbal and nonverbal information (i.e., Simultaneous), and one's ability to recall information in a specific order (i.e., Successive). The CAS was administered before and after the intervention; however, only the Planning subscale measures executive function. After the intervention, researchers found that the participants in the low- and high-dose condition had higher Planning scores compared to those in the control condition; there were no differences among participants for any of the other subtests (Davis et al., 2011). The randomization, stratification, and analyses conducted in this study strengthened the design and interpretation of the results making it one that serves as a strong basis for the current body of literature.

Academic Achievement

Relationship with physical activity. The research reviewed thus far has focused on various aspects of cognition affected by physical activity. However, of utmost importance to educational stakeholders is not cognition broadly, but rather academic achievement specifically. State standardized tests are often used as the measure of academic achievement (Bass et al., 2013; Joshi et al., 2011; Wittberg et al., 2010). In addition to the practicality and accessibility to standardized tests, one benefit to using these tests is that they often contain subscales for particular subjects (e.g., reading, math). This allows for a deeper analysis of particular subject areas that are affected by physical activity. However, different states utilize different standardized tests, making it hard to generalize the findings across studies.

Numerous studies have employed physical activity interventions in order to assess their affect on academic achievement (e.g., Ardoy et al., 2013; Davis et al., 2007; Joshi, Howat, Bryan, & Dick, 2011; Sibley & Etnier, 2003; Wittberg, Cottrell, Davis, & Northrup, 2010). Although the logistics of the interventions are not always consistent, there is evidence to suggest that increasing physical activity either increases or does not impact academic achievement. None of the studies reviewed found a decrease in academic achievement as a result of increased physical activity.

Three of the studies previously reviewed in the cognitive benefits section also looked at the effect of physical activity on academic achievement. Davis and colleagues (2011) not only looked at executive function as an outcome measure of the aerobic exercise intervention but also academic achievement. The Broad Reading and Broad Mathematics forms of the Woodcock-Johnson Tests of Achievement III were administered to the participants pre- and post-intervention. The results revealed a significant linear, dose-response benefit of exercise on mathematics achievement, with the high-dose condition scoring the highest followed by the low-dose condition and control condition respectively. There were no differences in reading achievement (Davis et al., 2011).

In the study by Ardoy and colleagues (2013) students' average classroom grades were used as the measure of academic achievement (i.e., Language, Mathematics, Foreign Language, Social Sciences, Natural Sciences, Technology, Plastic-Visual Education, Music, and Physical Education). The students in EC2 (i.e., increased number and intensity of physical education classes) had significantly higher average academic achievement when including all subjects post-intervention compared to those students in EC1 (i.e., increased only number of physical education classes) and CG after adjusting for sex, sexual maturation as measured by stage of pubertal development (Tanner & Whitehouse, 1976), and attendance. Specifically, there were significant differences for Mathematics, Technology, Natural Sciences, and Physical Education (Ardoy et al., 2013). Using classroom grades as the measure of academic achievement is a limitation of this study because of the subjectivity in classroom grades and variability between teachers.

The Wide Range Achievement Test 3 (WRAT3; Wilkinson, 1993) was administered in addition to the modified flanker test following an acute bout of treadmill walking (Hillman et al., 2009). The WRAT3 measures students' ability to read, spell, and compute math problems. Following the acute exercise, participants performed significantly better on reading comprehension compared to following a period of rest. There were no differences for spelling or arithmetic (Hillman et al., 2009).

Other physical activity interventions have taken advantage of the classroom and the classroom teachers. In one such intervention, Physical Activity Across the Curriculum (PAAC), the goal was to have elementary school students achieve 90 minutes of moderate to vigorous physically active academic lessons per week (Donnelly & Lambourne, 2011). For example, an academic lesson may have students run to designated areas of the classroom that correspond to directions on a compass rose. Not only did students' BMI decrease as minutes of exposure to PAAC increased, but significant improvements in academic achievement were also observed. Specifically, following a three-year randomized, controlled trial of PAAC, the schools who received PAAC had significantly higher composite, reading, math, and spelling scores on the Wechsler Individual Achievement Test II compared to the control schools.

In another study that utilized the classroom environment, the effects of a physical activity intervention during literacy lessons were examined in 72 African American preschoolers from a low socioeconomic Head Start program (Kirk, Vizcarra, Looney, & Kirk, 2013). Two preschools participated in the study, one of which incorporated 30 minutes of physical activity into the literacy lesson (4 classrooms) and the other of which served as the control (3 classrooms). Alliteration and picture naming significantly improved for children receiving physically active literacy lessons from baseline to 3 months and 3 months to 6 months following the intervention compared to the control school. There were no significant differences between preschools for rhyming (Kirk et al., 2013). This study suggests that incorporating physical activity into academic lessons as early as preschool can help students improve their learning.

Relationship with physical fitness. Because physical activity has been found to increase physical fitness (Rowlands, Eston, & Ingledew, 1999), and physical activity is related to academic achievement (Davis et al., 2011), it is important to also look at the relationship between physical fitness and academic achievement. Empirical research has investigated the relationship between physical fitness and academic achievement by looking at different health-related components of physical activity, such as cardiorespiratory endurance or muscular strength (Bass et al., 2013; Tomporowski et al., 2011; Wittberg et al., 2010).

Castelli, Hillman, Buck, and Erwin (2007) sought to determine which components of fitness were related to academic achievement as measured by the Illinois Standards Achievement Test (ISAT; Illinois State Board of Education, 2007). The ISAT measured reading achievement, math achievement, and overall achievement. This study was carried out with 259 third- and fifth-grade students who completed the Fitnessgram and PACER. Three subscales of the Fitnessgram (i.e., PACER, push-ups, and curl-ups) were correlated with all three subtests of the ISAT. PACER, push-ups, and curl-ups measure aerobic capacity, muscular strength, and muscular endurance, respectively. The back-saver sit and reach, a measure of flexibility, was positively correlated with total academic achievement and math achievement, but not reading achievement. In a series of hierarchical regressions, it was determined that higher academic achievement scores were associated with greater total fitness (i.e., BMI for each age group subtracted from a z-score for all four Fitnessgram subtests) after including the status of the school (i.e., low performing vs. high performing) in the first step of the model. In addition, total fitness was positively related to mathematics achievement. After adding age, sex, and school performance status to the regression, lower BMI and higher aerobic fitness were positively related to total, reading, and mathematics achievement.

In a similar study, 838 middle school students' scores on the Fitnessgram and PACER were correlated with student performance on the ISAT (Bass et al., 2013). The results indicated the strongest correlations between aerobic fitness and academic achievement followed by muscular endurance and academic achievement, providing further support for the study by Castelli and colleagues (2007) and suggesting that there is a relationship between physical activity and academic achievement for both elementary and middle school students. After taking socioeconomic status (SES) and age into account, boys who were in the HFZ for aerobic fitness or muscular endurance were 2.5-3 times more likely to meet achievement test standards than boys not in the HFZ, whereas girls in the HFZ for aerobic fitness were 2-4 times more likely than girls not in the HFZ to meet the criterion. After adjusting for SES and age, the ratios for girls in the HFZ for muscular strength and endurance were weakened (Bass et al., 2013).

In another study, 1740, fifth grade students' scores on the Fitnessgram were correlated with student performance on various subscales on the West Virginia Educational Standards Test (WESTEST; Wittberg, Northrup, & Cottrell, 2009). The results indicated that aerobic fitness was correlated with all WESTEST subscales separately as well as together; however, students in the

HFZ for upper body strength scored significantly higher in math and students in the HFZ for flexibility scored significantly higher in math and science compared to students not in the HFZ (Wittberg et al., 2009). The results suggest that aerobic fitness may be important for all aspects of achievement, whereas other measures of fitness may be uniquely important to specific subjects. After controlling for BMI, gender, and SES, aerobic capacity was the only fitness variable associated with academic performance.

The percent of tests and overall number of tests passed on the Fitnessgram also reportedly relates to academic achievement (Blom, Alvarez, Zhang, & Kolbo, 2011; Joshi, Howat, Bryan, & Dick, 2011). When looking at 19,695 students in grades 4, 8, and 10, most of the students who achieved the HFZ for at least 75% of the Fitnessgram tests scored Advanced or Mastery on the Louisiana Education Assessment Program; whereas, most students who achieved HFZs in less than 50% of the tests scored Basic or Unsatisfactory on the Louisiana Education Assessment Program (Joshi et al., 2011). Those students who passed between 50-75% of the tests had a range of scores on the achievement test (i.e., Advanced, Basic, Approaching Basic, Unsatisfactory; Joshi et al., 2011).

Blom and colleagues (2011) further identified a linear trend between academic achievement, as measured by the second version of the Mississippi Curriculum Test (Mississippi Department of Education, 2008), and overall fitness level, as measured by the number of tests passed on the Fitnessgram. This finding suggests that the more HFZs the student achieved, the higher his or her academic achievement (Blom et al., 2011). This is consistent with research indicating that for every one fitness test passed, the odds of passing the Mathematics portion of the Massachusetts Comprehensive Assessment System (MCAS) standardized test increased by 38% and the odds of passing the English portion increased by 24% after controlling for gender, ethnicity, lunch status, and weight status (Chomitz et al., 2009). A total of 2,127 students in grades 4, 6, 7, and 8 participated in this study. The number of fitness tests passed on the Fitnessgram was used as the measure of fitness achievement and ranged from 0 to 5.

When looking specifically at aerobic fitness as measured by the PACER subtest of the Fitnessgram, Rauner, Walters, Avery, and Wanser (2013) found those students who entered the HFZ had significantly greater odds of passing the Nebraska State Accountability reading and math tests compared to students who did not enter the HFZ. The effect was, however, significantly greater for those students not receiving free/reduced lunch (Rauner et al., 2013).

Wittberg and colleagues (2010) looked at the relationship between physical fitness and academic achievement and whether it is based on a threshold or dose-response schedule. A threshold schedule suggests that once a child reaches a certain aerobic capacity, they start to experience academic benefits. A dose-response schedule suggests that as children's aerobic capacity becomes greater they will continue to experience greater academic benefits. Fifth grade students completed the mile-run and PACER subtests of the Fitnessgram. The WESTEST was used as the measure of academic achievement. The results revealed a correlation between boys' mile run average and girls' Pacer circuit average with each subscale of academic achievement (i.e., reading/language arts, mathematics, science, and social studies). There was a threshold for boys' mile run at nine minutes, suggesting that if a boy can run the mile in at least nine minutes, he is more likely to experience academic benefits. The girls' results were not as clear. There were two peaks in Pacer circuit numbers: one peak at 12 circuits and another peak at 30 circuits, possibly suggesting a dose-response schedule. This study suggests differences in the how aerobic capacity influences academic achievement for boys and girls.

In an attempt to understand the relationship between physical activity, aerobic fitness, and academic achievement, Lambourne and colleagues (2013) hypothesized that physical activity would have an indirect effect on academic achievement and would be mediated by aerobic fitness. In order to test this hypothesis, second and third grade students wore accelerometers to assess their physical activity and completed the PACER subtest of the Fitnessgram to assess aerobic fitness. They also completed the WIAT-III as a measure of academic achievement in three subjects (i.e., math, reading, and spelling). The results revealed that physical activity directly influenced aerobic fitness and indirectly affected math achievement via aerobic fitness. There were no significant relationships with reading or spelling scores and this study did not look at differences between genders (Lambourne et al., 2013).

Gender and Physical Fitness

The aerobic capacity of 1,279 girls and 1,261 boys was measured six times over a seven-year period using a cycle ergometer test in a sample of 8- to 16-year old youths (McMurray et al., 2002). Results indicated that aerobic capacity was higher for boys than for girls at all ages. In addition, aerobic capacity increased with age for boys and to a lesser extent for girls. Aerobic capacity for African American youth was greater than the capacity for Caucasian youth at all ages (McMurray at al., 2002). Thus, differences between boys and girls on measures of aerobic capacity are expected.

Children are also capable of increasing muscular strength through physical activity and resistance training (Faigenbaum et al., 1996). In a review of pediatric strength assessment, it was concluded that muscular strength for both boys and girls increases with age (De Ste Croix, 2007). Girls’ strength appears to increase up until puberty where it eventually plateaus (around age 16-17), whereas boys experience a boost in strength after puberty (De Ste Croix, 2007).

Thus, it is expected that both boys and girls will exhibit growth on measures of muscular endurance and strength to a different extent.

Given the differences for boys and girls on measures of physical fitness, more research needs to be conducted on how these differences moderate the relationship with academic achievement. The greater aerobic capacity and muscular strength for boys may have a differential effect on academic achievement.

Conclusions

Overall, these studies have found that some components of physical fitness correlate more strongly with measures of academic achievement. For example, PACER, push-ups, and curl-ups were correlated with reading, math, and total achievement as measured by the Illinois Standards Achievement Test; however, the back-saver sit and reach was only correlated with total achievement and math achievement but not reading (Castelli et al., 2007). Bass and colleagues (2013) found the strongest correlations between aerobic fitness and academic achievement followed by muscular endurance and academic achievement. Castelli and colleagues also looked at a composite score of fitness (i.e., subtraction of BMI within each age group from the aggregated z score of the other four Fitnessgram subtests) and found that higher academic achievement scores were associated with greater total fitness. Additionally, previous research has looked at the relationships between physical fitness and academic achievement separately for boys and girls. This research has found differences in the extent to which aerobic capacity related to academic achievement for boys and girls (Wittberg et al., 2010). Bass and colleagues (2013) also found differing correlations between Fitnessgram components and academic tests for boys and girls. However, no studies have looked at how gender moderates the relationship between physical fitness and academic achievement. It remains unknown which components of physical fitness predict academic achievement and the extent to which gender moderates this relationship. Knowing this information can allow physical educators to focus more closely on developing these skills. The purpose of the current study was to gain insight into the extent to which components of physical fitness predict academic achievement and the extent to which gender moderates this relationship.

CHAPTER THREE:

METHODS

The aim of the proposed study was to gain insight into the relationship between physical fitness and academic achievement. In order to fulfill this aim, this study investigated the following research questions:

1. To what extent do components of physical fitness as measured by the Fitnessgram predict academic achievement as measured by the Discovery Education assessment?
2. To what extent does gender moderate the aforementioned relationship?

The following chapter describes the participants, measures, procedures, and analyses for the current study. This chapter concludes with a discussion of the ethical considerations.

Participants and Setting

The current study analyzed data collected from fifth-grade students at one elementary school in a Southeastern state. The school is located in a predominantly White, suburban, middle-class community. The school participates in a grant through the Presidential Youth Fitness Program and collects Fitnessgram data once a year. Fifth grade students were chosen as participants in this study because the transition from elementary school to middle school is characterized by many changes, one of which is a decrease in motivation to engage in physical activity (Ullrich-French & Cox, 2014). As such, it is important to study students during late elementary school before their motivation to engage in physical activity decreases. The researcher gathered participants' demographic information including sex, free or reduced-price lunch status, and race/ethnicity from school records (Table 1). Demographic data from the school also are provided alongside that of the sample. The sample's demographics were similar to those of the entire school.

Table 1

Demographic Characteristics of Sample and School

	Total Sample (N = 74)		School
Variable	*n*	%	%
Gender			
Male	35	47.3	52.4
Female	39	52.7	49.3
Free or Reduced-Price Lunch			
Free	19	25.7	30
Reduced	3	4.1	2.58
Full Price	52	70.3	67.42
Race/Ethnicity			
White	65	87.8	85.3
African American	1	1.4	1.6
Hispanic	5	6.8	8.5
Multiracial	3	4.1	2.9

Inclusion Criteria

Students' data were included in the study if they completed both the academic and fitness measures included in the data analysis. Students were excluded if they were missing one or more fitness measures. Of the total 113 fifth-grade students enrolled in the elementary school during the 2014-2015 school year, 79 students completed the Fitnessgram and Discovery Education. The elementary school from which data were obtained has special classrooms for students with Autism Spectrum Disorder. These students are not required to complete the Fitnessgram assessment, which accounts for some of the 34 missing students. In addition, Fitnessgram data from one entire class were missing. A total of five students were excluded from analyses due to missing one or more of the Fitnessgram subscales.

Measures

Physical fitness. The Fitnessgram (Plowman & Meredith, 2013) is a standardized measure of physical fitness and activity levels used in schools and was the measure of physical fitness in this study. The program measures aerobic capacity, muscular strength, muscular endurance, and flexibility through various exercises that do not require skill or agility. There are numerous tests for each component of health-related fitness, and physical education teachers are encouraged to choose the one that works best in their setting. The Fitnessgram uses criterion references to classify students into either the Healthy Fitness Zone (HFZ) or Needs Improvement Zone (NIZ) based on their scores on each test. In a study of 1,010 students, the reliability of fitness testing was evaluated (Morrow, Martin, & Jackson, 2010). Twenty-three teachers tested the students two weeks apart to assess reliability and teacher administrators were compared to expert testers. Expert training included becoming familiar with the Fitnessgram manual, watching an online DVD demonstrating how to administer the tests, completing a certification online, a hands-on training, and practice administrations. The teachers received manuals, video training, and some teachers received additional instruction from trained district or school personnel. Classification agreements for repeated test administration were calculated using percent agreement and ranged from 0.74 for push-ups to 0.97 for BMI. Expert administration reliabilities ranged from 0.77 for push-ups to 0.96 for BMI. Additionally, comparisons of trained teachers with expert testers suggested that both groups obtained similar results (Marrow, Martin, & Jackson, 2010).

There are two tests for aerobic capacity. The first is the mile-run (Appendix A) in which students are timed on how long it takes them to run or walk a mile. The second measure is the Progressive Aerobic Cardiovascular Endurance Run (PACER; Appendix B; Leger & Lambert, 1982). During the PACER, a student runs back and forth across a 20-meter space. The student must get to the other side of the space before a beep goes off. The beep represents the pace the student should maintain, and the time between the beeps gets shorter after each circuit. This means that the student must run faster each circuit. The student is finished with the test when the beep goes off before he or she makes it to the other side. The student's score is the number of circuits completed. In a study of 51 fifth-grade students, researchers sought to confirm the reliability and validity of the PACER and mile-run (Vincent, Barker, Clarke, & Harrison, 1999). Students were randomly assigned to counterbalanced conditions (i.e., mile-run then PACER or PACER then mile-run) and wore heart rate monitors during all trials. Reliability coefficients for the PACER were 0.79 for boys, 0.75 for girls, and 0.82 combined. The correlations between PACER and mile-run were -0.83, -0.70, and -0.80 for boys, girls, and combined, respectively. Additionally, there were no significant differences between the final heart rate after the PACER and the final heart rate after the mile-run, indicating that both tests are related to aerobic capacity (Vincent et al., 1999). A study of 1666 students in grades 3-12 sought to determine the classification agreement between the PACER and mile-run (Welk, De Saint-Maurice Maduro, Laurson, & Brown, 2011). Percentage agreement exceeded 90% among aerobic fitness tests, indicating that both assessments will result in a similar classification of students into the HFZ and NIZ. The student's PACER laps and mile run time are used to calculate aerobic capacity (i.e., VO_2max). For this study, students' PACER laps were used as the measure of aerobic fitness.

Muscular strength and muscular endurance are measured by flexed-arm hang (Appendix C) and curl-ups (Appendix D; Plowman & Meredith, 2013). During flexed-arm hang, students hang with their chins above a horizontal pull-up bar for as long as possible (The Cooper Institute, 2013). With the help of one or more assistants, the student raises their body to a position where their palms are facing away from their body, chin is above the bar, and chest is close to the bar. The P.E. teacher starts a stopwatch as soon as the student takes the position and stops when the student's chin touches the bar, the student tilts his or her head back to keep the chin above the bar, or the student's chin falls below the bar. Morrow and colleagues (2010) reported an 82% classification agreement when teachers administered the test two-weeks apart. The curl-up assessment requires two students. Student A performs the curl-ups while student B counts and watches for form errors. The student performing the curl-ups lies on a mat with their knees bent and feet flat on the floor. Student A curls up slowly while keeping the heels in contact with the mat then curls back down until his or her head touches the mat. Students are stopped after completing 75 curl-ups, when they have made two errors in form, or when they can no longer continue. There was a 78% classification agreement when teachers tested the students and an 87% agreement when two experts tested the students. There was 81% classification agreement when comparing trained teachers with expert administrators and 64% agreement when comparing untrained teachers with expert administrators. In the database, the number of seconds the student performs the flexed-arm hang and the number of repetitions for curl-ups are recorded.

Flexibility is measured by the BSR (Appendix E; Plowman & Meredith, 2013). This assessment requires a box 12-inches high. A ruler is taped on top of the box with nine inches hanging over the end. The student sits down at the box with one leg fully extended with the foot flat against the box and the other leg bent so the foot is flat on the floor. The student reaches with the palms down along the scale four times and holds the position of the fourth reach for at least 1 second. The student then performs the same steps for the other leg. The P.E. teacher records the number of inches on each side to the nearest ½ inch reached (The Cooper Institute, 2013). The reliability of the BSR was tested in a study of 179 girls and boys, 6- to 12-years-old (Hartman & Looney, 2003). Intraclass correlation coefficients were 0.98 and 0.97 for the right leg and 0.97 and 0.96 for the left leg for boys and girls, respectively. Additionally, Morrow and colleagues (2010) obtained 89% classification agreement between teachers and 86% between experts. There was a 73% agreement between untrained teachers and experts and 68% agreement between trained teachers and experts. The number of inches the student reaches for the right and left legs are recorded in the database.

Due to differences in the criteria to meet the Healthy Fitness Zone (HFZ) for males and females, difference scores were calculated. Students' scores were subtracted from the midpoint of the HFZ range. If the criteria for males and females were the same, the scores were not transformed. Table 2 shows the HFZ standards for each subtest of the Fitnessgram along with the midpoint used to calculate the difference scores. For example, if a 10-year-old female performed 25 curl-ups, her difference score would be 6 (i.e., 25-19). Additionally, the average between the difference for BSR right and left was calculated into one variable.

Table 2

Fitnessgram Performance Standards for Health Fitness Zone

	Pacer		Curl-Up		Trunk Lift		Flexed-Arm Hang		BSR (Right)		BSR (Left)	
	HFZ	MP	HFZ	MP	HFZ	MP	HFZ	MP	HFZ	MP	HFZ	MP
Males												
10	23-61	42	12-24	18	9-12	n/a	4-10	7	8	8	8	8
11	23-72	47.5	15-28	21.5	9-12	n/a	6-13	9.5	8	8	8	8
12	32-72	53.5	18-36	27	9-12	n/a	10-15	12.5	8	8	8	8
Females												
10	7-41	40.2	12-26	19	9-12	n/a	4-10	4	9	9	9	9
11	15-41	40.2	15-29	22	9-12	n/a	6-12	6	10	10	10	10
12	15-41	40.1	18-32	25	9-12	n/a	7-12	7	10	10	10	10

Note. HFZ = Healthy Fitness Zone, MP = Midpoint

Academic achievement. Discovery Education (DE) reading scores were used in this study to indicate students' academic achievement in reading (Discovery Education, 2014). DE is a standardized, criterion-referenced assessment administered to students four times per year in grades three through high school in order to measure students' progress toward meeting benchmark goals established by the Language Arts Florida Standards. Subskills assessed by the DE are divided into Literature, Information, and Writing. The DE English/language arts vertical growth scale score comparisons for Fall 2007 and Spring 2008 are found in Table 3. The scale ranges from 1000 to 2000 and student are expected to show growth both within and between school years. The Spring 2008 Test B reading and mathematics reliabilities were 0.86 and 0.86, respectively (Discovery Education, 2014). To ensure content validity, the Web Alignment Tool (Webb, 2005) and Norman Webb's (1997) method of alignment were used. The reading growth scores on DE were found to correlate with reading scores on the Florida Comprehensive Academic Test (FCAT) with correlation coefficients ranging from 0.66 in fifth grade to 0.74 in grades 3, 8, and 9. The DE assessments were created using Rasch (1960) measurement models to ensure they can be used to measure growth over time (Discovery Education Assessment, 2014.). For this study, fifth grade reading scores for the cohort of 2014-2015 fifth graders were obtained from the school's database. These data are housed in an online database accessible through the DE website.

Table 3

Vertical Growth Score Comparisons for Fall 2007 and Spring 2008

	Gr. 2	Gr. 3	Gr. 4	Gr. 5	Gr. 6	Gr. 7	Gr. 8	Gr. 9	Gr. 10
English/Language Arts									
Fall 2007	1327	1395	1418	1486	1504	1541	1562	1620	1623
Spring 2008	1364	1409	1477	1495	1548	1555	1598	1627	1639

Procedures

An application to the University of South Florida's (USF) Institutional Review Board (IRB) was submitted and the IRB determined the activities did not meet the definition of human subjects research. Thus, this study was not under the purview of the USF IRB and approval was not required. Approval from the school district's IRB was obtained. After approval from the school district, school principals from three different elementary schools were contacted via email. One school principal agreed to participate in the study. The other two school principals reported that their schools were no longer collecting Fitnessgram data and thus were not able to participate.

The principal investigator contacted the physical education (PE) teachers in the participating school to gain access to the Fitnessgram data. Fitnessgram data were collected once in March 2015. Students were measured on the PACER, curl-up, back-saver sit and reach (BSR), trunk lift, and flexed arm hang subtests of the Fitnessgram. Students who scored in the HFZ were given a Presidential Fitness patch as an incentive. In addition, students were able to compete with themselves by trying to beat their previous scores on the Fitnessgram. Once the PE teachers were contacted, the principal investigator told them the variables of interest (i.e., individual student's raw scores for each Fitnessgram test). The PE teachers sent the identified data to the supervisor of the Office for Accountability, Research, and Measurement. To access the Discovery Education data, the supervisor of the Office for Accountability, Research, and Measurement was contacted and given the variables of interest (i.e., gender, free and reduced lunch price status, race, DE scaled scores) along with the identified Fitnessgram data. Classroom teachers administer the DE assessment on computers four times per year and the current study utilized April 2015 scores. The supervisor of the Office for Accountability, Research, and

Measurement linked the Fitnessgram data with Discovery Education data and demographics, and emailed the researcher an electronic de-identified Excel file of the data.

Data Analyses

A series of statistical analyses were performed in order to answer the research questions posed in this study.

Preliminary analyses. Means, standard deviations, range, skewness, kurtosis, and reliability were calculated and reported for DE scores and Fitnessgram data. Pearson product-moment correlations were conducted between gender and both DE scores and Fitnessgram components as well as DE scores and Fitnessgram components to measure the strength of the associations between those variables.

Regression analyses.

1. *To what extent do components of physical fitness as measured by the Fitnessgram predict academic achievement as measured by the Discovery Education assessment?*

Multiple regression analyses were conducted with gender and the various Fitnessgram components as the independent variables and DE assessment scores as the dependent variable.

2. *To what extent does gender moderate the relationship the aforementioned relationship?*

Moderating variables allow researchers to examine differential effects for levels of a variable (MacKinnon, 2011). MacKinnon (2011) suggested using moderating variables in order to generalize results and identified age, sex, and race as common moderators. Therefore, this study utilized moderation in order to determine if physical fitness has similar effects on academic achievement for males and females. The moderating effect of gender was examined by looking at the interaction between components of the Fitnessgram and gender predicting DE scores. An interaction term was created by multiplying gender (i.e., male = 0, female = 1) by the difference score on each subtest of the Fitnessgram (MacKinnon, 2011). The interaction term was then entered into the regression model. An alpha level of 0.05 was used to determine statistical significance.

CHAPTER IV:

RESULTS

This chapter describes the results from statistical analyses that were used to answer the two research questions. The first research question addressed the extent to which components of physical fitness as measured by the Fitnessgram predict academic achievement as measured by the Discovery Education assessment. The second research question addressed to what extent gender moderates the relationship between physical fitness and academic achievement.

Preliminary Analyses.

Analysis of assumptions. There are four major assumptions of linear regression. All assumptions were assessed through visual analysis and follow-up statistical testing when necessary. The first assumption is independence of error. To test this assumption, scatter plots of the residuals versus predicted values of the independent variables were created. Overall, there did not appear to be any significant violations of this assumption. The second assumption is that the residuals associated with the dependent variables are normally distributed. Visual analysis revealed all variables were normally distributed and, thus, this assumption was not violated. Skewness and kurtosis were also assessed (Table 4) and there were no violations of this assumption. The third and fourth assumptions are that the variance of error is equally distributed across all predictor variables and relationships are not curvilinear. Visual analysis of residuals versus predicted values indicated these two assumptions were not violated.

Table 4

Skewness and Kurtosis of Residuals

Standardized Residuals	Skewness	Kurtosis
Pacer	0.80	1.14
Curl-Up	0.89	1.38
Trunklift	0.78	1.13
Flexed Arm Hang	0.88	1.29
BSR	0.84	1.44

Descriptive analyses. Descriptive statistics for each of the Fitnessgram components (Table 5) were calculated and each component were correlated with each other (Table 6). Higher scores on these tests indicate greater physical fitness. For example, a score of 30 on the Pacer indicates greater aerobic fitness than a score of 19. All of the means for the Fitnessgram components fell within the corresponding healthy fitness zone according to the Fitnessgram performance standards (see Table 2). Means and standard errors for each of the Fitnessgram components were also calculated for each gender (Table 7). Pearson product-moment correlations were conducted between gender and the Fitnessgram components to measure the strength of the associations between these variables (Table 8). In general, being male was associated with performing better on the Pacer, a measure of aerobic capacity, whereas being female was associated with performing better on the trunklift and BSR which are measures of flexibility. Pearson product-moment correlations between DE and Fitnessgram components for the entire sample (Table 9) and for boys and girls separately (Table 10) were also calculated. Lastly, descriptive statistics for the Discovery Education were calculated (Table 11). The average vertical scale score for fifth-grade students is 1547 and the mean for this sample was 1661.77. A one-sample t-test indicated the sample used in this study scored significantly higher than the average vertical scale score, $t(73) = 12.38$, $p < 0.001$.

Table 5

Descriptive Statistics for Fitnessgram Data

	Pacer (N = 74)	Flexed Arm Hang (N = 74)	Curl-Ups (N = 74)	Trunklift (N = 74)	BSR (N = 74)
Mean	27.46 (laps)	10.59 (seconds)	39.38 (repetitions)	10.59 (inches)	9.08 (inches)
SD	15.10	11.93	24.47	1.58	2.72
Minimum	6	0	3	5	2
Maximum	74	61	75	12	12
Range	68	61	72	5	10
Skewness	1.51	2.47	0.33	-1.15	-0.87
Kurtosis	2.25	7.47	-1.40	1.01	-0.18

Table 6

Correlations Between Fitnessgram Components

	1	2	3	4	5
1. Pacer	-				
2. Flexed Arm Hang	0.30**	-			
3. Curl-Ups	0.42**	0.28*	-		
4. Trunklift	0.04	-0.07	0.09	-	
5. BSR	0.32**	0.14	0.36**	0.24*	-

*$p < 0.05$; **$p < 0.01$

Table 7

Means and Standard Errors for Fitnessgram Data by Gender

	Pacer (laps) *M(SE)*	Flexed Arm Hang (seconds) *M(SE)*	Curl-Ups (repetitions) *M(SE)*	Trunklift (inches) *M(SE)*	BSR (inches) *M(SE)*
Male (*n = 35)*	33.51(2.96)	12.94(2.63)	37.97(3.84)	9.97(0.29)	7.74(0.43)
Female (n = 39)	22.03(1.60)	8.49(1.10)	40.64(4.19)	11.15(0.19)	10.28(0.37)

Table 8

Correlations Between Gender and Fitnessgram Components

	Pacer	Flexed Arm Hang	Curl-Ups	Trunklift	BSR
Gender (0 = Female, 1 = Male)	0.38**	0.19	-0.06	-0.38**	-0.47**

** $p < 0.01$

Table 9

Correlations Between Discovery Education and Fitnessgram Components

	Pacer	Flexed Arm Hang	Curl-Ups	Trunklift	BSR
DE Scores	0.002	-0.03	0.04	0.14	-0.001

Table 10

Correlations Between Fitnessgram Components and Discovery Education Scores Separately by Gender

	Pacer	Flexed Arm Hang	Curl-Ups	Trunklift	BSR
DE Scores (girls)	-0.17	-0.15	0.04	0.07	0.01
DE Scores (boys)	0.003	-0.02	0.06	0.06	0.03

Table 11

Descriptive Data for Discovery Education Scores

	Spring 2015
Mean	1661.77
SD	79.76
Range	397
Skewness	0.87
Kurtosis	1.32

Regression Analyses

A series of regression analyses were conducted to determine the extent to which physical fitness as measured by components of the Fitnessgram predict academic achievement as measured by the DE assessment (Table 10). Statistical significance was set at $p \leq 0.05$. Model 1 included gender as the predictor variable for academic achievement. Scores on the Fitnessgram were entered into Model 2. Each physical fitness component had its own model. In Model 3, the interaction between gender and the physical fitness component was included. The R^2 for Model 1, which analyzed the relationship between gender and academic achievement, did not reach statistical significance ($p = 0.20$) and accounted for 2.3% of the variability in Discovery

Education assessment scores. None of the Model 2 equations were significant. Model 2 for the Pacer accounted for 2.8% of the variability in Discovery Education scores, curl-up accounted for 2.4%, truck lift accounted for 6.6%, flexed arm hang accounted for 2.7%, and BSR accounted for 2.3%. None of the Model 3 equations were significant. Model 3 for the Pacer accounted for 3.5% of the variability in Discovery Education scores, curl-up accounted for 2.4%, trunk lift accounted for 7.3%, flexed arm hang accounted for 3.3%, and BSR accounted for 2.3%. The R^2 values for Model 2 and 3 equations for all Fitnessgram components are presented in Table 11. Overall, each equation accounted for less than 4% of the variability in Discovery Education scores.

Table 10

Summary of Multiple Regression for Academic Achievement

Variable	Model 1			Model 2			Model 3		
	n = 73			*n* = 73			*n* = 73		
	B (SE)	*Beta*	*p*	*B (SE)*	*Beta*	*p*	*B (SE)*	*Beta*	*p*
Pacer									
Gender (0 = Male, 1 = Female)	23.86 (18.49)	0.15	0.20	20.63 (19.32)	0.13	0.29	28.68 (22.41)	0.18	0.21
Pacer				-0.40 (0.66)	-0.07	0.55	-2.27 (2.70)	-0.42	0.40
Gender x Pacer							1.08 (1.50)	0.37	0.48
R^2	0.023			0.028			0.035		
F for change in R^2	1.67			0.37			0.51		
Curl-Up									
Gender	23.86 (18.49)	0.15	0.20	24.13 (18.62)	0.15	0.20	23.58 (23.14)	0.15	0.31
Curl-Up				0.12 (0.38)	0.04	0.75	0.08 (1.15)	0.02	0.95
Gender x Curl-Up							0.03 (0.77)	0.01	0.97
R^2	0.023			0.024			0.024		
F for change in R^2	1.67			0.10			0.002		

Table 10 (Continued)

Variable	Model 1			Model 2			Model 3		
	n = 73			n = 73			n = 73		
	B (SE)	*Beta*	*p*	*B (SE)*	*Beta*	*p*	*B (SE)*	*Beta*	*p*
Trunk Lift									
Gender	23.86 (18.49)	0.15	0.20	37.26 (19.65)	0.24	0.06	-66.02 (143.85)	-0.42	0.65
Trunk Lift				11.33 (6.26)	0.22	0.07	-4.61 (22.88)	-0.09	0.84
Gender x Trunk Lift							9.61 (13.25)	0.61	0.47
R^2	0.023			0.066			0.073		
F for change in R^2	1.67			3.28			0.53		
Flexed Arm Hang									
Gender	23.86 (18.49)	0.15	0.20	25.53 (18.83)	0.16	0.18	24.88 (18.92)	0.16	0.19
Flexed Arm Hang				-0.43 (0.80)	-0.07	0.59	-3.07 (3.89)	-0.46	0.43
Gender x Flexed-Arm Hang							1.44 (2.09)	0.40	0.49
R^2	0.023			0.027			0.033		
F for change in R^2	1.67			0.30			0.48		
BSR									
Gender	23.86 (18.49)	0.15	0.20	25.00 (21.06)	0.16	0.24	23.78 (22.81)	0.15	0.30
BSR				0.45 (3.88)	0.02	0.98	-0.14 (5.67)	-0.005	0.98
Gender x BSR							1.13 (7.83)	0.03	0.89
R^2	0.023			0.023			0.023		
F for change in R^2	1.67			0.013			0.02		

Table 11

Summary of R^2 Values

Variable	Model 1	Model 2	Model 3
Pacer	0.023	0.028	0.035
Curl-Up	0.023	0.024	0.024
Trunk Lift	0.023	0.066	0.073
Flexed Arm Hang	0.023	0.027	0.033
BSR	0.023	0.023	0.023

Due to the nonsignificant interactions, a multiple regression with all of the Fitnessgram components as predictor variables and Discovery Education scores as the dependent variable was conducted. None of the predictor variables were significant and the model accounted for less than 4% of the variability in academic achievement.

Table 12

Summary of Multiple Regression for Academic Achievement

Predictor Variables	*B (SE)*	*Beta*	*p*
Pacer	-0.79 (0.73)	-0.15	0.28
Curl-Up	0.28 (0.45)	0.09	0.53
Trunk Lift	6.82 (6.11)	0.14	0.27
Flexed Arm Hang	-0.05 (0.86)	-0.01	0.96
BSR	-0.45 (4.28)	-0.01	0.92
R^2	0.037		
F for change in R^2	0.53		

Overall, gender did not significantly predict academic achievement and none of the Fitnessgram components predicted academic achievement. When the interactions between gender and the Fitnessgram components were included in the models, none of the results were significant. In addition, when all of the Fitnessgram components were included in one model, they did not significantly predict academic achievement.

CHAPTER 5:

DISCUSSION

Research has found that components of physical fitness correlate with measures of academic achievement. For example, PACER, push-ups, and curl-ups were correlated with reading, math, and total achievement as measured by the Illinois Standards Achievement Test (Castelli et al., 2007). Bass and colleagues (2013) found the strongest correlations between aerobic fitness and academic achievement followed by muscular endurance and academic achievement. Castelli and colleagues also looked at a composite score of fitness and found higher academic achievement scores were associated with greater total fitness. These studies have looked at fitness test scores separately or combined them in such a way that each fitness test has equal weight. In contrast, the overall purpose of the current study was to gain insight into the extent to which components of physical fitness predict academic achievement and the extent to which gender moderates this relationship. In this chapter, results from this study will be discussed and tied into the current literature base. Additionally, study limitations, future directions, and how these findings can inform future practice will be explored.

Research Questions

1. To what extent do components of physical fitness as measured by the Fitnessgram predict academic achievement as measured by the Discovery Education assessment?
2. To what extent does gender moderate the aforementioned relationship?

To answer these questions, Fitnessgram and Discovery Education data were collected from a sample of fifth-grade students from one elementary school. Overall, 52.7% of the sample was female. The sample was largely White and ineligible for free or reduced lunch, indicating high socioeconomic status.

A series of regression models were created with Discovery Education assessment scores as the dependent variable and each of the Fitnessgram measures as the independent variables. Overall, no measures of physical fitness predicated Discovery Education scores. In addition, gender did not significantly moderate any of the relationships between physical fitness components and Discovery Education scores. The null findings for the various other measures of physical fitness are discussed below.

The Pacer, flexed arm hang, curl-up, and BSR did not predict academic achievement as measured by the Discovery Education assessment. There are several possible explanations for this finding. The measure of academic achievement used in this study was that of reading. Although previous research has found physical fitness to be related to overall achievement as well as math and reading achievement separately, several studies have also found physical fitness to be related to only mathematics scores and not reading scores. Wittberg, Northrup, and Cottrell (2009) found that children who scored in the healthy fitness zone (HFZ) on upper body strength (i.e., push-up, modified push-up, pull-up, or flexed arm hang) and flexibility (i.e., BSR or shoulder stretch) only scored significantly higher on the mathematics subtest compared to students who scored in the needs improvement zone (NIZ). No differences were found for scoring in the HFZ on the reading subtest. Blom et al. (2011) found that the odds of high academic achievement in mathematics increased to a greater extent with the number of HFZs achieved compared to that of high reading achievement. Lastly, physical fitness had an impact on mathematics scores as measured by the WIAT-III, but not on the reading and spelling subtests (Blom et al., 2013).

Taken together, there appears to be a stronger relationship between physical fitness and math achievement compared to physical fitness and reading achievement. This may be due to the effect that physical activity has on differing brain regions. Davis et al. (2011) found that students who participated in exercise scored higher on measures of executive functions and mathematics achievement but not reading achievement compared to students in the control group. Furthermore, the students in the exercise group had increased bilateral prefrontal cortex activity and decreased bilateral posterior parietal cortex activity when engaging in a task that measured executive function. A meta-analysis of 52 functional magnetic resonance imaging (fMRI) studies of children with mean ages of 4 to 17 was conducted to determine brain regions most involved in numerical abilities and reading (Houde, Rossi, Lubin, & Joliot, 2010). Researchers found numerical abilities resulted in brain activity in the right inferior frontal gyrus, the left superior frontal gyrus, and the part of the left middle occipital gyrus, whereas reading resulted in left frontal, temporoparietal, and occipitotemporal activity. Taken together, physical activity may increase neural stimulation resulting in cognitive changes (Davis et al., 2011) that benefit parts of the brain that lead to greater mathematics achievement. Therefore, the null findings in this study could be due to the fact that the measure of academic achievement was one of reading and not mathematics.

Another possible explanation as to why the Pacer, flexed arm hang, curl-up, and BSR did not predict academic achievement is due to the high socioeconomic status (SES; i.e., free/reduced price lunch status) of the current sample. Seventy percent of the students in this sample paid full price for their lunch, while 26% received free lunch and 4% received reduced lunch. In a sample of 954 middle school students (i.e., grades 6, 7, and 8), Bohr and colleagues (2013) found girls of high SES as measured by whether they received a free lunch, completed more Pacer laps, push-ups, and curl-ups compared to girls of low SES. There were no differences between girls with high and low SES on the BSR. Additionally, there were no differences in physical fitness for boys of high and low SES on any measure of physical fitness. A study conducted with 507 youth from Madeira, Portugal found differences between high, average, and low SES on measures of physical fitness at different ages (Freitas et al., 2007). Boys with low SES outperformed those with average or high SES on the BSR from ages 10-18 years and girls from low SES outperformed peers at 15-18 years. From 12-13 and 16-18 years, boys with high SES performed significantly better for sit-ups compared to average and low SES. High SES boys ages 10-11 and 12-13 years also performed better on the shuttle run compared to lower SES groups, and this was similar for girls. These two studies (i.e., Bohr et al., 2013 and Freitas et al., 2007) found varied results suggesting the relationship between SES and physical fitness is still largely unknown. However, the studies do seem to suggest that SES plays a role in physical fitness. The current study consisted of a large majority of students from a high SES background. It is hypothesized that this lack of variability resulted in difficulty detecting a relationship between academic achievement and physical fitness.

The same lack of variability was seen for racial differences. Eighty-eight percent of the sample was White, 1% African American, 7% Hispanic, and 4% Multiracial. In a study of 537 fifth- and sixth-grade students, physical activity was measured using an accelerometer (Kwon, Mason, & Welch, 2015). Students came from either predominantly White, Black, Hispanic, or racially mixed schools. Boys in majority White schools spent significantly more time in physical activity compared to boys in majority Black schools. Girls in majority White schools spent significantly more time in physical activity compared to girls from Black, Hispanic, and mixed schools. These findings suggest that students from majority White schools may engage in more physical activity compared to those from a minority school. The sample in this current study was predominately White and thus it is hypothesized that students were more physically fit and higher achieving compared to students from different racial backgrounds. As a result, the null findings from this study may be partly explained by the lack of variability in racial differences. Overall, the findings from this study suggest physical fitness may not predict academic achievement in a sample of already high achieving, high SES, and predominantly White fifth-grade students.

Limitations

One limitation of the study as previously noted is the lack of variability in race and SES. Due to the research that suggests racial and socioeconomic differences in physical fitness, the null findings from this study may not generalize to lower socioeconomic and racially diverse students. Lack of variability in academic achievement is also a limitation. The sample in this study had reaching achievement scores significantly greater than what was expected. Another limitation of this study is that data were only obtained from fifth graders from one elementary school. Although only analyzing data from one school and one grade level provided internal control, the generalizability of the findings are limited. This study utilized data previously collected by the physical education teachers at the elementary school. Thus, the current researcher was unable to assess the fidelity and standardization of data collection procedures. In addition, data from one class were missing. It remains unknown whether this class performed similarly as far as academic achievement and physical fitness, which could have influenced the results. This relates to another limitation regarding accessing data from a school district. Inconsistent procedures in storing and reporting data presented challenges with accessing complete data in a timely manner. Lastly, there have been limited studies on the reliability and construct validity of the Fitnessgram. However, the individual measures of the Fitnessgram (i.e., Pacer, flexed arm hang, curl-ups, and trunk lift) are valid measures of health-related components of physical fitness including cardiorespiratory endurance, muscular strength, muscular endurance, and flexibility.

Future Directions

The results of this study indicate the need for future research into the extent to which physical fitness predicts academic achievement. At the most basic level, the extent to which physical fitness predicts academic achievement and the moderating role of gender in this relationship should be explored with a larger, more racially and socioeconomically diverse sample. Utilizing a larger sample size will increase the power and the ability to detect significant results. Additionally, using a more diverse sample would increase the generalizability of the findings to other groups.

Future studies should also explore the extent to which physical fitness predicts mathematics achievement specifically. Given the studies that found fitness levels to be correlated with mathematics achievement and not reading achievement (e.g., Blom et al., 2011; Davis et al., 2011; Wittberg, Northrup, & Cottrell, 2009), it is important to continue to uncover the possible explanations for these findings.

Lastly, very few longitudinal studies have been conducted to determine how fitness and achievement are related over time. Two longitudinal studies (e.g., London & Castrechini, 2011; Wittberg, Northrup, & Cottrell, 2012) have been conducted both of which categorized students according to HFZ and NIZ. One of the limitations of categorizing students in this manner is that those who have moderate fitness are not taken into account. Thus, future studies should use students' raw fitness scores instead of categorizing them. Additionally, the longitudinal studies in the literature looked at growth in achievement in either fourth and sixth graders or fifth and seventh grades. Future research should determine the relationship between the change in physical fitness and the change in academic achievement over multiple, consecutive school years (e.g., third through fifth).

Implications for Practice

The National Association of School Psychologists (NASP; 2010) set forth a *Model for Comprehensive and Integrated School Psychological Services*. As part of service delivery, school psychologists engage in student-level services such as interventions and instructional support to develop academic skills, as well as interventions and mental health services to develop social and life skills (NASP, 2010). Although this study did not find that physical fitness predicted academic achievement, a negative relationship was not discovered either. This means that physical fitness at the very least does not have a negative impact on academic achievement. In addition, the health benefits of physical activity are well-established, so it remains important for school psychologists to promote physical activity within the school setting. The model also specifies that school psychologists engage in systems-level services such as supporting school-wide practices (NASP, 2010). Increasing physical fitness can serve as a school-wide practice via physical education and recess. Jump Rope for Heart and Hoops for Heart are two national educational and fundraising events sponsored by the American Heart Association which foster physical activity as well as raising money for children with heart-health issues (American Heart Association, 2016). School psychologists can encourage school-wide programs such as these as additional ways to promote physical fitness.

Conclusion

Previous research has found physical fitness is related to academic achievement. In this study, the extent to which physical fitness predicted academic achievement and the extent to which gender moderated this relationship was explored. Although this study found that physical fitness did not predict academic achievement as measured by the Discovery Education assessment, and gender did not moderate the relationship, these results are incongruent with previous studies. Several reasons for the differences in findings were discussed with respect to sample size and limited diversity, as well as the selection of variables explored (i.e., reading versus math achievement). Despite the lack of findings in this study, school psychologists should continue to promote physical activity and physical fitness within and outside of the school setting due to the known health benefits. Future research is needed to continue to explore the role of physical fitness in predicting academic achievement in order to promote student success.

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