The role of Physical FITNESS and Physical ACTIVITY on Academic Achievement Among Eighth Grade Students in Alabama

By

Jessica Baker O’Neal

A Dissertation

Submitted in Partial Fulfillment

of the Requirements for

the Degree of Doctor of Education

in Curriculum and Leadership

(Curriculum Development)

Columbus State University

Columbus, GA

July 2015

Dedication

I dedicate this dissertation to the students of Alabama and, most importantly, my precious bunch of eighth grade Bobcats. My purpose for this research study was to provide educators, school policy makers, and health care officials with the information needed to combat adolescent overweight/obesity health risks, as well as academic underachievement. Students in Alabama need support, encouragement, and education to break free of the stereotypes they see themselves as and extinguish everything that holds them back. Stakeholders should be aware that sacrificing the health of our students only to try and accomplish academic goals is not the answer. As a teacher, it is upsetting to see students think so poorly of themselves because of the way they look or because of their academic failures which diminishes their hope for the future. I hope this research will highlight the importance of physical activity and physical education programs in schools. Implementing effectual physical activity programs could awaken motivation that despondent students of Alabama need in order to flourish both academically and in society.

Acknowledgments

To the members of my committee, your help has been instrumental throughout this entire process. Dr. Michael Richardson, thank you for being so kindly intimidating that you made me step up my level of thinking and writing. I quickly recognized I had to know what I was doing and why I was doing it so that I could answer all of your questions with complete confidence! Dr. Deidre Greer, thank you for sparking my interest in cognition and the many wonders of how the adolescent brain works. Dr. Brian Tyo, thank you for providing me with the latest exercise science research and technology. Your knowledge and advice have been incredibly influential to this dissertation. Dr. Margie Yates, I am forever grateful for the momentous role you played in shaping my research and education. Thank you for always providing a smiling face and endless encouragement when I wasn't sure if I could make it any further. I knew I could do it with you by my side!

To my beloved friends and family, I thank God for providing me with the world's best source of strength and support. The completion of this dissertation definitely took a village and I am forever indebted to you all. Thank you for the free babysitting, countless words of encouragement, powerful prayers, and laughter through my many tears. To my Monday Night Girls, your friendship, endless words of encouragement, and prayers have meant the world to me!

Lastly, most thanks goes to Josh, my rock and the love of my life. Thank you for helping make my dream a reality and staying by my side through it all. I praise God for a husband who does it all with a servant's heart. Thank you for never giving up on me. I look forward to this new chapter in our lives and am eager to witness God's plan for our family.

Jessica B. O'Neal

815 Azalea Drive• LaGrange, GA 30240
Phone: 912-531-1362 • E-Mail: baker_jessica3@columbusstate.edu

Education

Ed.D. Doctor of Education, Major: Curriculum and Leadership
Columbus State University 2012-2015
Columbus, Georgia

Ed.S. Education Specialist, Major: Curriculum and Instruction
LaGrange College, 2010-2011
LaGrange, Georgia

MAT Master of Art in Teaching, Major: Middle Grades Education
LaGrange College, 2007-2008
LaGrange, Georgia

BSK Bachelor of Science in Kinesiology, Major: Exercise Science
Georgia Southern University, 2002-2006
Statesboro, Georgia

Teaching Experience

- Auburn Junior High School, Auburn City School System — 2015-Present
  Mathematics Department, Grade 8
- Beulah High School, Lee County School System — 2007-2015
  Mathematics Department, Grades 7-8
  - Response to Intervention (RtI) Chair — 2012-2015
  - Response to Intervention (RtI) Committee Member — 2009-2012
  - Continuous Improvement Plan (CIP) Chair — 2013-2015
  - Continuous Improvement Plan (CIP) Committee Member — 2009-2013
  - Administrative Team Member — 2014-2015
  - Varsity Cheerleading Coach — 2008-2010

Research Experience

- Physical Activity, Physical Fitness and Academic Achievement — 2012-2015
- The Role of Culturally Relevant Teaching and Homework in the Junior High Classroom — 2010-2011
- Gregory P. Domin Graduate Research Conference Presenter: "The role of Physical Fitness and Physical Activity on Academic Achievement Among Eighth Grade Students in Alabama" — October 2014

Certifications

- Georgia, Highly Qualified Teacher
    - Mathematics, Grade 4-8
    - Science, Grade 4-8
- Alabama, Highly Qualified Teacher
    - Mathematics, Grade 4-8

Community Involvement

- Junior Service League of LaGrange — 2008-Present
    - Junior Service League of LaGrange, President — 2015-2016
- Member of First Baptist Church on the Square — 2011-Present

Honors and Awards

- 2013-2014 Beulah High School Teacher of the Year — 2013-2014
- 2013-2014 Lee County School System Secondary Teacher of the Year — 2013-2014

Professional Development

- Presenter: Engaging Students through Station Teaching, Technology, and Investigations — February 2015
- Trained to Administer Assessments for Dyslexia — January 2015
- Assist-The Adaptive System of School Improvement — August 2014
- VAL-ED Implementation Training, Phase 3 — February 2014
- Laying the Foundation Training-Year 1 Mathematics — June 2013

Grants

- Columbus State University, — Spring 2014
  Dr. Brian Tyo, Assistant Professor, Health and Wellness
  Internal Grant, $4,238

References

- Dr. Margie Yates, *Dissertation Committee Chair*
  Columbus State University
  706-507-8507, yates_helen@columbusstate.edu
- Sue Larkin, *Colleague*
  Beulah High School
  706-302-5506, suzylarkin2@gmail.com
- David Owen, *Assistant Principal/Supervisor*
  Beulah High School
  334-740-4667, owendaviddl@gmail.com
- Heather Camp, *Department Head*
  Beulah High School
  334-399-3731, boyd.heather1996@gmail.com

Abstract

The purpose of this correlational study was to determine the extent of the relationship between physical fitness, body composition, physical activity, and academic achievement. School leaders have justified the reduced time for physical activity and physical education as they take away from classroom instruction time; yet, national assessment outcomes have indicated the condition of education in America has failed to measurably improve student achievement. An additional public health concern, increased sedentary lifestyles and unhealthy-weight conditions have significantly increased in the past 30 years among American children and adolescents.

The researcher incorporated a quantitative design to examine these relationships in an eighth-grade student sample (N=48) from a high school in Alabama. Within this study, there were two dependent variables, math and reading ACT Explore scores, and three independent variables, physical fitness results, BMI category, and Physical Activity levels. Data were analyzed using Path Analysis and MANOVA. Results of the path analysis showed $R^2_{MATH} = .08$; $F_{8,25} = .268$, $p = .971$ and $R^2_{READING} = .21$; $F_{8,25} = .85$, $p = .568$. The effects of CV fitness, flexibility, AB strength, muscular strength, PA, and PAQ-A were not statistically significant in the model. Results stemming from the one-way MANOVA allowed the researcher to determine there was no statistical difference between the three BMI group means on the combination of dependent variables. Results from the PAQ-A were statistically significant to physical activity levels measured by the accelerometer. Based on these results, the researcher was able to substantiate research findings stating the PAQ-A has been shown to exhibit consistent validity among objective physical activity measures, such as the ActiGraph accelerometer.

Table of Contents

List of Tables

List of Figures

CHAPTER I

INTRODUCTION

Providing children with an education that delivers the opportunity for success in an ever changing, global society is key for the future of the United States. Students need critical thinking skills, innovative problem solving abilities, and the autonomy, confidence and motivation to produce superior academic achievement to compete with their global counterparts (Vazou, Gavrilou, Mamalaki, Papanastasiou, & Sioumala, 2012). A good contribution to America's future may come through a keen investment in physical fitness and physical activity. Researchers have provided evidence that greater physical fitness and a physically active lifestyle increase academic achievement and enhance cognitive performance (Blom, Alvarez, Zhang, & Kolbo, 2011; Castelli, Hillman, Buck, & Erwin, 2007; Chomitz et al, 2009; Davis et al., 2011; Fedewa & Ahn, 2011; Hillman et al., 2009b; Van Dusen, Kelder, Kohl, Ranjit, & Perry, 2011). This researcher has found support for increased physical activity involvement as a way to combat the growing tendency among modern societies for children to participate in sedentary activities that could increase their risk for cardiovascular diseases and academic underachievement (Aberg et al., 2009; Best, 2012; Davis et al., 2011; Donnelly et al., 2009; Chomitz et al., 2009; Santiago, Roper, Disch, & Morales, 2013; Syväoja et al., 2013). The importance of this study was evident as obesity rates doubled among American children and tripled among adolescents in the past 30 years (Centers for Disease Control and Prevention [CDC], 2013). Schools provide an ideal place for intervention as students spend most of their waking hours at school and according to the U.S. Census Bureau, over 90% of the 59 million children enrolled in school attended a public school (Davis & Bauman, 2013). Although activities at school may be an ideal means of improving the physical fitness and physical activity levels of America's youth, schools have delivered major roadblocks as school leaders have fearfully reduced time and funds for programs like physical education as a way to increase instructional learning time in core subjects (Center for Education Policy, 2007; Jennings, 2012; Wittberg, Cottrell, Davis, & Northrup, 2010).

Statement of the Problem

A total of 18 countries had higher average mathematics, reading, and science scores than the United States on the Program for International Student Assessment (PISA) (Organization Economic Co-operation and Development [OECD], 2013). Moreover, according to the 2013 National Assessment of Educational Progress (NAEP), Alabama scored well below the national average at the fourth and eighth grade level in reading and mathematics (National Center for Education Statistics [NCES], 2013b). According to the Trends in International Mathematics and Science Study (TIMSS), Alabama eighth graders scored below the U.S. and TIMSS average in mathematics and science assessments (Aud et al., 2013, Provasnik et al., 2012). Students in the U.S., including those students in Alabama, are not keeping up with their global counterparts, even with significantly more instructional time (Aud et al., 2013, NCES, 2013b; Provasnik et al., 2012).

Meanwhile, despite well-documented evidence that physical exercise can have countless health benefits, average fitness levels of U.S. children have declined (American Cancer Society, 2012; CDC, 2013; National Association for Sport and Physical Education & American Heart Association [NASPE], 2012). Since the early 1980s obesity has tripled among adolescents and remains high (CDC, 2013). Wang, Beydoun, Liang, Caballero, and Kumanyika (2008) have suggested the prevalence of childhood obesity has the potential to reach 30% by 2030, while other scholars believe, that although at a peak level, the childhood obesity epidemic may have statistically plateaued (CDC, 2013; Ogden, et al., 2012). Obese children and adolescents are more likely to develop risk factors for cardiovascular disease, such as high cholesterol and high blood pressure, and are at a greater risk of becoming obese adults (CDC, 2013). The U.S.

Department of Health and Human Services states that there is a direct correlation between physical exercise and health among children and adolescents (U.S. Department of Health and Human Services [USDHHS], 2008). For instance, children who participate in regular vigorous exercise develop strong hearts, lungs, bones and muscles, and have less body fat than their sedentary peers (Berg, 2010). Physically active children also reduce their risk for heart disease, type II diabetes, cancer, and obesity (Berg, 2010).

In 2012, the National Association for Sport and Physical Education (NASPE), along with the American Heart Association (AHA), released their annual 'Shape of the Nation' report revealing health statistics among American youth as well as progress among physical education programs (NASPE, 2012). Together, the NASPE and AHA recommend 150 minutes per week (30 minutes per day) of physical education (PE) for elementary school children and 225 minutes per week (45 minutes per day) for middle and high school students. Currently, there are no states that follow these recommendations at every level and only six states (Illinois, Hawaii, Massachusetts, Mississippi, New York, and Vermont) that require physical education at every grade level (NASPE, 2012). Although many claim they mandate students take PE, 33 states allow students to substitute other activities for their required PE credit and 28 states allow schools to grant exemptions for PE classes (NASPE, 2012).

These nation-wide declines in physical fitness and PE are continuing although research suggests that physically active children have higher academic achievement (Castelli, Hillman, Buck, & Erwin, 2007; Fedewa & Ahn, 2007; Labban & Etnier, 2011; Mead et al., 2013; Tomporowski, Davis, Miller, & Naglieri, 2008; Wittberg, et al., 2010) and improved cognitive abilities (Berg, 2010; Colcombe et al., 2004; Hillman et al., 2009; Vawter, 2010). The cognitive benefits of a physically active lifestyle and increased physical fitness such as improved inhibition, working memory, and attention span persistence, as well as mental flexibility and subsequent goal-oriented behaviors, have been exhibited as early as two years old and have predicted later academic achievement (Francis & Susman, 2009; Graziano, Calkins, & Keane, 2010). The presence of a physical fitness achievement gap involves academic achievement repercussions on future educational and health outcomes aimed at even the youngest students (Aberg et al., 2009; London & Castrechini, 2011).

Physical education classes have taken a back seat to core classes such as math and reading over the past decade due to shrinking school budgets and an increased pressure to demonstrate high levels of academic achievement for all learners (Fairclough & Stratton, 2005; Fedewa & Ahn, 2011; Mead et al., 2013). School leaders were forced to choose between physical and academic activities as a way of maximizing learning opportunities, especially for struggling students (Berg, 2010; Coe, Pivarnik, Womack, Reeves, & Malina, 2006; London & Castrechini, 2011). Students are being pulled from physical education classes for remediation and test-taking strategies while their higher-achieving peers are allowed to participate in physical activities (Coe et al., 2006). However, researchers suggest physical education may help improve academic achievement rather than hinder learning opportunities (Berg, 2010; Bize, Johnson, & Plotnikoff, 2007; Fedewa & Ahn, 2011; Tomporowski, Davis, Miller, & Naglieri, 2008).

Significant health-risk behaviors, comparable to physical fitness and an active lifestyle, contribute to the leading causes of disease and mortality among youth and adults (CDC, 2012). These behaviors, which have been shown to add to the physical fitness achievement gap, are most commonly established during childhood and adolescence and are preventable (CDC, 2012; London & Castrechini, 2011). Educators have been narrowing their focus solely on the teaching and learning aspect, while neglecting the importance of educating the whole child. Countless hours are spent teaching new instructional strategies, learning tools, acronyms, and intervention ideas to help students learn, all of which do not involve exercise. Schools and School leaders may need to look beyond current strategies and programs and shift the focus on meeting the physical needs of the students in order to maximize academic achievement and health benefits.

Research Questions

The primary aim of this study was to examine the relationship between Physical Fitness and Academic Achievement. Thus, the following research questions were implemented to guide the study:

1. To what extent is there a relationship between Alabama Physical Fitness Assessment (APFA) scores and Explore test scores among eighth grade students?

2. To what extent is there a relationship among BMI classifications (underweight, normal weight, overweight, and obese) and Explore test scores among eighth grade students?

The secondary aim of this study was to examine the relationship between Physical Activity levels and Academic Achievement. Thus, the following research question was implemented to guide the study:

3. To what extent is there a relationship between physical activity levels (both objective and subjective measures) and Explore test scores among eighth grade students?

Definitions

A brief description of the terms and technical language used throughout the study is included in this section.

Academic Achievement

Academic achievement in this study refers to the students' math and reading scores on the state mandated ACT Explore Assessment.

Physical Education:

"... a curricular area offered in K–12 schools that provides students with instruction on physical activity, health-related fitness, physical competence, and cognitive understanding about physical activity, thereby enabling students to adopt healthy and physically active lifestyles" (CDC, 2010, p. 10).

Physical Fitness

"Physical fitness is a set of attributes that are either health- or skill-related. The degree to which people have these attributes can be measured with specific tests" (Caspersen, Powell, & Christenson, 1985).

Physical Activity

"Any movement of the body produced by skeletal muscles and resulting in energy expenditure" (Caspersen, Powell, & Christenson, 1985).

Recess

"Recess is a time during the school day that provides children with the opportunity for active, unstructured or structured, free play" (CDC, 2010, p. 10).

Chapter One Summary

Anticipating increased standardized test scores for students, school leaders have justified the reduced time for physical activity and physical education as they take away from classroom instruction time. As a result, average health and fitness levels of U.S. children have declined along with national and international educational assessment scores (NCES, 2013a, NCES, 2013b; Wittberg et al., 2010). Students in the U.S., including those students in Alabama, are not keeping up with their global counterparts, even with increased instructional time (Aud et al., 2013, NCES, 2013b; Provasnik et al., 2012). The USDHHS has identified a direct correlation between physical exercise and health among children and adolescents (USDHHS, 2008). Corroborating with the USDHHS, researchers have provided evidence that greater physical fitness and a physically active lifestyle increase academic achievement and enhance cognitive performance (Blom, Alvarez, Zhang, & Kolbo, 2011; Castelli, Hillman, Buck, & Erwin, 2007; Chomitz et al. 2009; Davis et al., 2011; Fedewa & Ahn, 2011; Hillman et al., 2009b; Van Dusen, Kelder, Kohl, Ranjit, & Perry, 2011). Thus, increased sedentary lifestyles and unhealthy-weight conditions among American children and adolescents may be steering even the best efforts to improve education in the exact opposite direction (Blom et al., Castelli et al., 2007; 2011, CDC, 2013; Hillman et al., 2009; Ogden et al., 2012; Sabia, 2007). These researchers lend support for increased physical activity involvement as a way of combating the growing tendency among modern societies for children to participate in sedentary activities that could increase their risk for cardiovascular diseases and academic underachievement (Aberg et al., 2009; Best, 2012; Davis et al., 2011; Donnelly et al., 2009; Chomitz et al., 2009; Santiago, Roper, Disch, & Morales, 2013; Syväoja et al., 2013).

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

The literature used to inspire and shape the current research study has been taken from the fields of education, exercise science, and neuroscience with a specific focus on research that is applicable to middle school children and the authentic school setting. Middle childhood is often a time of making friends, absorbing new things, and being physically active. Stressful transitions occurring during this developmental stage can result in negative health consequences such as obesity, anxiety, and learning difficulties (Berger, 2009; Washington, 2009). According to brain-based research, a person's cognitive and physical health plays an important role in his or her ability to learn (McDaniel, 2012; Onchwari & Keengwe, 2011). Understanding the challenges struggling students face may provide educators a way to help students overcome their obstacles and increase their academic achievement.

Academic Achievement

A successful future for the United States will result when all children are equipped with an education that provides the opportunity for achievement. Student success is determined by academic achievement and is often the result of various constructs of the student's life, educational policies, and societal forces all functioning together (Glatthorn, Boschee, & Whitehead, 2009; Lucio, Rapp-Paglicci, & Rowe, 2011). Historically, America has witnessed many educational reform movements when teachers that have attempted to increase academic achievement (Jennings, 2012). Expanding equitable learning opportunities for handicapped, poor, and minority children was the focus of the equity-based reform movement of the 1960s and 1970s, while educators facing the issue of effective schools led to the school choice and voucher movement of the 1990s (Jennings, 2012). In 1991, Jonathan Kozol reminded the American public that students were not being equally educated in his publication *Savage*

Inequalities (Glatthorn et al., 2009). Kozol's book uncovered vast academic achievement disparities among schools serving students living in low-poverty as compared to schools serving more affluent students (Glatthorn et al., 2009). Attempting to fully eradicate inequalities in American education and close the achievement gap, the standards-based reform movement and the No Child Left Behind Act (NCLB) of 2002 held schools accountable for the success of all students (Jennings, 2012). The standards-based movement pinpointed the need for standards of learning that students should acquire at each grade level and required measurable objectives and tests to determine student proficiency (Jennings, 2012). Under NCLB, if schools did not pass the annual state exam, they risked losing funding and were publicly labeled as failing (Center for Education Policy, 2007; Jennings, 2012). Consequently, the standards-based movement resulted in test-centered teaching, more time in the classroom, and less time in recess, physical education, and other electives (AAHPERD, 2004; AHA, 2006; Berzin et al., 2011; Center for Education Policy, 2007; Jennings, 2012). According to Wittberg et al. (2010), school leaders justified the reduced time for physical activity and physical education movement as they "take time away from the classroom desk" (p. 285).

National Standards of Academic Achievement

The standards-based accountability movement of the late 1990s highlighted a public need for current and accessible information regarding the progress of education in the United States. To meet this need, members of Congress mandated the National Center for Education Statistics (NCES) create an annual report, *The Condition of Education*, presenting the public with information regarding educational developments, conditions, trends, and population characteristics obtained through surveys and administrative records from the elementary school level to postsecondary education (Aud et al., 2013). Producers of this national report card communicate academic achievement findings through the National Assessment of Educational

Progress (NAEP) and allow educational stakeholders to determine whether a policy, such as increased instruction time through reduced physical education, is helping improve academic achievement (Aud et al., 2013).

The NAEP is based on curriculum frameworks developed by the National Assessment Governing Board and, since 1969, has periodically assessed a nationally representative sample of fourth, eighth, and twelfth grade students in various academic subjects such as reading, mathematics, science, writing, U.S. history, geography, and civics (Aud et al., 2013). Information collected from the NAEP is used to evaluate the condition and evolvement of education at the national and state level. Scores on the NAEP range from zero to 500 and achievement levels consist of Basic, Proficient, and Advanced (Aud et al., 2013). The basic achievement level denotes partial mastery, the proficient level indicates competency of subject matter, and the advanced level signifies superior performance (Aud et al., 2013).

In 2013 there were 190,400 fourth grade and 171,800 eighth grade students who participated in the reading portion of the NAEP (NCES, 2013a). Nationally, scores from the fourth grade reading assessment saw no significant change since 1992 with only 35% of students scoring at or above the proficient level and an average score of 222 (NCES, 2013a).

Considerably less than the national average of 34%, only 29% of fourth-grade students in Alabama scored at or above the proficient reading level with an average NAEP reading score of 219 in 2013 (NCES, 2013b). Alabama's reading score was one point lower in 2013 than in 2011, when fourth-grade students had an average score of 220 (NCES, 2013b). Fourth-grade students in Alabama have not shown gains on the reading portion of the NAEP since 2005 (NCES, 2013b). Comparably, 2013 eighth-grade reading scores revealed only 34% of eighth-grade students nation-wide scored at or above the proficient level while merely 25% of Alabama eighth-graders scored at or above the proficient level in reading (NCES, 2013b). Eighth-grade students in Alabama have not shown gains on the reading portion of the NAEP since 2007 (NCES, 2013b).

In 2013 there were 186,500 fourth-grade and 170,100 eighth-grade students who participated in the mathematics portion of the NAEP (NCES, 2013a). Nationally, 41% of fourth-grade students scored at or above the proficient level in mathematics with an average score of 242 in 2013, one point higher than in 2011 (Aud et al., 2013; NCES, 2013a). In 2013, 29% of fourth-grade students in Alabama scored at or above the proficient level in mathematics with an average score of 233 (NCES, 2013b). This score was not significantly different than the 2011 mathematics score for Alabama, and was also significantly less than the national average (NCES, 2013b).

Nationally, 34% of eighth-grade students scored at or above the mathematics proficiency level with a score of 284 in 2013, merely one point higher than in 2011 (Aud et al., 2013; NCES, 2013a). In 2013, only 19 percent of students in Alabama scored at or above the mathematics proficiency level with an average score of 269 (NCES, 2013b). Moreover, approximately 80% of Alabama's eighth-grade students scored at or below the basic level for mathematics; out of the 50 states and the District of Columbia, Alabama's eighth grade mathematics score ranked at the lowermost end at number 50 (NCES, 2013b). Eighth-grade students in Alabama have not shown gains on the mathematics portion of the NAEP since 2007 (NCES, 2013b).

International Comparisons of Academic Achievement

To compare the academic achievement of American students to students in other countries, the United States has participated in numerous international assessments such as the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) (Aud et al., 2013; OECD, 2013). Operating under the auspices of the International Association for the Evaluation of Educational Achievement, the TIMSS has evaluated mathematics and science achievement at both the fourth and eighth grade level since 1995 (Aud et al., 2013; Provasnik, Kastberg, Ferraro, Lemanski, Roey, & Jenkins, 2012). Every four years, the TIMSS has compared United States student performance to other countries and educational systems (Provasnik et al., 2012). The report classifies "complete, independent political entities" as countries and educational systems as "a portion of a country, national, kingdom, or emirate" (Provasnik et al., 2012, p. iii).

In 2011, the United States average mathematics score among eighth-grade students was 509, which was not significantly different from the average mathematic score from 2007 (Aud et al., 2013; Provasnik et al., 2012). There were 11 educational systems that significantly outperformed the United States (Aud et al., 2013; Provasnik et al., 2012). Systems scoring above the U.S. score were Chinese-Taipei, Hong Kong, Japan, Quebec, the Republic of Korea, the Russian Federation, and Singapore. Educational systems within the United States, Indiana, Massachusetts, Minnesota, and North Carolina, all scored above the United States mathematics average and TIMSS scale average (Aud et al., 2013). Colorado, Connecticut, and Florida scored above the TIMSS average, but fell below the U.S. average score of 509. Alabama scored below both the U.S. national average and TIMSS scale score average with a score of 466 in mathematics (Aud et al., 2013, Provasnik et al., 2012).

In 2011, the average United States eighth grade science score of 525 was, again, not significantly different from the average science score from 2007 (Aud et al., 2013; Provasnik et al., 2012). In addition, there were 12 educational systems that significantly outperformed the United States (Aud et al., 2013; Provasnik et al., 2012). Countries scoring above the United States average score included Singapore, Chinese-Taipei, Korea, Japan, Finland, Alberta-

Canada, Slovenia, the Russian Federation, and Hong Kong-China (Aud et al., 2013; Provasnik et al., 2012). Massachusetts, Minnesota, and Colorado all scored above the United States and TIMSS science average while Indiana, Connecticut, North Carolina, and Florida scored above the TIMSS average score of 500, but fell below the United States average score of 525 (Aud et al., 2013; Provasnik et al., 2012). Alabama scored below the United States and TIMSS average with an average science score of 485 (Aud et al., 2013, Provasnik et al., 2012).

The coordinators of the 2011 TIMSS further collected information from school principals on the amount of instructional time their students received at the fourth- and eighth-grade level (Aud et al., 2013). The overall instructional time, accompanied by a more detailed account of time their students received instruction in mathematics and science, allows educational systems to analyze international differences and similarities (Aud et al., 2013). In 2011, the United States had an average of 1,078 total instructional hours for fourth-grade (Aud et al., 2013). This was higher than the international average of 897 total instructional hours for fourth-grade (Aud et al., 2013). The United States spent 206 hours directly on mathematics instruction and 105 hours on science instruction for eighth-grade students (Aud et al., 2013). The international averages of instructional time were lower for fourth grade mathematics and science at 162 and 85 hours, respectively (Aud et al., 2013). Similarly, the average number of instructional hours at the eighth-grade level was higher in the United States than the international average (Aud et al., 2013). In 2011, the United States had an average of 1,114 total instructional hours for eighth-grade, while the international average was 1,031 hours (Aud et al., 2013). Students in the United States spent 157 hours directly on mathematics instruction while the international average remained at 138 instructional hours (Aud et al., 2013).

Coordinated by the Organization for Economic Cooperation and Development (OECD) and conducted by the NCES, the PISA has measured mathematics, reading, and science literacy among 15-year-old students every three years since 2000 (OECD, 2013). In addition, the PISA uses cross-curricular analyses to identify students' functional skills, problem-solving abilities, and financial literacy (OECD, 2013). The PISA selected the age of 15 for their assessment as this age typically marks the end of compulsory schooling for students in other countries (OECD, 2013). PISA mathematics, science, and reading scale scores are reported on a scale of zero to 1,000 and are evaluated among six proficiency levels with each level increasing in performance capabilities, knowledge, and skills (OECD, 2013). Scale scores at levels five and six denote the top performers while scale scores at levels one and two indicate "a baseline level of proficiency, at which students begin to demonstrate the...literacy competencies that will enable them to participate effectively and productively in life" (OECD 2010, p. 154).

According to the 2012 PISA, Shanghai-China was in the lead with 55% of students performing at mathematics proficiency levels five and above (OECD, 2013). The United States, ranked 34th and lower than the OECD average, had nine percent of students at mathematics proficiency levels five and above (OECD, 2013). Compared to Shanghai-China's four percent, the United States had 26 percent of 15-year-old students score below level two, the baseline of proficiency (OECD, 2013). This was also greater than the OECD average of 23% of mathematics proficiency level two performers (OECD, 2013). The United States scored below the OECD average of 494 in mathematics literacy with an average score of 481 (OECD, 2013). The United States score was significantly lower than 29 countries (OECD, 2013).

According to the 2012 PISA, Shanghai-China led other countries with 27% of students performing at science proficiency levels five and above (OECD, 2013). The United States, ranked 27th and lower than the OECD average, had seven percent of students at science proficiency levels five and above (OECD, 2013). Compared to Shanghai-China's three percent, the United States had 18 percent of 15-year-old students score below level two, the baseline of proficiency (OECD, 2013). This was also greater than the OECD average of 23 percent of science proficiency level two performers (OECD, 2013). The United States science score of 497 was not measurably different from the OECD average of 501 (OECD, 2013). The United States science score was significantly lower than 22 countries (OECD, 2013).

According to 2012 PISA reading scores, Shanghai-China outperformed other countries with 25 percent of students performing at reading proficiency levels five and above, while the United States had eight percent of students at levels five and above (OECD, 2013). Compared to Shanghai-China's 3 percent, the United States had 17 percent of 15-year-old students score below level two, the baseline of proficiency for reading literacy (OECD, 2013). This was also greater than the OECD average of 23 percent of reading proficiency level two performers (OECD, 2013). Although United States students' reading score of 498 was not measurably different from the OECD average of 496, it was significantly lower than 19 educational systems (OECD, 2013).

A total of 18 countries had higher average PISA scores than the United States in all three-subject areas (OECD, 2013). These countries include Australia, Canada, Chinese-Taipei, Estonia, Finland, Germany, Hong Kong-China, Ireland, Japan, Liechtenstein, Macao-China, Netherlands, New Zealand, Poland, Republic of Korea, Shanghai-China, Singapore, and Switzerland (OECD, 2013). Similar to TIMSS, the coordinators of the 2012 PISA analyzed performance data over time to measure growth among educational systems. According to the findings, the 2012 United States average scores in reading, mathematics, and science were not measurably different from average scores in any of the previous PISA assessment years (OECD, 2013).

The ability to pinpoint the reason behind educational growth fluctuations may help predict and even determine future academic successes (Glatthorn et al., 2009). Nationally, the United States has seen little, if any, academic growth since the 1970s and 1980s in mathematics and reading (Aud et al., 2013). According to NAEP score results, the majority of students in fourth- and eighth- grade performed below the proficient level in reading and mathematics in 2013 (Aud et al., 2013). In addition, American students spend more time in class than their international peers, yet results from international assessment reveal the United States trailing behind other countries in mathematics, reading, and science (OECD, 2013).

Physical Fitness, Activity, and Education

Information that has evolved from national and international assessments, along with a heightened prevalence of childhood obesity among American children, has encouraged educational researchers to suggest the United States may need to examine other factors of a student's life that may be associated with academic success (Berg, 2010; Bize et al., 2007; Fedewa and Ahn, 201; Tomporowski et al., 2008). Because U.S. students spend two-thirds of their waking hours at school, schools that provide well-structured physical education programs and short activity breaks during the school day are able to increase the number of students who are physically active and healthy (Active Living Research, 2009, 2013; Luepker et al., 1996). Researchers have also indicated that physically fit children tend to have heightened academic achievement and students that are given the chance to take physical activity breaks during school hours demonstrate improved classroom behavior and focus (Active Living Research, 2009). In addition, Trudeau and Shephard (2010) found that academic learning increased per unit of class time by physically active students.

Fitness, Health, and Obesity Statistics

The American Cancer Society states that one-third of cancer deaths are attributed to obesity or lack of physical activity (American Caner Society, 2012). According to the CDC, obese children and adolescents are more likely to develop risk factors for cardiovascular disease, such as high cholesterol and high blood pressure, and are at a greater risk of becoming obese adults (CDC, 2013). The CDC further reported that more than 68% of American adults are either overweight or obese (CDC, 2013). According to the 2011 Behavioral Risk Factor Surveillance System (BRFSS), obesity rates were highest for Baby Boomers (aged 45 to 64 years) and reached 40% in Alabama and Louisiana (CDC, 2013). Additionally, 9 out of the 10 states with the highest rates of type II diabetes were in the South, with Alabama ranking third. The top ten states leading the nation in hypertension rates are all southern states, with Alabama ranking number one. The Alabama Department of Public Health identified a significant amount of high systolic and diastolic blood pressures among Alabama children (APFA, 2011, p. 2). Furthermore, children as young as six years of age have been diagnosed with type II diabetes in Alabama (APFA, 2011, p. 2). Consequently, the American Public Health Association and Partnership for Prevention, under the United Health Foundation, has estimated that obesity will cost the United States $344 billion in medical-related expenses by 2018, nearly 21% of the nation's health-care spending budget (United Health Foundation, 2009).

Since the early 1980s, obesity has tripled among adolescents and remains high (CDC, 2013). Wang et al. (2008) have suggested the prevalence of childhood obesity has the potential to reach 30% by 2030, while other scholars believe, that although at a peak level, the childhood obesity epidemic may have statistically plateaued (Ogden, et al., 2012; CDC, 2013).

The National Health and Nutrition Examination Survey (NHANES) was designed to examine the health and nutritional status of adults and children in the United States through interviews and physical examinations (Ogden et al., 2012). Researchers with the 2011 NHANES found that 31.7% of children 2 to 19 years old were overweight or obese; 16.9% of those students were categorized specifically as obese. These percentages translate to more than 11 million overweight children and over 12 million obese children (Ogden et al., 2012). Comparably, the National Survey of Children's Health (NSCH), a study based on the survey of parents from each state, examined the prevalence of obesity among children 10 to 17 years old. Researchers conducting the 2011 NSCH found that 7 out of the 10 states with the highest childhood obesity rates were in the South, with Mississippi ranking highest at 21.7% (National Survey of Children's Health [NSCH] (2011).

Researchers of the CDC's Youth Risk Behavior Surveillance System (YRBSS), a self-reported survey given to high school students, found 13% of high school students were obese and 15.2% were overweight in 2011 (CDC, 2012). Additionally, the YRBSS found student obesity levels ranged from a low of 7.3% in Colorado to a high of 17% in Alabama, with the median being 12% in 2011 (CDC, 2012). Levels of overweight adolescents ranged from a low of 10.7% in Colorado to a high of 19.5% in Louisiana, with a median rate of 14.7% (CDC, 2012). Alabama's overweight prevalence was reported higher than the median at 15.7% (CDC, 2012). The 2011 YRBSS further identified the prevalence of obese and overweight high school students according to their gender and race/ethnicity. According to the 2011 YRBSS, approximately 9.8% of high school females and 16.1% of high school males were obese. The prevalence of obesity was more than double for Caucasian (15%) and Hispanic (19.2%) males as compared to Caucasian (7.7%) and Hispanic (8.6%) females. In contrast, the prevalence of obesity was higher among African American females (18.6%) than African American males (17.7%) (CDC, 2012).

Physical Activity Statistics

The USDHHS stated there is a direct correlation between physical activity and health among children and adolescents (USDHHS, 2008). For instance, children who participate in regular vigorous exercise develop strong hearts, lungs, bones, and muscles and reduce their risk for heart disease, type II diabetes, cancer, and obesity (Berg, 2010). In an effort to produce evidence-based physical activity guidelines, Strong et al., (2005) systematically reviewed over 850 research articles and found that children and adolescents who participated in 60 minutes of moderate-to-vigorous physical activities achieved optimal health and behavioral effects when compared to lower intensity activities (Strong et al., 2005). Accordingly, in 2008 the federal government first issued its Physical Activity Guidelines, informing the public of research-based advice on the type and amount of physical activity necessary for substantial health benefits (Borrud, Chiappa, Burt, et al., 2014). According to these guidelines, children and adolescents should engage in 60 minutes or more of physical activity daily, including aerobic, muscle strengthening, and bone strengthening exercises (USDHHS, 2008). It is further recommended the majority of the aerobic exercises be performed at a moderate-to-vigorous intensity level (USDHHS, 2008).

Nationally, only 20% of school systems required recess in 2012 (NASPE, 2012). Distinctive from physical education, "recess is a time during the school day that provides children with the opportunity for active, unstructured or structured, free play" (CDC, 2010, p. 10). Alabama has not required a minimum weekly amount of physical activity time for students at any grade level, nor has the state required schools to provide daily recess or physical activity breaks (NASPE, 2012). According to the 2012 Shape of the Nation Report, Alabama permitted school leaders to withhold physical activity breaks, including recess, as punishment for disciplinary reasons and also allowed physical activities to serve as a punishment for inappropriate behavior during school hours (NASPE, 2012).

According to the CDC's Youth Risk Behavior Survey (YRBSS) of 2011, 48% of American students were not scheduled to attend physical education classes, while 69% of students that were scheduled for physical education attended class less than five days a week (NASPE, 2012). On an average school day, approximately 32% of students reported watching television and 31% reported using a computer for three or more hours (NASPE, 2012).

The Alabama State Department of Education and the CDC indicated, when compared to other states, Alabama youth were inactive (APFA, 2011, p. 2). Students in the state of Alabama reported on the 2011 YRBSS that 17% (23% of females and 12% of males) did not participate in at least 60 minutes of physical activity on any day during the seven days before the survey (CDC, 2013). In addition, 54% of Alabama high school students were not scheduled for physical education classes (CDC, 2013). Moreover, on an average school day, approximately 41% of students in Alabama reported watching television and 30% reported using a computer for three or more hours (CDC, 2013).

Physical Education Guidelines

According to Green and Reese (2006), a quality physical education program can be a major factor in reducing childhood obesity. In 2012, the NASPE and the AHA released their annual Shape of the Nation report revealing health statistics among American youth as well as progress among physical education programs (NASPE, 2012). This report, aimed at tracking improvements in physical education in the United States, examined each state's physical education guidelines (NASPE, 2012). According to NASPE and AHA, comparing physical education data reports has been "challenging," as there is no federal law that requires American schools to provide physical education to students, thus there is no standard benchmark and mandates vary among all states (NASPE, 2012, p. 1). Individual states outline their own sets of requirements while individual school systems are held accountable for its implementation (NASPE, 2012). Due to the lack of incentives for states or schools to offer physical education programs, school systems may freely choose to meet minimum standards (NASPE, 2012).

The NASPE and AHA recommend 150 minutes per week (30 minutes per day) of physical education for elementary school children and 225 minutes per week (45 minutes per day) for middle and high school students (NASPE, 2012). Currently, there are no states that follow these recommendations at every level, and only six states (Illinois, Hawaii, Massachusetts, Mississippi, New York, and Vermont) require physical education in every grade (NASPE, 2012). Although many state leaders claim they mandate students take physical education courses, students in 33 states are allowed to substitute other activities for their required physical education credit and administrators in 28 states allow school leaders to grant exemptions for physical education classes (NASPE, 2012). According to NASPE (2012), the state of Alabama falls under both categories, with school leaders allowing physical education course substitutions and exemptions for students. Alabama state officials grants the substitution of “interscholastic sports, Junior Reserve Officer Training Corps or marching band for their required physical education credit” (NASPE, 2012, p. 15). Exemptions for physical education are granted for a two-year time period (NASPE, 2012).

Alabama’s state standards for physical education, known as the Alabama Course of Study (ACOS), as well as a state curriculum, are based on the National Standards for Physical Education (NASPE, 2012). Physical education content standards within the ACOS have been organized into four strands: skill development, cognitive development, social development, and physical activity and health (APFA, 2011, p. 1). Developers of the curriculum specifically states that yoga and online physical education courses are not allowed to serve in the place of a physical education course (NASPE, 2012). Unlike in many states, Alabama officials allow, but do not require, physical education grades into a student's overall grade point average (GPA) (NASPE, 2012). School leaders in Alabama mandate a minimum of 30 minutes of physical education each day in kindergarten through fifth grade (NASPE, 2012). Authorities recommend, but do not require, that students in sixth through eighth grade participate in at least 50 minutes of physical education per day (NASPE, 2012). Alabama high school students are only required to take a one-credit personal wellness course, the Lifelong Individualized Fitness Education (LIFE) class, in place of physical education (NASPE, 2012).

Public School Physical Fitness Assessments

Several state supervisors have implemented health assessments to inform and create awareness to parents and the community on the overall health of students (NASPE, 2012). Out of 50 states and the District of Columbia, authorities in 26 require some type of student assessment and in only 14, including Alabama, is a physical fitness assessment (NASPE, 2012) required. Directors of the American Academy of Pediatrics (2003) and Institute of Medicine (2007) also recommend annual BMI screenings for school-age children and youth. According to writers of the Shape of the Nation Report, only officials in 9 states (out of 51) require schools to measure BMI and executives in only three states, the District of Columbia, Georgia, and Pennsylvania, require the measurement at every grade level (NASPE, 2012). School leaders in Alabama do not require schools to measure BMI, nor do they require school authorities to measure students' height and weight (NASPE, 2012).

Previously, administrators in Alabama implemented the norm-referenced fitness assessment, the President's Challenge, to evaluate and compare student levels of health and fitness; however, the overseers in the Alabama Department of Education saw the need for an improved method for identifying student health and fitness levels as the President's Challenge had not been updated since 1984 (APFA, 2011, p. iii). In 2010, the Alabama State Superintendent appointed educators from all grade levels, including the collegiate level, parents, business and health professionals to develop the Alabama Physical Fitness Assessment (APFA), a criterion-referenced assessment (APFA, 2011, p. vi). The APFA was first implemented in the 2012-2013 school year and students are assessed who are enrolled in physical education beginning in the second grade (NASPE, 2012).

Although not a component of the APFA, body composition is a critical element in identifying an individual's level of health-related physical fitness in that it reveals the proportions of fat and lean mass (bones, tissues, organs, and muscle) in the body (CDC, 2009; Esmat, 2012; Going, Lee, Blew, Laddu, & Hetherington-Rauth, 2014; Wagner & Heyward, 1999). Clinicians employ body composition measurements to predict, diagnose, and treat diseases as well as to monitor the progress of a treatment program (Going et al., 2014). Body composition levels within the normal range indicate that a person has a lower risk of developing obesity-related diseases such as diabetes, high blood pressure, and certain types of cancer (Esmat, 2012). Moreover, there are also negative health effects when a person's body composition is too low, such as vitamin deficiencies to the organs and reproductive system failure (Esmat, 2012). Body composition is estimated using a wide variety of methods, some more advanced and technical than others. The more complex and advanced methods include dual x-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA), and air displacement plethysmography (ADP), and hydrodensitometry (Wagner & Heyward, 1999). More commonly used for large populations and "field research" due to their ease of use and efficiency are body mass index (BMI), waist circumference, and skinfolds (Esmat, 2012; Going et al., 2014, p. 2).

Skinfold exams, DXA, BIA, and ADP are methods that explore body fat directly (CDC, 2009; Esmat, 2012). Although BMI does not differentiate between fat mass and fat-free mass, it is considered a surrogate measure of body fat and it is a common and reasonable measure of body fatness (Barlow, 2007; CDC, 2009; Esmat, 2012; Going et al., 2014; Mei et al., 2002; Nihiser et al., 2007).

To measure BMI, a person's weight, in kilograms, is divided by their height, in meters, squared (kg/m^2) (CDC, 2009). Although BMI is calculated the same for adults and children, the results must be examined otherwise. Unlike adults, BMI for children between two and 20 years depends on their age and gender as their amount of body fat significantly fluctuates due to these variables (CDC, 2009). BMI classifications for children and adolescents are as follows: less than 5th percentile is underweight, percentiles greater than the 5th and less than the 85th are categorized as healthy weight, percentiles greater than the 85th and less than the 95th are categorized as overweight, percentiles equal to or greater than the 95th percentile are considered obese, and percentiles greater than or equal to the 99th percentile are considered severely obese (CDC, 2013). Although simple, inexpensive, and noninvasive, BMI calculations for children and adolescents can have many limitations such as height and level of sexual maturation (CDC, 2009, p. 2). Despite this fact, BMI has been shown to correlate with direct measures of body fat and is recommended by the CDC, the Academy of Pediatrics, and the Institute of Medicine as an indicator of health-related fitness and obesity screening tool (CDC, 2009).

Physical Fitness and Academic Achievement

Physical fitness indicators may pose as valuable instructional tools for educators seeking to better understand student behavior and improve classroom management. When children engage in physical activities that promote cooperation, sharing, and learning to follow rules, they are able to transfer these skills into the classroom (Taras, 2005). Researchers Oketayo et al. (2010) stated that high levels of physical fitness were significantly associated with better school attendance, fewer disciplinary incidents and better academic performance. Researchers investigating physical fitness have further indicated improved cognitive performance among children and adolescents with higher levels of physical fitness (Blom et al., 2011; Castelli et al., 2007; Chomitz et al., 2009; Santiago et al., 2013). Consequently, an analyzers of the CDC's 2012 Behavioral Risk Factor Surveillance System (BRFSS) found that over 35% of adults who did not graduate high school were obese, significantly higher than the 22% of adults who graduated from college (Trust for America's Health and Robert Wood Johnson Foundation, 2012).

In order to explore the relationship between physical fitness and standardized test performance, Van Dusen et al. (2011) investigated 254,743 Texas schoolchildren in elementary, middle, and high school. Due to the large sample size, the researchers were able to analyze the independent effects of each fitness component from the FitnessGram on academic performance as measured by the Texas Assessment of Knowledge and Skills (TAKS). The six components of the FitnessGram included aerobic capacity (measured by the PACER test or mile run), body composition (measured by BMI), abdominal strength and endurance (measured by curl-ups), trunk extensor strength and flexibility (measured by trunk-lift), upper body strength and endurance (measured by push-ups), and flexibility (measured by shoulder stretch or the sit-and-reach test) (Welk & Meredith, 2008).

The researchers compared TAKS scores from students performing highest in each fitness component to TAKS scores from students performing lowest in each physical fitness component.

Van Dusen et al. (2011) found significant positive associations between each of the fitness components (excluding BMI) and TAKS scores and were further able to identify a dose-response relationship between cardiovascular fitness and academic performance, meaning, as cardiovascular fitness scores increased, academic performance increased accordingly. All relationship measures among physical fitness and academic performance were significant (Van Dusen et al., 2011). Math TAKS scores had stronger associations with the FitnessGram fitness components than reading overall, although predominantly among the cardiovascular and strength components (Van Dusen et al., 2011). The researchers also found stronger associations among cardiovascular and strength fitness and reading for girls than boys; however, the results were reversed among tests of flexibility. The strongest associations across grade levels were found between cardiovascular fitness and academic performance among students in grades seven through ten.

Results of this study significantly added to the research investigating the critical role physical fitness plays on academic achievement among schoolchildren. Most importantly, the researcher provided evidence that students who were more fit performed significantly higher academically than lower fit students, physical fitness had a greater effect on academic performance among middle and high school students, specifically in eighth and tenth grade, than elementary, and cardiovascular fitness proved to be a more reliable indicator of academic performance than tests of strength or flexibility.

In addition, Chomitz et al. (2009) employed multivariate logistic regression analyses to evaluate the relationship between physical fitness and academic achievement among a racially diverse and urban student population from Massachusetts. The students ranged in grade level from fourth to eighth. The examiners used data from the Massachusetts Comprehensive

Assessment System achievement tests in both mathematics and English to evaluate academic achievement. To objectively determine if a specific level of physical fitness could be used to predict academic achievement, the researchers used the number of fitness components passed on the FitnessGram by each student. The researchers indicated a significant positive relationship between students' academic achievement and the number of physical fitness tests passed (Chomitz et al., 2009). Significance was present between both math and English achievement; however, results from the math assessment revealed a stronger association than the English (Chomitz et al., 2009). In addition, the researchers discovered the odds of passing the math assessment increased by 38% with each increase in the number of fitness tests passed and the odds of passing the English assessment increased by 24% with each increase in the number of fitness tests passed (Chomitz et al., 2009).

Similarly, Martin and Chalmers (2007) investigated the relationship between academic achievement and physical fitness; however, the researchers sought to uncover the "practical significance" of the results instead of the statistical significance (p. 214). Martin and Chalmers (2007) evaluated physical fitness through scores on the norm-referenced President's Challenge Youth Fitness Test and academic achievement through scores on the Iowa Tests of Basic Skills (ITBS). The 5,847 students in the Seattle, Washington public school systems ranged from third grade to eighth grade (Martin & Chalmers, 2007). Similar to the FitnessGram, the President's Challenge evaluates physical fitness through aerobic capacity, muscle strength and endurance, and flexibility. In this study, the students participated in the one-mile run/walk, the shuttle run, curl-ups, either the pull-up or flexed arm hang, and the V sit-and-reach flexibility test (Martin & Chalmers, 2007, p. 216). The scores from all five of the fitness tests were averaged together to give the student an overall fitness score for the statistical analysis (Martin & Chalmers, 2007).

The ITBS included reading, language arts, and mathematics tests; the three test scores were averaged together for the student's overall academic score (Martin & Chalmers, 2007). Researchers Martin and Chalmers (2007) plotted the relationship between fitness and academic achievement and further employed Pearson coefficient correlation to determine the strength of the relationship. With a correlation of 0.19, Martin and Chalmers (2007) stated the relationship had little practical significance and could only account for 3.6% of the variance in academic achievement as a result of physical fitness (p. 219). The researchers concluded, "rationalizing school physical education as a means to improve academic achievement of students…does not appear justified" (p. 219).

In contrast, Castelli et al. (2007) were able to demonstrate that children with higher physical fitness levels were more likely to have increased academic achievement than those with lower fitness levels. Castelli et al. (2007) revealed significant associations between physical fitness and academic achievement among 259 third and fifth grade students in Illinois. The researchers implemented objectively-measured fitness data from the FitnessGram and academic achievement data from the Illinois Standards Achievement Test (Castelli et al., 2007). To compare group mean differences and to investigate associations, Castelli et al. (2007) implemented dependent *t* tests, Pearson product-moment correlation, and regression analyses. Castelli et al. (2007) discovered a significant, positive relationship between three fitness components (aerobic capacity, abdominal strength and endurance, and upper body strength and endurance) and math, reading, and total academic achievement on the ISAT ($p < .01$). Average scores for the sit-and-reach flexibility component were positively associated with total academic achievement and math academic achievement ($p < .05$); however, the flexibility component had no effect on reading achievement ($p = .09$) (Castelli et al., 2007). Through two-step hierarchical regression analyses, Castelli et al. (2007) discovered significant effects that indicated higher academic achievement scores in reading and math were associated with increased total fitness. Additional two-step hierarchical regression analyses were conducted to determine which FitnessGram fitness components were related to total academic achievement, reading achievement, and math achievement. Castelli et al. (2007) discovered significant effects for BMI and aerobic capacity on total all three achievement categories, which indicated that lower BMI scores and higher aerobic capacity levels were related to higher total, reading, and math academic achievement on the ISAT.

Understanding that additional variables play a role in determining a student's academic success, Blom et al. (2011) explored the relationships between the fitness and academic achievement by investigating academic behavior variables. The researchers employed measures of physical fitness through the FitnessGram, standardized math and English test scores through the Mississippi Curriculum Test, school attendance records, school discipline reports, and school socio-demographic information to formulate the study. Results included chi-square to evaluate the level of significance of observed differences between academic achievement and academic behaviors concurring with gender, race, grade level, lunch status, or number of fitness zones achieved on the FitnessGram. The researchers further employed multiple logistic regression analyses to identify the factors leading to varying academic achievement levels and specific academic behaviors (Blom et al., 2011). Blom et al. (2011) discovered that gender, race, socioeconomic status, and physical fitness were all significantly related to academic achievement; specifically, females, White students, high socioeconomic status, and increased number of healthy fitness zones achieved were all predictors of increased academic achievement. Similar to Chomitz et al. (2009) and due to a significant positive relationship among physical fitness and academic achievement ($p < .0001$), the researchers specified that the odds of obtaining high academic achievement increased as the number of physical fitness zones achieved on the FitnessGram increased (Blom et al., 2011). In addition, Blom et al. (2011) found that White students, students with low socioeconomic status, and students with few healthy fitness zones achieved were more likely to be absent eight or more times than their peers while Black students, boys, and students with low socioeconomic status were twice as likely to receive disciplinary action than their peers. Moreover, physical fitness was not associated with disciplinary actions (Blom et al., 2011). Corroborating with Van Dusen et al. (2011) and Chomitz et al. (2009), this investigator found significant relationships between academic achievement and physical fitness. Beneficial for school leaders and policymakers, this researcher identified cooperating factors that have the ability to veer a student toward academic success or failure, absenteeism and discipline, and the affect physical fitness has on both.

To extend physical fitness and academic achievement research, Santiago et al. (2013) sought to investigate the relationship between physical fitness and academic achievement of Hispanic elementary school students. The fourth and fifth grade Texas public school students attended school where 99 percent of the students qualified for free/reduced lunch, 83 percent were considered Limited-English Proficient, and 92 percent were considered academically at risk. To quantify physical fitness, the researchers used the aerobic capacity fitness component of the FitnessGram to determine aerobic capacity levels and BMI to measure body composition of the 155 students in the study (Santiago et al., 2013). To measure academic achievement, Santiago et al. (2013) used calculated grade point averages The researcher did not find significant associations between aerobic capacity and academic achievement on the combined group of boys and girls; however, when controlling for gender, results from the stepwise regression analyses revealed a significant positive relationship between aerobic capacity and math achievement among girls. Aerobic capacity was found to be a predictor of math achievement for Hispanic girls in the study. The results of this study were consistent with Wittberg et al. (2010) who also found a significant positive relationship between physical fitness and math academic achievement among primarily Caucasian girls in the fifth grade.

Physical Fitness and Cognition

As the previous research studies evidenced associations among fitness levels and academic achievement, the following research studies add to the literature suggesting a possible association between physical fitness and cognition. According to Tomporowski et al. (2008), "cognition is a general term that reflects a number of underlying mental processes" (p. 112). In the past, researchers centered their attention on utilizing physical fitness as a way to decrease cognitive decline during aging; however, during childhood and adolescence, a time when the central nervous system displays substantial plasticity, researchers have demonstrated that physical fitness may also improve an individual's cognitive function (Aberg et al., 2009; Kramer & Hillman, 2006). Moreover, researchers have evidenced that more fit children are able to cognitively outperform their less fit peers, as demonstrated by cognitive control tests essential for academic achievement (Chaddock et al., 2010; Diamond, 2006; Hillman, Erickson, & Kramer, 2008; Pontifex et al., 2011).

Hillman, Buck, Themanson, Pontifex, and Castelli (2009a) examined the relationship between aerobic fitness and executive control among nine-year-old children attending a summer camp at the University of Illinois. According to the researchers, executive control describes the "subset of goal-directed processes that encompass the selection, scheduling, and coordination of computational processes that are involved in perception, memory, and action" (p. 114). The executive control function is constantly improving throughout childhood, along with the development of the frontal lobes, and increases the child's ability to disregard irrelevant stimuli and focus on what is pertinent at the time (Hillman et al., 2009a). Hence, managing interferences through executive control is essential to academic achievement as students typically learn new information in an environment full of external stimuli.

For the study, Hillman et al. (2009a) employed the Eriksen flanker task to evaluate the student's interference ability. The Eriksen flanker task required the student to distinguish between central and peripheral letters shown in a collection (Hillman et al., 2009a). If the collection is composed of a series where the central and peripheral letters are the same, it is indicated as a congruent task; if the collection involves a different center letter than the peripheral letters, it is indicated as an incongruent task (Hillman et al., 2009a). For example, HHHHH or SSSSS would denote a congruent task, while HHSHH or SSHSS would denote an incongruent task (Hillman et al., 2009a, p. 117). According to Hillman et al. (2009a), congruent tasks require less executive control; therefore, they prompt a shorter response time (RT) and greater response accuracy (RA) than the incongruent tasks, which require larger amounts of executive control. Hillman et al. (2009a) hypothesized the higher-fit students would demonstrate greater task performance through shorter RT and increased RA on the Erikson flanker task when compared to the lower-fit students in the study.

The 38 students in the study were given the FitnessGram test of aerobic fitness, the PACER (Hillman et al., 2009a). Students with aerobic fitness scores in the top 10% were selected and placed in the higher-fit category and the students with aerobic fitness scores in the lowest 10% were selected and placed in the lower-fit category for the study (Hillman et al., 2009a). Hillman et al. (2009a) utilized mixed-model MANOVAs with repeated measures to statistically analyze group differences in performance and Pearson product-moment correlations to evaluate the strength of the relationship between variable measures. Although flanker task results did not reveal a fitness effect for response time, Hillman et al. (2009a) discovered a fitness effect for response accuracy, evidencing the higher-fit students (M= 82.1 ± 10.2%) responded more accurately than the lower-fit students (M= 75.2 ± 9.9%) on the congruent and incongruent tasks (p. 119). Hillman et al. (2009a) evidenced that physical fitness benefits cognitive development and functioning in preadolescent children. Moreover, the data stemming from this research may provide the causality lacking in studies similar to Castelli et al. (2007), Chomitz et al. (2009), and Van Dusen et al. (2011) where physical fitness was positively associated with academic achievement.

Similarly, Pontifex et al. (2011) explored the effects of aerobic fitness on cognitive, or executive control, among 48 preadolescent children with an average age of 10-years (p. 1334). Particularly, the researchers worked to uncover the relationship between aerobic fitness and the flexible modulation of cognitive control, or rather, if the fitness effects were general or selective in regards to the allocation of cognitive control (Pontifex et al., 2011). Pontifex et al. (2011) elicited aerobic fitness, task performance, and neuroelectric measures to elucidate possible associations among distinct cognitive operations and aerobic fitness. Participants completed the Edinburgh Handedness Inventory to determine handedness and the Kaufman Brief Intelligence Test (K-BIT) to evaluate intelligence while their guardian completed a health history, demographic questionnaire, and the Tanner Staging System to ensure the participant was included in the prepubescent status (Pontifex et al., 2011, p. 1334). Aerobic fitness was determined through maximal oxygen consumption (VO_{2max}) through a computerized indirect calorimetry system; which employed a modified Balke protocol (Pontifex, et al., 2011). If a participant's VO_{2max} results fell above the 70th percentile or below the 30th, they were asked to return the next day for experimental testing (Pontifex et al., 2011). Once the higher-fit and lower-fit participant groups were determined, the researchers employed a modified Eriksen flanker task to determine task performance while EEG activity was simultaneously recorded to determine the patterns of neuroelectric activation due to an event, or ERPs (Pontifex, et al., 2011). The modified flanker task employed arrows (>) and a stimulus-response compatibility component where the participant is asked to give either the direction of the centrally located arrow or, during an incompatible task, the direction opposite of the centrally located arrow. According to Pontifex et al. (2011), "the incongruent incompatible condition should necessitate the greatest amount of inhibitory control" (p. 1335). Utilizing repeated measures ANOVA analyses, the researchers evaluated flanker task and ERP performance among higher-fit and lower-fit adolescents.

The researchers revealed significant effects of fitness on response accuracy, with the lower-fit participants (mean= 75.9 ± 1.8%) responding less accurately than the higher-fit participants (mean= 84.8 ± 1.8%) (Pontifex et al., 2011, p. 1338). The researchers further investigated this interaction and discovered the lower-fit participants performed significantly worse on the incompatible tasks as compared to the compatible tasks, while the higher-fit participants maintained their accuracy performance scores regardless of task condition (Pontifex et al., 2011). In addition, Pontifex et al. (2011) identified significant associations between fitness and neuroelectric measures among lower-fit participants compared to higher-fit participants. Lower-fit participants exhibited similar neuroelectric performances across both compatible and incompatible conditions, while higher-fit participants exhibited significantly different among task conditions requiring increased levels of cognitive control and performed more accurately (Pontifex et al., 2011). The investigators indicated, "lower-fit participants exhibit greater activation of action-monitoring processes in response to erroneous behaviors" (p. 1342). Due to these findings, the researchers suggested that higher-fit adolescents possessed a “greater capability to flexibly modulate cognitive control processes” than lower-fit adolescents (Pontifex et al., 2011, p. 1340). This study corroborated and extended research by Hillman et al. (2009) by examining cognitive control processes across multiple levels of conflict through the additional compatibility component.

Aberg et al. (2009) extended the literature by investigating the longitudinal relationship between physical fitness and cognition of young adults. The researchers examined 1, 221, 727 Swedish males that enlisted in the military at age 18 (Aberg et al., 2009). Data were collected through databases that included the participant’s physical fitness and intelligence enlistment examination results, school achievement, socioeconomic status, and family history (Aberg et al., 2009). The physical assessments used on the enlistment examination included a cardiovascular fitness component, resulting from an ergometer cycling assessment, and an isometric muscle strength component, resulting from knee extension, elbow flexion, and hand-grip measures (Aberg et al., 2009, p. 20910). The cognitive assessment portion of the enlistment examination included four areas (logical, verbal, visuospatial/geometric perception, technical/mechanical skills with mathematical and physics problems) and averaged all four scores to produce an overall cognitive ability score (Aberg et al., 2009, p. 20910).

Linear multiple regression analyses revealed cardiovascular fitness scores were significantly associated with all cognitive assessment components ($b = 0.168$, 95% CI 0.166-0.171, $r^2 = 0.163$); however, stronger associations were exhibited with logic and verbal intelligence (p. 20907). Corroborating similar results from Castelli et al. (2007), significant associations were not found for muscle strength and cognition (Aberg et al., 2009). To ensure the significant relationship between fitness and cognition was not due to family or genetic factors, the researchers implemented multiple regression analyses once again, but further added intelligence scores of brother pairs as covariates (Aberg et al., 2009, p. 20907). Significant associations remained evident after adjusting for genetic factors, leading the researchers to suggest the "association was predominantly caused by environmental factors" (Aberg et al., 2009). The researchers subsequently employed National Swedish Board of Education school records to obtain participant academic and physical education grades from their last year in school to determine whether cardiovascular changes during adolescence impacted cognitive performance (Aberg et al., 2009). The researchers determined those participants with increased fitness levels between age 15 and 18 subsequently had higher cognitive performance measures than those participants with decreased fitness levels (Aberg et al., 2009). The researchers concluded their study by exploring the probability that physical fitness determined later education attainment (college degree versus high school diploma or less) as well as the probability that physical fitness determined occupational attainment (occupation with a greater socioeconomic index versus low socioeconomic index) (Aberg et al., 2009, p. 20910). Through use of the Cox proportional-hazardous regression model and by utilizing educational and occupational data from the Statistics Sweden National Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA), Aberg et al. (2009) revealed that higher-fit participants were more likely to attain a college degree and procure an occupation with a superior socioeconomic index (HR = 1.51, CI: 1.47-1.55) than lower-fit participants (p. 20910).

Corresponding to Aberg et al. (2009), Chaddock et al. (2012) aimed to determine the duration of the positive effects physical fitness has on cognition; however, the researchers focused their investigation on pre-adolescent youth. Specifically, the researchers investigated whether adolescent aerobic fitness and brain volume measurements focused on the dorsal striatum of the basal ganglia could predict cognitive performance after one year (Chaddock et al., 2012). Participants in the study were from Illinois, between nine and ten years old, and met the following inclusion criteria: qualified as either higher-fit or lower-fit, displayed right-handedness, reported no adverse health or neurological disorders, reported no use of central nervous system medications, and completed a mock magnetic resonance imaging (MRI) protocol (Chaddock et al., 2012, p. 423). Having met all inclusion requirements, the 32 participants, 14 higher-fit and 18 lower-fit, were given an aerobic fitness evaluation to determine their maximal oxygen uptake (VO_{2max}), a cognitive evaluation through a modified version of the Eriksen flanker task, and an MRI to determine basal ganglia and overall brain volume at the initial test visit (Chaddock et al., 2012). At the follow-up visit one year later, the researchers administered a follow-up flanker task to participants; Chaddock et al. (2012) did not administer the aerobic fitness evaluation or the MRI at the follow-up visit.

Chaddock et al. (2012) statistically analyzed flanker task performance through a 2 x 2 x 2 x 2 repeated measure ANOVA for the following: fitness group (higher-fit, lower-fit), flanker task compatibility (compatible, incompatible), flanker task congruency (congruent, incongruent), and test session (initial test, follow-up test) (Chaddock et al., 2012, p. 425). Controlling for participant head size, the researchers employed analyses of covariance (ANCOVAs) to compare the volumes of four sections of each participant's basal ganglia, including the caudate nucleus, putamen, nucleus accumbens, and globus pallidus, to their overall brain volume (Chaddock et al., p. 425). Lastly, Chaddock et al. (2012) elicited Spearman correlations to evaluate the association between basal ganglia volumes and flanker task performance.

Substantiating results from Hillman et al. (2009), Chaddock et al. (2012) revealed that higher-fit participants demonstrated significantly greater response accuracy than the lower-fit participants across all task conditions, initial tests, and follow-up tests. Moreover, higher-fit participants were able to maintain their accuracy levels through the compatible (mean = 85.8%, s_x = 2.4%) and incompatible (mean = 84.2%, s_x = 3.0%) tasks while the lower-fit participants demonstrated significantly different accuracy levels during compatible (mean = 79.8%, s_x = 2.1%) and incompatible (mean = 74.0%, s_x = 2.7 ms) tasks, suggesting higher-fit individuals are better able to inhibit irrelevant stimuli during a cognitive task than lower-fit individuals (Chaddock et al., 2012, p. 426).

Although Chaddock et al. (2012) could not reveal response time significance, consistent with similar observations from Hillman et al. (2009a), during the initial flanker task assessment; the researchers were able to uncover response time significance resulting from the follow-up assessment with higher-fit participants exhibiting shorter response times (mean = 494.3 ms, s_x = 28.3 ms) than the lower-fit participants (mean = 617.0 ms, s_x = 24.9 ms). Therefore, researchers Chaddock et al. (2012) stated “the lower-fit children became slower and the higher-fit children faster over the course of the year” (p. 426). Results from the ANCOVA analyses allowed Chaddock et al. (2012) to determine that higher-fit participants had larger putamen volumes of the dorsal striatum as well as larger globus pallidus volumes than lower-fit participants (p. 426). Furthermore, Spearman correlation data between basal ganglia volumes and flanker task results allowed the researchers to discover positive correlations between participant putamen and globus pallidus volumes with regards to incompatible accuracy from the initial test (Chaddock, et al., 2012). Subsequently, positive correlations were identified during the follow-up assessment between both putamen and globus pallidus volumes and shortened compatible and incompatible reaction time (Chaddock et al., 2012).

The researchers concluded that basal ganglia volume and aerobic fitness were able to predict enhanced cognitive performance as higher-fit participants had larger putamen and globus pallidus volumes at the initial assessment as well as superior accuracy and reaction time performance at the follow-up flanker assessment (Chaddock, et al., 2012).

Body Composition and Academic Achievement

The effect of body composition on academic achievement has shown mixed results in the literature (London & Castrechini, 2011; Ogunsile, 2012; Sabia, 2007; Van Dusen et al., 2011). Many researchers have found significant negative relationships between BMI (Castelli et al., 2007; Gurley-Calvez & Higginbotham, 2010; Hoffman, Policastro, Quick, & Lee, 2006; Ogunsile, 2012; Oketayo et al., 2010; Van Dusen et al., 2011; Yusuf & Adigun, 2010) while others have found no relationship between BMI and academic performance (Santiago et al., 2013; Wang & Veugelers, 2008). Moreover, Alatupa et al., (2010) found that poor school performance was a predictor of adult obesity and overweight while London and Castrechini (2011) found physical fitness was a better predictor of academic achievement than body mass index. The following studies have examined the inconclusive relationship between body composition and academic achievement through national and international lenses.

In order to investigate the link between childhood overweight and school outcomes, Datar and Sturm (2006) examined data from the Early Childhood Longitudinal Study-Kindergarten Class (ECLS-K), a study sponsored by the NCES. The researchers identified elementary school outcome variables as academic achievement, behavior problems, social skills, learning style, attendance, and grade repetition (Datar & Sturm, 2006). For the overweight status variable, BMI was calculated using objectively-measurements of height and weight; students were classified as overweight if their BMI was greater than or equal to the 95th percentile, according to CDC growth charts (Datar & Sturm, 2006). To evaluate the academic achievement variable, students in the ECLS-K were given two-stage assessments in reading and mathematics in which the student's academic performance on the first assessment, or routing assessment, determined their second assessment to ensure the student was given test items that matched his or her ability level (Datar & Sturm, 2006). As the students did not take the exact test, scale scores were calculated for comparable score reporting. The ECLS-K employed the teacher-reported social rating scale (SRS) to evaluate student negative behaviors, such as social skill deficits and problem behaviors; higher scores on this rating system indicate increased negative behaviors and skill deficits (Datar & Sturm, 2006). Similarly, the SRS also measures positive student behaviors that include learning styles, attentiveness, interpersonal skills, and self-control; higher scores on this rating system indicate more positive conclusions (Datar & Sturm, 2006). Control variables, such as school attendance, grade retention data, family structure, and demographics, were received from the student's teachers (Datar & Sturm, 2006). The dependent variables for this study included the student's school outcome (the results from their assessments and evaluations) in the spring of their third grade year and the change in their overweight status between kindergarten and third grade as either "never overweight," "became overweight," or "always overweight" (Datar & Sturm, 2006, p. 1452). Due to insufficient statistical power, the researchers did not categorize the limited students who went from overweight in kindergarten to not-overweight in third grade.

Following data collection methods, researchers Datar and Sturm (2006) utilized multivariate linear and logistic regression models to search for associations. Researchers Datar and Sturm (2006) determined from BMI results that approximately 83% of the children were never overweight, 8% became overweight, and 9% were always overweight, thus increasing the prevalence rate of overweight from 9% in kindergarten to 17% in third grade (Datar & Sturm, 2006, p. 1452). The researchers also found that reading and math test scores were significantly higher in both kindergarten and third grade for students that were never overweight as compared to students that became overweight and were always overweight (Datar & Sturm, 2006). In addition, students that became overweight over the course of the four-year study and the students that were always overweight exhibited analogous reading and math test results in both kindergarten (although weight classifications were different) and in the third grade (Datar & Sturm, 2006). Significant associations were found among teacher ratings of externalizing behavior problems, such as fighting, acting impulsively, disturbing others, and arguing, among always-overweight students in kindergarten; however, this association was not evident in third grade (Datar & Sturm, 2006). Similarly, the researchers uncovered significant associations at the baseline (in kindergarten) among teacher ratings of internalizing behavior problems, such as low self-esteem, sadness, loneliness, and anxiety, and students that became overweight, even though these students were not overweight at the time (Datar & Sturm, 2006). Although this association was significant at the baseline, the significance was not evident four years later. In contrast, researchers discovered significant associations among students that were always overweight and internalizing behaviors at the end of their third grade year, although the association was not present in kindergarten for these students (Datar & Sturm, 2006). Teacher ratings of self-control abilities, interpersonal skills, and approaches to learning were significantly less among students that became overweight and students that were always overweight when compared to never-overweight students (Datar & Sturm, 2006). Moreover, students that were always overweight had significantly more absences in kindergarten (9.52%) and third grade (6.82%) than students that became overweight (8.97% and 6.51, respectively) and students that were never overweight (7.96 and 6.17, respectively) (Datar & Sturm, 2006, p. 1753). Additional significant associations were evident among students that became overweight and grade retention, although the association was not evident among the never-overweight and always-overweight groups (Datar & Sturm, 2006). Datar and Sturm (2006) further analyzed change in overweight status among girls and boys and school outcomes in search of possible relationships. The researchers found significant positive relationships among girls that became overweight and externalizing behavior problems and significant negative relationships among academic achievement, self-control, interpersonal skills, and approaches to learning (Datar & Sturm, 2006). Girls that were always overweight exhibited significantly greater amounts of internalizing behavior problems and were more likely to repeat a grade than girls that became overweight (Datar & Sturm, 2006). Fewer significant relationships were evident among boys that became overweight compared to boys that were always overweight and school outcomes. In contrast to girls, significant negative associations were found among weight changes and externalizing behavior problems; thus, as boys that became overweight or remained overweight were less likely to exhibit externalizing behavior problems compared to boys that were never overweight (Datar & Sturm, 2006). In addition, a final significant association was found among boys that became overweight and school absences.

In summary, Datar and Sturm (2006) found that girls with a shift in overweight status were more at risk of negative school outcomes than any other group. Researchers also evidenced that girls between kindergarten and third grade that remained overweight, demonstrated academic achievement deficits and increased internalizing behavior problems, important information for educators and parents to recognize (Datar & Sturm, 2006). Moreover, students that remained in the normal weight category demonstrated superior school outcomes than students that became or remained overweight. The researchers emphasized the importance of examining data longitudinally as students that were never overweight and those students that became overweight would be categorized in the same group because they were both not overweight at the baseline, although they exhibited drastic changes in overweight status and school outcomes over the course of four years. This distinctive study not only demonstrated the link between overweight status and school outcomes, but also the shift in overweight status and school outcomes through direct assessments, teacher reporting, and school records (Datar & Sturm, 2006). Researchers Datar and Sturm (2006) suggest that “to the extent that learning in school is cumulative, lower achievement in early grades may translate into bigger achievement gaps between overweight and not-overweight children in the later years” (p. 1455).

Extending the literature on associations between BMI and academic achievement, researchers Kristjánsson, Sigfúsdóttir, Allegrante, and Helgason (2009) commissioned 2000 Youth in Iceland survey data from 5,810 adolescents. Gender, parents’ education (a substitute for economic status) and family structure (a psychological well-being measure), were identified as control variables for the study (Kristjánsson et al., 2009). Students in the study estimated their academic achievement by self-reporting their academic grades in core subject areas. Icelandic student grades ranged from zero to 10 and any grade below a five indicated a fail (Kristjánsson et al., 2009). Each student’s BMI was calculated from his or her self-reported height and weight measures. Kristjánsson et al. (2009) additionally examined school contentment responses to determine the possibility of a mediating variable among BMI and academic achievement. Students reported school contentment by evaluating their responses on a likert scale of 1-“applies almost always to me” to 5-“applies almost never to me” for the following statements: “I want to quit school,” “I want to switch schools,” and “I feel bad at school” (Kristjánsson et al., 2009, p. 72). The researchers employed structural equation modeling to clearly identify effects resulting directly or indirectly from both measured and latent variables, followed by goodness-of-fit measures to ensure the model fits the data (Kristjánsson et al., 2009, p. 74). After statistically analyzing the data, the researchers were able to identify associations between BMI, school contentment, and academic achievement. Kristjánsson et al. (2009) revealed a small, yet significant, negative association between BMI and school contentment (β= -0.03, $t > 1.96$) (p. 76). In addition, a stronger negative association was exhibited between BMI and academic achievement (β= -0.05, $t > 1.96$), with little due in part to school contentment (Kristjánsson et al., 2009, p. 76). Consistent with Van Dusen et al. (2011) and Datar and Sturm (2006),the relationship between BMI and increased academic achievement were further examined by the reaserchers.

In a later study, researchers Kim and So (2013) examined the relationship between academic achievement and body composition among South Korean adolescents in 7th through 12th grade. Using data from the Korea Youth Risk Behaviour Web-based Survey conducted by the Korea Centers for Disease Control and Prevention, the researchers analyzed health risk data from 72,399 students with an average age of 15 years (Kim & So, 2013, p. 180). The researchers calculated student body composition through BMI and implemented the World Health Organization's Asia Pacific standard of obesity for normal, overweight, and obesity rankings (Kim & So, 2013). Students with BMI levels less than 23 kg/m^2 were considered normal weight, levels between 23 and 25 kg/m^2 were considered overweight, and levels above 25 kg/m^2 were considered obese (Kim & So, 2013, p. 180). Academic achievement was determined by the student's self-reported likert-scale responses with one being "very good" and five indicating "very poor" academic achievement over the past year (Kim & So, 2013, p. 181). The researchers adjusted for the following covariate variables: student age, parents' education level, economic status, mental stress level, sleep duration, and the frequency of muscle strengthening exercises, moderate and vigorous physical activities, smoking and drinking behaviors (Kim & So, 2013, p. 181). For data analysis, Kim and So (2013) employed multiple regression analyses to search for associations between body composition and academic achievement. When compared to students with a normal weight, Kim and So (2013) found significant associations in that overweight boys had 1.182 (1.052-1.329, $p = 0.005$) increased odds of poor academic achievement. Significant associations among boys were also discovered with obese boys having 1.461 (1.294 -1.648, $p < 0.001$) increased odds of poor academic achievement, and 1.443 (1.256 -1.657, $p < 0.001$) increased odds of obtaining very poor academic achievement as compared to boys with normal weight (Kim & So, 2013, p. 182). Similar significant associations were found as overweight girls had 1.314 (1.124-1.536, $p < 0.001$) increased odds of poor academic achievement and 1.296 (1.084-1.548, $p = 0.004$) increased odds of very poor academic achievement when compared to normal weight girls in the study (Kim & So, 2013, p. 181). Significant associations among girls were further discovered as obese girls had 1.672 (1.339-2.089, $p < 0.001$) increased odds of poor academic achievement, and 1.887 (1.478-2.409, $p < 0.001$) increased odds of obtaining very poor academic achievement as compared to girls with normal weight (Kim & So, 2013, p. 182).

By incorporating such a large sample size, the researchers were able to generalize their results to all South Korean adolescents. Therefore, Kim and So (2013) ultimately found that BMI levels within the overweight and obese classifications increased the odds of decreased academic achievement in South Korean boys and girls. However, this study faced several limitations due to the researchers' reliance on self-reported measures as their main data source. The students in this study self-reported all data, including economic status, parents' education level, academic achievement, and their own height and weight measures. According to Kim and So (2013), “adolescents tend to overestimate their height and underestimate their weight”; therefore, the actual number of students in the overweight and obese categories may be higher than what the data reveal, thus increasing academic achievement deficits (p. 182).

Due to the increased prevalence of obesity, many studies have focused on the monitoring of obese and overweight adolescents, while less focus is given to those students who are underweight (Bhattacharya & Currie, 2000; Taras, 2005). Although extreme nutritional deprivation is rare in the United States, many adolescents suffer from nutrient deficiencies and excessive leanness, which both can be detrimental to one’s health (Taras, 2005; Welk & Meredith, 2008). According to Taras (2005), malnutrition is a serious problem with long-term effects on the performance of school children. To elucidate this association, Van Dusen et al. (2011) compared the highest and lowest BMI categories to the middle, or more moderate, BMI categories to standardized test scores. In doing so, the researchers found that boys with the lowest BMI had significantly lower TAKS scores than the moderate BMI group; no associations were found between the highest BMI group and the moderate BMI group, indicating that boys with a low body weight are at-risk for low academic achievement (Van Dusen et al., 2011). Further, no associations were found among the three BMI categories and TAKS scores for girls. Consistent with previous research linking academic achievement deficits to underweight boys, this study revealed low BMI boys were more at risk of academically underperforming than high BMI boys (Cawley, 2004; Sabia, 2007; Van Dusen et al., 2011).

Building on the works of Van Dusen et al. (2011) and Datar and Sturm (2006), Bisset, Fournier, Pagani, and Janosz (2013) found similar results among boys and girls four to seven years old. The researchers employed developmental BMI trajectory identification to determine if BMI could predict educational outcomes on 2,120 participants from the Quebec Longitudinal

Study of Child Development. The researchers found that children at-risk of being underweight were more likely to suffer cognitive and academic deficits than children at-risk of being overweight and healthy-weight children (Bisset et al., 2013). Moreover, the researchers revealed that children with stable overweight or obese BMI levels are less susceptible to negative cognitive and academic effects than those children that transition into elevated BMI classifications from healthy-weight BMI classifications.

Body Composition and Cognition

It is widely known that obesity is linked with countless negative health effects, such as heart disease, cardiovascular disease, sleep apnea, depression and an increased cancer risk; however, researchers have further evidenced that obesity is related to decreased cognitive functioning (Reinert, Poe, & Barkin, 2013; Sabia, Kivimaki, Shipley, Marmot, & Singh-Manoux, 2009; Stanek et al., 2013). Moreover, researchers have emphasized the importance of elucidating the negative effects obesity may have on cognition during a vulnerable period of brain development: childhood and adolescence (Reinert et al., 2013). The following have examined the relationship between executive function and obesity in children and adolescents. According to Reinert et al. (2013), executive functions are "self-regulatory processes that are associated with monitoring and controlling both thought and goal-directed behaviors" and are critical to academic success (p. 1).

Drid et al. (2013) aimed to discover whether obesity or excess amounts of adipose tissue had a negative impact on cognitive ability. The researchers examined cognitive abilities of 910 children, 11 to 14 years old, in relation to their BMI and subcutaneous fatty tissue levels, as measured by skinfold tests of the abdomen, triceps, and subscapula (172). Overweight and obese indicators were determined using criteria stemming from the International Obesity Task Force (IOTF) weight classifications (Drid et al., 2013). The Raven's Standard Progressive Matrices

(RSPM) was utilized to measure the cognitive abilities of the 910 participants (Drid et al., 2013). A multiple-choice assessment, the RSPM required participants to encode and analyze matrix blocks, each getting increasingly more difficult, in order to solve and complete the puzzle (Drid et al., 2013).

The researchers divided the 413 boys and 497 girls into three groups (A, B, C) based on anthropometric measures with group A indicating the leanest, group B indicating average or normal classifications for weight, and group C indicating the high end of the weight spectrum (Drid et al., 2013). Statistical analyses included multi-variant analysis of variance (MANOVA) and ANOVA calculations to determine the differences among the groups and outcome variables, followed by Sheff's post-hoc procedures to determine differences between pairs of groups and outcome measures (Drid et al., 2013). Drid et al. (2013) discovered significant cognitive ability differences among boys, with group B (43.93, SD = 9.64, $p < 0.01$) exhibiting highest cognitive abilities, compared to those in group A (41.49, SD = 8.75, $p \leq 0.01$) and group C (41.27, SD = 10.26) (p. 174). Significant differences were not evident among boys in group A and group C, indicating that boys with the lowest BMI and subcutaneous adipose tissue measures had parallel cognitive deficits as boys with the highest BMI and subcutaneous adipose tissue measures, when compared to healthy-weight boys. These results confirm similar findings from Bisset et al. (2013), Sabia (2007), Taras (2005), and Van Dusen et al. (2013), who found that boys with low BMI levels exhibited equal, if not greater, deficits than boys with high BMI levels in regards to academic achievement. In contrast to boys, Drid et al. (2013) did not reveal significant differences among cognitive assessment outcomes for girls. These findings were comparable to Van Dusen et al. (2013) as the researchers were unable to significantly link BMI and academic achievement among female participants in their study; however, the conclusions of Drid et al. (2013) contrasted significant results from Datar and Sturm (2006) and Sabia (2007).

Of the studies that have examined associations between BMI and executive function, most focus on the inhibitory control component and nearly all have revealed parallel results: poorer inhibitory control was significantly associated with higher BMI among children (Anzman & Birch, 2009; Francis & Susman, 2009; Graziano et al., 2010; Piché, Fitpatrick & Pagani 2012; Riggs et al., 2012) and adolescents (Batterink, Yokum, & Stice, 2010; Maayan, Hoogendoorn, Sweat, & Convit, 2011; Verdejo-García et al., 2010). Researchers who investigated the link between BMI and executive function with a focus on the attention, mental flexibility, and working memory components of executive function have collectively found BMI to be negatively related to tasks involving attention and mental flexibility (Faith & Hittner, 2010; Mond, Stich, Hay, Kraemer, & Baune, 2007; Riggs et al., 2012; Verdejo-García et al., 2010). Specifically, Faith and Hittner (2010) found that boys exhibiting increased attention span persistence at age one demonstrated lower weight gain five years later, when compared with boys exhibiting less attention span persistence. Likewise, Mond et al. (2007) found that both overweight and obese females exhibited an inability to focus significantly more often than healthy-weight females. Researchers that have focused on associations between BMI and the working memory component of executive function have found that overweight and obese participants were more likely to exhibit decreased working memory performance than the healthy-weight participants (Maayan et al., 2011).

Physical Activity and Academic Achievement

Increased physical inactivity among middle school students may be a contributing factor to a decline in academic performance (Coe et al., 2006; Donnelly et al., 2009; Everhart, Dimon, Stone, Desmond, & Casilio, 2012; Shoval, 2011; Syväoja et al., 2013). In addition, negative academic behaviors such as tardiness and disciplinary referrals have been found to decrease with increased physical activity levels, while enjoyment and intrinsic motivation have been found to increase along with increased physical activity levels among students (Donnelly et al., 2009; Vazou, Gavrilou, Mamalaki, Papanastasiou, & Sioumala, 2012; Yu, Chan, Cheng, Sung, & Hau, 2006). Specifically, Coe et al. (2006) stated, "The mechanisms by which students may improve academic achievement as a result of physical education include increased arousal and reduced boredom, which may lead to increased attention span and concentration" (p. 1515).

In a comprehensive meta-analysis conducted by researchers Fedewa and Ahn (2011), the relationship between children's physical activity levels and academic achievement were analyzed. The meta-analysis was conducted through computed effect size analysis of 195 effect sizes stemming from 59 studies. Most of the 59 studies involved in the meta-analysis were conducted in the United States; however, seven were from other countries including: Canada, China, and Australia (Fedewa & Ahn, 2011). Fedewa and Ahn (2011) focused mainly on experimental studies that examined the "intervention effect" of exercise on cognitive outcomes (p. 525).

During their fixed-effects model and subsequent random-effects model statistical analysis, researchers Fedewa and Ahn (2011) calculated the estimated weighted mean difference of 0.32 among effect sizes to be within the 95% confidence interval (0.26-0.37), allowing the researchers to indicate the presence of a significant association between physical activity and cognitive outcomes among children. The magnitude of this association, 0.28 with a standard error of 0.03, demonstrated a small to medium effect (Fedewa & Ahn, 2011). Differences among study characteristics were explored and revealed that larger effect sizes among experimental studies (d=0.35) than correlational or cross-sectional data (d=0.32). Thus, the reasoning for the small to medium effect size may point to the fact that most studies involved in the meta-analysis were mostly correlational or cross-sectional (Fedewa & Ahn, 2011). In addition, larger effect sizes were revealed when the physical activity focused on aerobic training, involved a small group intervention, and when the exercise intervention was provided three times a week (Fedewa & Ahn, 2011). Moreover, effect sizes were largest when the outcome measure was math achievement and closely followed by IQ and reading achievement, when compared to language arts/English and science outcome measures (Fedewa & Ahn, 2011, p. 528). The following participant characteristics also revealed more significant results: groups that consisted of mixed gender, elementary school students, cognitively impaired, and athletes (Fedewa & Ahn, 2011). Due to the findings of this study, Fedewa and Ahn (2011) state that “not only is physical activity worth the time, but it appears to benefit those children who need it most, particularly in the areas where high stakes testing demands proficient achievement: mathematics and reading” (p. 532).

To determine whether academic achievement differences were due to increased physical activity levels stemming from enrollment in a semester of physical education, Coe et al. (2006) evaluated self-reported physical activity levels among 214 sixth-grade students from Michigan. The students were placed into two physical education groups: one group was enrolled in physical education for the first semester and the second group was enrolled in physical education the second semester (Coe et al., 2006). Students attended the physical education class five days per week for 55 minutes. Students self-reported their physical activity levels outside of school using a three-day activity recall (Coe et al., 2006). Coe et al. (2006) used the data in conjunction with grades from core classes as well as Terra Nova Standardized Tests to measure academic achievement. The researchers also employed direct observation during physical education classes to add explanatory evidence regarding the intensity of the activities performed through the System for Observing Fitness Instruction Time (SOFIT) (Coe et al., 2006, p. 1516).

Although the researchers hypothesized that students enrolled in physical education would exhibit greater academic achievement in core classes than those students not enrolled in physical education during that semester, significant associations were not found (Coe et al., 2006). With the aid of SOFIT data, Coe et al. (2006) were able to determine that each physical education class spent an average of 19 minutes per class in MVPA, leading the researchers to suggest this small amount of time was not sufficient enough to impact academic achievement (p. 1517). Building on this theory, Coe et al. (2006) found significant associations among self-reported physical activity levels and academic scores. Specifically, students who reported performing vigorous physical activities exhibited increased academic achievement during the first semester ($x^2 = 10.1$; $df = 2$; $P < 0.006$) and second semester ($x^2 = 6.05$; $df = 2$; $P < 0.049$) compared to those students who did not report performing any vigorous physical activities (Coe et al., 2006, p. 1517). In conclusion, Coe et al. (2006) have shown that students enrolled in physical education during a semester did not exhibit academic achievement deficits, although they had 55 minutes less class instruction time than their peers. Moreover, Coe et al. (2006) have provided additional evidence that “a threshold of activity intensity may be needed to bring about changes in the child that contribute to increased academic achievement” (p. 1518).

Similarly in an international context, Syväoja et al. (2013) evaluated the relationship between physical activity and academic achievement using both objectively measured and self-reported moderate-to-vigorous physical activity (MVPA) levels. The researchers identified the following activities as MVPA: “running, walking quickly, rollerblading, biking, dancing, skateboarding, swimming, snowboarding, cross-country skiing, soccer, basketball, and Finnish baseball" (p. 2099). The researchers further explored the relationship between self-reported screen time (watching television, playing video games, using the internet, etc.) and academic achievement to determine if screen time played a role in student's physical fitness and/or activity levels (Syväoja et al., 2013). The study investigated 277 students, average age of 12.2 years, from a public school district in Finland (Syväoja et al., 2013). Academic achievement was measured through grade point averages collected from the school district. Students self-reported their physical activity levels through questions used in the WHO Health Behavior in School-Aged Study and gave objectively-measured physical activity levels through the use of an ActiGraph accelerometer worn on the right hip over the course of seven consecutive days (Syväoja et al., 2013). The accelerometer was not worn during activities that included water, such as bathing or swimming (Syväoja et al., 2013, p. 2099). Physical activities were deemed sedentary at 100 counts per minute or less and MVPA after 2296 counts per minute (Syväoja et al., 2013, p. 2290). Student accelerometer data were included in the study if the student obtained at least 500 minutes per day on two weekdays and one weekend day (Syväoja et al., 2013).

For the statistical analyses, the researchers distributed students into three groups each, according to the amount of objectively measured MVPA and sedentary time, as well as self-reported MVPA and sedentary time (Syväoja et al., 2013). Syväoja et al. (2013) utilized ANOVA and linear regression analysis to investigate associations among physical activity, sedentary, behavior, and academic achievement. The researchers found that boys ($t_{239} = 8.10$, $P = 0.049$) self-reported at least 60 minutes of MVPA per day significantly more often than girls, corroborating objectively measured results that found increased frequency of sedentary time for girls ($t_{218} = 2.71$, $P = 006$) than boys (Syväoja et al., 2013, p. 2100). No significant individual differences were found between boys and girls for objectively measured MVPA or self-reported screen time (Syväoja et al., 2013).

Overall, the researchers evidenced a significant negative relationship between screen time and GPA; GPA decreased as screen time increased. Researchers were unable to find significance between objectively measured MVPA and GPA; however, significant associations were evidenced between self-reported MVPA and GPA, with students that reported being physically active at least 60 minutes a day for five to six days per week having the highest GPA and those students who reported only being physically active up to two days a week having the lowest GPA (Syväoja et al., 2013, p. 2100). According to Syväoja et al. (2013), this association was deemed curvilinear in that academic achievement levels positively increased as MVPA times increased per week, peaked at five to six times per week, then the relationship decreased as MVPA times increased to more than six times per week (p. 2101).

Syväoja et al. (2013) note that the study contains limitations that may provide explanation for the inconsistent results among objectively measured and self-reported data. The first being the failure of the accelerometer to explicitly capture all physical activities such as swimming as the accelerometer could not be worn in water, and skateboarding, as accelerometers more accurately measure aerobic activity versus balance or agility skills (Syväoja et al., 2013, p. 2102). The researchers also reference the difficulty children experience when trying to estimate their precise physical activity levels and consequently embellish due to social desirability bias; thus, the self-reported physical activity levels may be inaccurate (Syväoja et al., 2013b). In addition, Syväoja et al. (2013) only required three days worth of accelerometer data to signify an entire year when a much larger volume is necessary to provide an accurate proportion (Togo et al., 2008). Similarly, Clemes, Matchett, and Wane, (2008) indicate that accelerometer data over a short period of time has been shown to upwardly skew data, thus hindering the opportunity for association detection.

This study was unique in that the researchers compared self-reported levels of physical activity to objective measures of physical activity and further revealed the self-reported levels of physical activity to be a more accurate predictor of academic achievement for this study. Furthermore, increased levels of screen time were found to decrease levels of academic achievement, yet levels of sedentary time, objectively measured by the accelerometer, had no significant association with academic achievement. The researchers found evidence from this study of the effects of physical activity on academic achievement; however, they also elucidated the need for additional research incorporating more diverse methods of capturing these associations.

Further investigating the link between physical activity and academic achievement, Donnelly et al. (2009) implemented the Physical Activity Across the Curriculum (PAAC) program over three years among elementary students in northeast Kansas. The PAAC program fostered physically active academic lessons that incorporated 90 minutes of MVPA each week (Donnelly et al., 2009). The researchers selected 90 minutes as the target amount in that students were receiving 60 minutes of physical education and the combined amount (150 minutes) met Healthy People 2010 physical activity recommendations (Donnelly et al., 2009, p. 337). Out of 24 total schools, 14 served as PAAC schools with 814 students and 10 served as the control with 713 students Donnelly et al., 2009, p. 337). Teachers in PAAC schools received training on how to implement the PAAC within their subject and were subsequently monitored and evaluated to ensure students were receiving equitable amounts of the treatment (Donnelly et al., 2009). Researchers implemented SOFIT software to measure PAAC intensity through direct observations of academic lessons. The Wechsler Individual Achievement Test-2nd edition was implemented to measure student academic achievement at the baseline and after three years (Donnelly et al., 2009). The researchers calculated student BMI categories, using height and weight measurements, and further employed ActiGraph accelerometers to objectively measure physical activity levels on a random sample of 77 students (Donnelly et al., 2009). Accelerometers were worn for four consecutive days (Thursday through Sunday) in the spring of each year (Donnelly et al., 2009). The researchers utilized adjusted t-tests to reveal possible intraclass correlations and linear mixed model was used to analyze longitudinal data (Donnelly et al., 2009, p. 338).

Comparable to Datar and Sturm (2006) and Bisset et al. (2013), Donnelly et al. (2009) revealed the longitudinal shift in BMI was significantly associated with increased PAAC time. Explicitly, the nine schools that utilized PAAC for over 75 minutes per week demonstrated significantly smaller BMI shift increases at the three-year mark compared to the five schools that utilized PAAC for less than 75 minutes per week (Donnelly et al., 2009, p. 338). From the accelerometer results, the researchers also noted that students from PAAC schools exhibited increased physical activity levels of 12%, 8%, and 17% during school hours, during weekdays and weekends, respectively, when compared to students at control schools (Donnelly et al., 2009, p. 339). Consistent with Vazou et al. (2012) the noteworthy increase in physical activity frequency, especially on the weekends, may indicate increased intrinsic motivation and competence for physical activities. Students at PAAC schools also demonstrated increased frequency (27%) of MVPA involvement than students attending the control schools (Donnelly et al., 2009, p. 339). Donnelly et al. (2009) further uncovered significant group differences among academic achievement changes from baseline to three years between students at PAAC schools when compared to students at control schools. Significant associations were evident among composite, reading, math, and spelling scores ($p < 0.01$) (Donnelly et al., 2009, p. 339).

In conclusion, Donnelly et al. (2009) clearly identified the sustainability of positive effects stemming from increased levels of physical activity. The evidence gained from this study has the potential to "profoundly impact school administration and teachers and their perception of PA in the classroom" (Donnelly et al., 2009, p. 340).

Physical Activity and Cognition

Recent evidence from studies conducted on animals and elderly humans has shown that increased physical activity results in improved cognitive performance; hence, researchers have initiated similar investigations to determine if the same relationship exists among children and adolescents (Colcombe et al., 2004; Davis et al., 2011; Davis et al., 2007; Hillman, Kamijo, & Studdard, 2011; Riggs et al., 2010). A measure of cognitive performance, better performing executive functions increase a student's chance for scholastic success as they aid in self-directed learning, regulate emotions, and help make the transition to the classroom easier due to larger behavior and attentional control capabilities (Blair & Diamond, 2008; Riggs, Blair, & Greenberg, 2004; Yang & Raine, 2009). Furthermore, Hillman, Kamijo, and Studdard (2011) state "physical activity may influence the integrity and flexibility in which attentional resources are administered within the external world, and the extent to which individuals monitor and adjust their actions in response to external demands" (p. 527). Physical activity could be one way of enhancing the executive function abilities of children (Best, 2012).

Davis et al. (2011) investigated the effects of three months of physical activity on the executive function in 171 sedentary and overweight children. The researchers hypothesized that, similar to adults, exercise would improve cognition and a dose-response relationship would be evident among children 7 to 11 years of age (Davis et al., 2011). Students in the study, which took place at the Medical College of Georgia, were randomly assigned to the low-dose exercise group, the high-dose exercise group, or the control (Davis et al., 2011). The low-dose and high-dose exercise groups differed in duration, with the low-dose group receiving 20 minutes and the high-dose group receiving 40 minutes of vigorous exercise; the two treatment groups did not differ in intensity level. Davis et al. (2011) included aerobic movement and activities such as running games, jump rope, and modified soccer with a direct focus on student intensity and enjoyment (p. 92).

Davis et al. (2011) measured student cognition through the Cognitive Assessment System, which measures planning, attention, simultaneous, and successive cognitive processes through individual subtests (Davis et al., 2011). The researchers focused on the planning outcome, as it was the only component to explicitly gauge executive function (Davis et al., 2011). Academic achievement was evaluated through Woodcock-Johnson Tests of Achievement III, with the mathematics and reading outcomes as the focus (Davis et al., 2011). The researchers additionally implemented functional MRI (fMRI) to observe brain activity during executive function tasks among a subgroup of 20 students (Davis et al., 2011).

Multiple comparison analyses were incorporated to compare the control with the low- and high-dose treatment groups. Specifically, Davis et al. (2011) commissioned prearranged group mean comparisons, or *a priori* contrasts, and linear trend analyses to determine if group means fluctuated in response to exposure to the exercise intervention. Consistent with the adult research findings of Colcombe et al. (2004), Davis et al. (2011) discovered a positive dose-response relationship among the control versus high-dose group, which exercise benefitted executive function (L = 2.7, 95% CI = 0.6 to 4.8, $t_{(165)}$ = 2.5, p = 0.013) (p. 95). Significant differences were further evident among the control group and both the low-dose and high-dose exercise groups, which revealed that exposure to either exercise condition resulted in increased executive function (*L* = -2.8, 95% CI = -5.3 to -0.2, $t_{(165)}$ = 2.1, *p* = 0.03) (p. 95) (Davis et al., 2011). Through additional *a priori* linear contrasts, Davis et al. (2011) revealed a positive dose-response relationship among the control and high-dose group, where exercise enhanced math achievement (*L* = 1.6, 95% CI = 0.04 to 3.2, $t_{(135)}$ = 2.03, *p* = 0.045) (p. 95), although no tutoring or academic services were provided (Davis et al., 2011). In contrast, no significant effects were evident among exercise and reading achievement (Davis et al., 2011). In examining neuroimaging data, Davis et al. (2011) found that students assigned to an exercise group exhibited increased bilateral prefrontal cortex activity (*U* = 20, *p* = 0.04) and decreased bilateral posterior parietal cortex activity (*U* = 18, *p* = 18) from baseline to posttest when compared to students in the control group (Davis et al., 2011, p. 96).

These researchers extended the data on physical activity and cognition by evidencing the dose-response benefit of exercise on both cognition and academic achievement among sedentary overweight children. Davis et al. (2011) also provided evidence of increased prefrontal cortex activity due to the exercise program, which, according to Yang and Raine (2009), the prefrontal cortex is associated with self-regulatory processes, such as attention, cognitive flexibility, and impulse control that comprise the executive functions. Results from this study could be taken as additional support of a causal link between increased physical activity and improved cognition in children.

Building on research from Davis et al. (2011) and Hillman et al. (2009a), Best (2012) sought to discover if physical activity could independently enhance children’s executive functioning or if cognitive engagement, triggered by physical activity, resulted in enhanced executive functions. Cognitive engagement (CE) refers to the arousal of higher order cognitive processes that prepare them for subsequent tasks (Best, 2012, p. 1501).

The researcher examined the immediate effects of physical activity on children's executive functioning by implementing physical activity (PA) tasks that require cognitive engagement versus repetitive tasks, such as treadmill walking or cycling. Best (2012) utilized *Exergames*, videogames that stimulate a physically active gaming experience and included 33 children, 6 to 10 years old (Best, 2012). The four sessions lasted 23 minutes each and consisted of a video session (Low CE, Low PA) where the participant watched a healthy living video, a sedentary video game session (High CE, Low PA) where the participant sat and played a sedentary video game, an exergame session (Low CE, High PA) where the participant completed an exergame which required jogging in place at a steady pace, and a mini-exergame session (High CE, High PA) in which the participant completed a series of mini-exergames, increasing with difficulty and requiring greater amounts of physical activities (running, jumping, rolling, dodging) to win the game (Best, 2012, p. 1503).

The Child Attention Network Test, a modified flanker task that used cartoon fish in the place of arrows, evaluated cognitive functioning after each experimental session (Best, 2012). Unlike previous research, the researcher assessed executive functioning selectively by finding the difference between participant performance scores on incongruent trials (containing interference) and congruent trials (without interference) (Best, 2012, p. 1502). Best (2012) revealed that compared to low PA sessions, high PA resulted in reduced interference scores ($F_{(1,87)} = 9.19$, $p < 0.01$, $\eta^2_p = 0.10$), thus improving the participant's performance on the more difficult incongruent trials (Best, 2012, p. 1505). Significant effects were not evidenced between

PA and performance on congruent trials. In addition, interactions were not evident among CE, nor did CE effect interference scores (Best, 2012).

The researcher demonstrated compelling evidence that physical activity can immediately enhance executive functions through exercise, without the need for cognitive engagement. Furthermore, by revealing positive effects of PA on interference scores only, Best (2012) determined that physical activity increased the participant's persistence to visuospatial conflict, thus identifying the precise location of the executive function improvement (Best, 2012, p. 1507). Consistent with Donnelly et al. (2009) and Vazou et al. (2012), the researcher successfully evidenced that physical activities have the ability to stimulate executive functions to improve their cognition, engagement, and behavior.

Chapter Two Summary

To increase high-stakes test performance outcomes, school leaders have justified the reduced time for physical activity and physical education as they take away from classroom instruction time; yet, national assessment outcomes have indicated the condition of education in America has failed to measurably improve student achievement (NCES, 2013a, NCES, 2013b; Wittberg et al., 2010). Similarly, international comparisons of academic achievement elucidated significant academic differences with students in the United States lagging behind other countries in math, reading, and science, although American students received an average of 181 more instructional hours at the fourth-grade level and 83 more instructional hours at the eighth-grade level than any other country (Aud et al., 2013, p. 118). An added public health concern, increased sedentary lifestyles and unhealthy-weight conditions among American children and adolescents may be driving even the best efforts to improve education into the ground (Blom et al., Castelli et al., 2007; 2011, CDC, 2013; Hillman et al., 2009; Ogden et al., 2012; Sabia, 2007).

Investigators between physical fitness and academic achievement have largely revealed that students who were more fit performed significantly higher academically than lower fit students (Blom et al., 2011; Castelli et al., 2007; Chomitz et al., 2009; Santiago et al., 2013; Van Dusen et al., 2013). In contrast, Martin and Chalmer (2007) found physical fitness could only account for a slight percentage of the variance in academic achievement within their study and consequently concluded that time spent in physical education was not a justifiable method of improving student academic achievement.

The association between body composition and academic achievement was evidenced to have an overall inverse relationship with academic achievement (Datar & Sturm, 2006; Kim & So, 2013; Kristjánsson et al., 2009; Van Dusen et al., 2011). Meanwhile, significant evidence emerged from Bisset et al. (2013), Datar and Sturm (2006), Drid et al. (2013), and Van Dusen et al. (2011) that indicated children at risk of being underweight were more likely to suffer academic and cognitive deficits than children at risk of being overweight, particularly among males.

Significant associations were additionally found between physical activity levels and both academic achievement and cognition (Best, 2012; Davis et al., 2011; Donnelly et al., 2009; Fedewa & Ahn, 2011; Syväoja et al., 2013). Specifically, Best (2012) found that physical activity had the unaided ability to enhance executive functions. In contrast, Coe et al. (2006) found no evidence that physical activity, through enrollment in physical education, could improve academic achievement; however, both Coe et al. (2006) and Martin and Chalmer (2007) noted that students who received decreased instruction time due to enrollment in physical education did not exhibit academic deficits.

During the review of literature regarding the effects of physical fitness and physical activity on academic achievement, the researcher uncovered numerous study and participant characteristics that led to significant associations. Cardiovascular measures proved to be a more reliable indicators of academic performance than tests of strength or flexibility (Aberg et al., 2009; Castelli et al., 2007; Fedewa & Ahn, 2011; Santiago, 2013; Van Dusen et al., 2013), while scores in mathematics had overall stronger associations with fitness components than reading, English/language arts, and science (Chomitz et al., 2009; Fedewa & Ahn, 2011; Santiago, 2013; Van Dusen et al., 2013). Syväoja et al. (2013) discovered significant associations between self-reported physical activity levels and academic achievement, while objectively measured physical activity levels failed to produce similar findings.Using self-reported data Coe et al. (2006) found that students who reported increased involvement in vigorous physical activities also demonstrated increased academic achievement levels compared to those students who reported participation in lower-intensity physical activities. Donnelly et al. (2009) reported significant associations between increased frequency of physical activities and academic achievement, as well as Fedewa and Ahn (2011), who found larger effect sizes when physical activities were performed three days per week versus two days per week. In contrast, frequent or strenuous physical activity in young people has been suggested to negatively affect cognitive achievement during adolescence (Etnier, Nowell, Landers, & Sibley, 2006; Tomporowski, 2003).

The studies reviewed in the literature provided additional evidence of predictive behaviors observed among overweight and obese students that negatively influence their opportunity for academic achievement (Bisset et al., 2013; Datar & Sturm, 2006; Faith & Hittner, 2010; Reinert et al., 2013). For example, children that were a healthy weight in kindergarten and became overweight in third grade frequently exhibited low self-esteem, sadness, loneliness, and anxiety in kindergarten, although they were not overweight at the time (Datar & Sturm, 2006; Reinert et al., 2013). Furthermore, when compared to healthy-weight children, overweight students were frequently observed fighting, acting impulsively, arguing, and disturbing others (Datar & Sturm, 2006; Reinert et al., 2013; Yang & Raine, 2009). Aberg et al. (2009) indicated that higher-fit participants were more likely to obtain a college degree and an occupation with superior greater socioeconomic index than lower-fit individuals, confirming the long-term effects of negative external and internalizing behaviors.

Conclusion

Improved overall health, which in turn affects school performance and future education attainment, could result in a healthier and more successful adulthood for American students. In corroboration with Hillman et al. (2011) who stated “the overall goal of this line of research is to improve scholastic performance, maximize health, and enhance the overall functioning of individuals as they progress through the human lifespan” (p. 527), this researcher plans to build upon this theory and extend the literature to include eighth grade students in a rural, low poverty, Alabama setting. The Alabama setting is of upmost importance due to academic achievement comparisons that have revealed Alabama students repeatedly perform lower than considerably less than both national and international averages (Aud et al., 2013; NCES, 2013b; Provasnik et al., 2012). Furthermore, authorities of the Alabama Department of Health identified a significant amount of Alabama children with high systolic and diastolic blood pressures, children as young as six years of age have been diagnosed with type II diabetes, and the YRBSS found that Alabama adolescents had the highest obesity levels (CDC, 2013; APFA, 2011).

CHAPTER THREE: METHODOLOGY

Introduction

The researcher sought to determine the extent of the relationship between physical fitness, body composition, physical activity, and academic achievement. A quantitative design was used to examine these relationships in a student sample from a high school, grades 7 through 12, in Alabama. Creswell (2003) stated that a quantitative study design requires the researcher to employ an inquiry strategy and collect statistical data for comparison. The following research questions guided the study:

1. To what extent is there a relationship between Alabama Physical Fitness Assessment (APFA) scores and Explore test scores among eighth grade students?
2. To what extent is there a relationship among BMI classifications (underweight, normal weight, overweight, and obese) and Explore test scores among eighth grade students?
3. To what extent is there a relationship between physical activity levels (both objective and subjective measures) and Explore test scores among eighth grade students?

Theoretical Framework

The framework for the study was built upon Ames' (1992) Achievement Goal Theory (AGT) due to its unique approach to understanding student motivation and achievement in both academic courses and physical activity (Xiang, Bruene, & McBride, 2004). Achievement goal theory suggests that individuals, motivated by psychological needs, determine personal goals in achievement settings, such as school and sports, as they believe goals have a purpose (Soares, Lemos, & Almeida, 2005; Weinberg & Gould, 2003).

Individuals are motivated to accomplish their goals according to preconceived notions of the effort and ability necessary to achieve the goal, (Woolard, 2008) as explained in Ames'(1992)Achievment Goal Theory. According to Weinberg and Gould (2003), achievement goals represent a specific outcome of what individuals are trying to achieve. Ames (1992) identified two types of achievement goals: mastery and performance. Mastery goals, also known as learning or task involvement goals, are attributed to an individual's belief that effort will lead to success. Performance goals, or ego involvement goals, focus on an individual's ability and self-worth as determined by achieving public recognition of superior performance with very little effort, including learning. Within the classroom, students perceive learning outcomes as either mastery- or performance-focused based upon how the teacher communicates the purpose of learning tasks and achievement. Teachers create a climate conducive to creating mastery goals among their students by implementing authentic tasks, involving students in the decision-making process, and incorporating meaningful learning. As a result, students demonstrate increased persistence, as they relate success to increased effort. Teachers elicit performance goal setting by focusing instructional strategies on learning outcomes such as grades, test scores, and social competition rather than on the enjoyment of cooperative culturally relevant learning. As a result, students demonstrate less effort, as they believe success comes from ability (Xiang et al., 2004).

Although teachers can influence student success or failure by their mastery- or performance-oriented classroom climate, increasing student motivation towards a physically fit and healthy lifestyle may result in the combination of mastery and performance goal orientations (Gao, Lodewyk, & Zhang, 2009). Students can be encouraged to become physically fit through teacher incentives and learning the importance of maintaining a healthy lifestyle; yet, researchers suggest that highly cognitive tasks are necessary to maintain the interests and consequently, the performance, of students in academic courses and physical activities. In the Achievement Goal Theory, Ames (1992) posits that goals focused on achievement activities expand student competency and that through mastery involvement, not performance, students exhibit increased intrinsic motivation. Similarly, Chen and Ennis (2004) indicate a more situational approach to mastery learning may increase motivation through an enhanced curriculum, regardless of the environment. Being physically fit and active is an important part of a child's life, yet with the performance goal climate of high-stakes testing, physical activity levels have decreased due to remediation pullouts during PE. As Ames (1992) suggests, motivation and the desire to learn are necessary for achievement goal setting. Accordingly, physical activity and physical fitness may provide the motivation for those who are not academically motivated (Xiang et al., 2004).

Research Design

To determine the extent of the relationship between physical fitness, body composition, physical activity, and academic achievement, statistical analyses were based on a convenience sample of approximately 100 individually matched Explore and APFA score reports, as well as data pertaining to BMI category and physical activity level of the participants. The number of students who returned their signed consent form and their parents' signed assent form determined the sample size for the study. The study contained two dependent variables, Math and Reading Explore scores, and three major independent variables, physical fitness results, BMI category, and Physical Activity levels. Data were analyzed using a form of Structural Equation Modeling known as Path Analysis to answer research questions one and three. Path analysis incorporates path diagrams that depict and clarify the relationships between independent and dependent variables through multiple regression analyses. Multivariate Analysis of Variance (MANOVA) was used to determine the extent of the relationship between body composition and reading and math scores, research question two. The procedures and data collection methods that shaped and directed this study are detailed further in this section as well in the data shell.

Table 3.1

Data Shell

Research Question	Literature Sources	Type: Method, Data, Validity	How data are analyzed	Rationale
To what extent is there a relationship between APFA scores and Explore test scores?	VanDusen et al., (2011) Chomitz et al., (2009) Blom et al., (2011) Santiago et al., (2013) Hillman et al., (2009a) Chaddock et al. (2012)	Method: *Fitness scores, Assessment data* Data: *Ordinal, Interval* Validity: *Content*	*Descriptive and inferential statistics:* *Path Analysis*	To determine if there are significant differences between physical fitness and academic achievement.
To what extent is there a relationship among BMI classifications and Explore test scores?	Datar & Sturm, (2006) Kristjánsson et al., (2009) Kim & So, (2013) Bisset et al., (2013) Drid et al., (2013)	Method: *BMI category, Assessment data* Data: *Ordinal, Interval* Validity: Construct	*Descriptive and inferential statistics:* *MANOVA*	To determine if there are significant differences between body composition and academic achievement.
To what extent is there a relationship between physical activity levels and Explore test scores?	Fedewa & Ahn, (2011) Coe et al., (2006) Syväoja et al., (2013) Donnelly et al., (2009) Best (2012) Davis (2011)	Method: *activity data, questionnaires, assessment data* Data: *Ordinal, Interval* Validity: *Construct, Criterion*	*Descriptive and inferential statistics:* *Path Analysis*	To determine if there are significant differences between physical activity levels and academic achievement.

Population and Sampling

Eighth-grade students, age range of 13 to 15 years, enrolled in PE classes from a high school in east central Alabama were the intended population for this study. The students had 55-minute PE classes five days per week throughout the entire school year. Exclusion criteria included students who were unable to participate normally within a PE setting due to the study being initiated within the framework of a normal PE class; therefore, eighth grade students enrolled in Adaptive PE were not included in the study.

This study was set in a high school in east Alabama that included grades seven through twelve. There were 46 teachers and 585 total students at the school; 132 of the students being eighth-graders. The male and female students shared an equal ratio of the school's population. The student-teacher ratio was one to fifteen, which was slightly less than the Alabama average of one to sixteen at the time of the study. The largest racial group was White (88%), the next largest was Black (11%), and Hispanic (1%). Out of the total student body, 31% were eligible for free lunch and 9% were eligible for reduced lunch. These numbers were based upon family income levels. The entire faculty of the school included highly qualified teachers. In addition to the researcher, one PE teacher and the junior high counselor aided in the data collection procedures. The PE teacher held a bachelor's degree in PE and had over 18 years' PE teaching experience. The junior high counselor held a master's degree in school counseling and had seven years teaching experience.

Permission to conduct the study was obtained from the Columbus State University Institutional Review Board (IRB), the Lee County School System (see Appendix A), and the cooperating school administration (See Appendix B). The parents provided written informed consent and the students provided written informed assent prior to participation in the study (see Appendices C and D).

Instrumentation

Equipment used in the study included: (a) Alabama Physical Fitness Assessment for physical fitness data collection; (b) Anthropometry instruments (digital weight scales, stadiometers) necessary to aid in calculating BMI for body composition data collection; (c) ActiGraph Accelerometers for objective physical activity data collection; (d) Physical Activity Questionnaire for Adolescents (PAQ-A) for subjective physical activity data collection; and (e) Explore reading and math test results for academic achievement data.

APFA

The APFA is used systematically to evaluates student health and fitness by focusing on aerobic cardiovascular endurance, muscular strength and endurance, abdominal strength and endurance, and flexibility (APFA, 2011). The student compares their APFA score results to their previous scores to identify and track improvements and to set goals. The purpose of the assessment is to provide students, parents, and teachers with information regarding student health and physical activity levels (APFA, 2011). Continuous score results from each APFA fitness component, except flexibility, are categorized into three health-related fitness zones: Needs Improvement Zone (N), Healthy Fitness Zone (H), and High Fitness Zone (HFZ) (APFA, 2011). Students in the needs improvement zone score below the established healthy fitness level; and indicate the student may be at risk for health-related problems (APFA, 2011). Scores in the healthy fitness zone are deemed suitable levels of health and fitness; scores in the high fitness zone are indicators of excellent health and fitness levels (APFA, 2011). Flexibility scores are recorded in the needs improvement zone or in the healthy fitness zone only, excluding the high fitness zone. The developers of the APFA state the objective of the fitness component is for students to have a healthy level of flexibility as any additional amount of flexibility, or hyper-mobility, does not indicate increased fitness or health (APFA, 2011). Students are given the APFA pretest in October and the posttest in March or April (APFA, 2011). APFA score results are confidentially recorded into the teacher's online grade book and are reported to the Alabama State Department of Education in June (APFA, 2011). Scores from the APFA are not assigned an academic grade and are not reported on the student's report card (APFA, 2011).

The APFA aerobic cardiovascular endurance component is assessed through a one-mile run or walk or the Progressive Aerobic Cardiovascular Endurance Run (PACER) (APFA, 2011). According to the APFA Testing Manual, the one-mile run or walk is preferred for students in grades 9 to 12 while the PACER is preferred for students in grades 2 to 8 due to their inability to aerobically pace themselves (APFA, 2011). The objective of the PACER is to run as long as possible, back and forth, within a 20-meter distance increasing speed with each passing minute (APFA, 2011). The physical education teacher accurately measures a 20-meter distance on a flat surface and marks the space using marker cones. The physical education teacher informs the students prior to the PACER that a single beep (from the compact disc (CD) or tape player) sounds the beginning and end of each lap and a triple beeps sounds at the end of each minute, alerting the students that the pace will increase (APFA, 2011). The cadence allots 9 seconds of running for the first minute and decreases by one-half second each progressing minute (APFA, 2011). A student's test is over when they fail to touch the finish line before the beep sounds on two separate occasions (APFA, 2011). PACER scores are recorded as the number of laps the student completed (APFA, 2011). The following table contains scoring requirements for the PACER according to age and gender.

Table 3.2

PACER Performance Ranges for Health-Related Fitness Zones

Age	Needs Improvement Zone (N)		Healthy Zone (H)		High Fitness Zone (HFZ)	
	Boys	Girls	Boys	Girls	Boys	Girls
12	0-31	0-14	32-72	15-41	>72	>41
13	0-40	0-22	41-83	23-51	>83	>51
14	0-40	0-22	41-83	23-51	>83	>51
15	0-50	0-31	51-94	32-51	>94	>61

Muscular strength and endurance are measured by the APFA by the maximum number of push-ups the student is able to correctly complete in two minutes (APFA, 2011). The student completes one push-up every three seconds as indicated by a cadence. A complete push-up begins and ends with the student in the up position (APFA, 2011). The student's push-up test is over when they break proper form for the second time or when they can no longer continue (APFA, 2011). The following table contains scoring requirements for the strength assessment according to age and gender.

Table 3.3

Push-Up Performance Ranges for Health-Related Fitness Zones

Age	Needs Improvement Zone (N)		Healthy Zone (H)		High Fitness Zone (HFZ)	
	Boys	Girls	Boys	Girls	Boys	Girls
12	0-9	0-6	10-20	7-15	>20	>15
13	0-11	0-6	12-25	7-15	>25	>15
14	0-13	0-6	14-30	7-15	>30	>15
15	0-15	0-6	16-35	7-15	>35	>15

Abdominal strength and endurance are measured by the APFA by the maximum number of continuous partial curl-ups the student is able to complete (APFA, 2011). A complete partial curl-up begins and ends when the student's head returns to his or her partner's hands on the floor (APFA, 2011). A cadence is used to initiate a curl-up every three seconds, or 20 per minute (APFA, 2011). The curl-up test is over when the student has either completed 75 curl-ups, received two form corrections, or can no longer continue (APFA, 2011). The following table contains scoring requirements for the abdominal strength assessment according to age and gender.

Table 3.4

Curl-Up Performance Ranges for Health-Related Fitness Zones

Age	Needs Improvement Zone (N)		Healthy Zone (H)		High Fitness Zone (HFZ)	
	Boys	Girls	Boys	Girls	Boys	Girls
12	<20	<20	20-39	20-34	>39	>34
13	<25	<25	25-41	25-36	>41	>36
14	<30	<25	25-44	25-36	>44	>36
15	<35	<30	30-44	30-35	>44	>35

The APFA implements the Back-Saver Sit-and-Reach test to measure joint flexibility on the left and right side of the body and implements the V Sit-and-Reach test to measure lower back and hamstring flexibility (APFA, 2011). The person scoring the Back-Saver uses an assembled box with a ruler attached for measuring the distance the student is able to reach. The student bends one knee and keeps the other knee straight and parallel to the floor. The student reaches forward four times with both hands on the top of the box. On the fourth reach, the student must hold the stretch for one-second minimum (APFA, 2011). This process is repeated to measure the flexibility of the other leg. The following table (Table 3.5) provides scoring ranges for the Back Saver.

Table 3.5

Back Saver Performances Ranges for Health-Related Fitness Zones (in inches)

AGE	Needs Improvement Zone (N)		Healthy Zone (H)	
	Boys	Girls	Boys	Girls
12	<8	<10	>8	>10
13	<8	<10	>8	>10
14	<8	<10	>8	>10
15	<8	<12	>8	>12

The V Sit-and-Reach test is measured by two perpendicular measuring lines for measuring lower back and hamstring flexibility; one line is two feet long and the other is 18 inches (APFA, 2011). The students sit on the line that is two feet long, or the baseline, with their feet approximately eight to twelve inches apart, thumbs clasped together, and palms facing downward (APFA, 2011). The students reach forward, parallel with the 18 inch line, and any distance past the 18 inch mark is positive (APFA, 2011). For example, if a student reaches one inch past the 18-inch mark, they would score a 19; if they were able to reach 2 inches past the 18-inch mark, they would score a 20 (APFA, 2011). The student bends at the waist and slowly reaches forward four times. On the fourth stretch, the student must hold the position for at least three seconds (APFA, 2011). Scoring ranges for the V Sit-and-Reach are included in table 3.6.

Table 3.6

V Sit-and-Reach Performance Ranges for Health-Related Fitness Zones (in inches)

AGE	Needs Improvement Zone (N)		Healthy Zone (H)	
	Boys	Girls	Boys	Girls
12	<19	<20	>19	>20

AGE	Needs Improvement Zone (N)		Healthy Zone (H)	
13	<19	<21	>19	>21
14	<19	<21	>19	>21
15	<19	<21	>19	>21

Morrow, Jackson, Disch, and Mood (2005) found distance runs have demonstrated criterion-related validity in research. Tests of muscular strength and flexibility have less criterion-related validity support; however, these fitness tests are generally accepted on the basis of content or logical validity (Morrow et al., 2005).

Anthropometry

To obtain participant BMI category, the PE teacher directly measured and recorded weight and height data. Participant weight (measured to the nearest pound), standing height (measured to the nearest centimeter), and seated height (measured to the nearest centimeter) was measured behind a privacy screen to ensure discretion. Participants were asked to remove bulky clothing (i.e. jackets) and shoes prior to measurement. The PE teacher used a stadiometer to measure height and a digital scale to measure weight. When measuring weight, two measures were taken and recorded with the participant stepping off the scale between measures. If the difference between the two measures was greater than 0.4 lb, a third measure was taken. The participant's recorded weight measure was the calculated mean of the weight measures (Abou-Hussein, Abela, & Savona-Ventura, 2011). Standing Height was measured using the stretch stature, or the distance from the floor to the vertex of the head. The participant was asked to stand with his back, buttocks and heels against the stadiometer, holding his feet together and flat on the floor. Two measures were taken, with the participant stepping away from the stadiometer each time. If the recorded measures differed by more than 0.4 cm, a third measure will be performed (Abou-Hussein, Abela, & Savona-Ventura, 2011). Each participant's standing height was the calculated mean of his or her two height measures (Abou-Hussein, Abela, & Savona-Ventura, 2011). Seated height, or trunk height, is "the maximum distance from the vertex to the base of the sitting surface" (Abou-Hussein, Abela, & Savona-Ventura, 2011, p. 243). Participants sat on a flat measuring box with their hands resting on their lap. A second reading was taken after the participant stepped away from the stadiometer and returned. If the recorded measures differ by more than 0.4 cm, a third measure was performed (Abou-Hussein, Abela, & Savona-Ventura, 2011). Each participant's standing height was the calculated mean of his or her two height measures (Abou-Hussein, Abela, & Savona-Ventura, 2011).

After recording the participant's weight and height, the PE teacher recorded the student's age, date of birth, and gender. After directly measuring height and weight data, the participants were classified as either underweight, healthy weight, overweight, or obese based on their BMI percentile calculated by the PE teacher. Percentiles were determined using the CDC's BMI calculator for adolescents (http://apps.nccd.cdc.gov/dnpabmi/Calculator.aspx). BMI classifications for children and adolescents were as follows: less than 5th percentile was underweight, percentiles greater than the 5th and less than the 85th are categorized as healthy weight, percentiles greater than the 85th and less than the 95th were categorized as overweight, percentiles equal to or greater than the 95th percentile were considered obese, and percentiles greater than or equal to the 99th percentile were considered severely obese (CDC, 2013).

Accelerometer

According to researchers, accelerometry is presumed to be the most objective measure of gross body movement in physical activity research (Ekelund, Tomkinson, & Armstrong, 2011; Hallal et al., 2013; Saint-Maurice, Welk, Beyler, Bartee, & Heelan, 2014). Each participant's physical activity levels were objectively measured using the ActiGraph. The accelerometer senses accelerations to provide information regarding the duration, intensity, and frequency of the user's stretch of physical activity (Abel et al., 2008). The information received from the device was recorded over a specified amount of time, called an epoch, and reported in the form of an activity count (Abel et al., 2008). Depending on the device, accelerometers implement a sampling rate of 30 Hz, or 30 measurements per second, while using a single-cell prismatic lithium ion rechargeable battery (Abel et al., 2008; Saint-Maurice et al., 2014). The battery holds a charge for approximately 14 days and can be recharged in several hours through an electrical outlet or a USB port in a computer (Abel et al., 2008). The accelerometer is able to hold 364 days of activity count data through its one-megabyte of nonvolatile flash memory (Abel et al., 2008).

Questionnaire

The PAQ-A was a self-administered questionnaire used to evaluate physical activity of adolescents (age 13 to 20 years) through a seven-day physical activity recall (Saint-Maurice et al., 2014). The questionnaire, only to be used during the school year, contained nine items (only eight were assessed) that asked the participant to check a list of activities for frequency of participation on a 5-point Likert scale ranging from *low physical activity* to *high physical activity* (Saint-Maurice et al., 2014). The average of all eight items constituted the PAQ-A summary score (Saint-Maurice et al., 2014). The questionnaire took approximately 20 minutes to complete and gave the researcher information on the type and context of physical activity performed over the past seven days, which strictly objective data did not explain. According to Biddle, Gorely, Pearson, and Bull (2011) the PAQ-A was one of the most suitable self-reporting measures found in their systematic review of self-reported physical activity instruments. Biddle et al. (2011) described the PAQ-A as "simple to complete, well used, and time efficient" (p. 7). The questionnaire has been shown to exhibit consistent validity even when compared to direct measures of physical activity, such as the doubly labeled water (Biddle et al., 2011).

Explore Test

The ACT Explore test, based on the ACT College Readiness Standards and Common Core State Standards, is comprised of four major assessments: English, mathematics, reading, and science. Each test is allotted 30 minutes for completion and the number of questions range from 28 (science) to 40 (English). Scores for each test, as well as the overall or Composite score, range from one to 25. Benchmarks are given for each subject to indicate whether the student's score received was *Below*, *At*, or *Above* the benchmark. Explore benchmarks for eighth-grade are as follows: English-13, Math-17, Reading-16, and Science-18.

Data Collection Procedures

Specific data collection procedures were further detailed by the three research questions driving the study. During all data collection procedures, student confidentiality was ensured through the use of direct coding. Identification codes for each participant were assigned by the physical education teacher and were kept in a locked file cabinet, to which only the researcher had the access key. The filing cabinet was kept in the researcher's locked classroom. The school's junior high counselor was given a list of the participant names and corresponding identification codes. Only three individuals had access to the codes: the researcher, the PE teacher, and the junior high counselor.

Demographic information for each participant including age, gender, ethnicity, special education status (IEP or no IEP), and socioeconomic status was obtained through the school's registrar. The socioeconomic status (SES) was determined by the participant's free or reduced lunch eligibility. The researcher labeled the demographic information for each participant using his or her identification code. The researcher removed the participant name from the documentation after reviewing that each name matched the identification code. Printed names of the participants removed from the demographic information were shredded. All records were kept in a locked filing cabinet.

Academic Achievement

To evaluate participant academic achievement and address all three research questions, data were collected from the ACT's Explore math and English assessments. The Explore was administered to the participants as regularly scheduled in October of 2014. The assessment was given over the course of two days. The first day consisted of the participants completing an interest survey where they answered questions regarding their personal interests, jobs, and possible careers. The second day was the actual day of the assessment. Each subject's assessment was allotted 30 minutes. The Explore lasted approximately 2 hours and 30 minutes. The results of the assessment were returned to the school's counselor in January of 2015. The junior high counselor labeled a 5x7 index card with the participant's matching identification code received from the PE teacher; this was identified as their Explore card. After allocating each participant an Explore card, the junior high counselor recorded each participant's math and English Explore results on the card. The researcher reviewed the cards with the participant-coding list to ensure accuracy. Explore score results ranged on a scale of 1 to 25; therefore these data were analyzed as interval data. Test-score outcomes are known as a type of data described as interval data. Interval data are indicated when a test is based on a fundamental scale such that one can discuss about how much more a higher performance is than a lesser one (Salkind, 2007).

Physical Fitness

To evaluate participant physical fitness and address research question one, data were collected from the APFA. The APFA was administered to the participants in the study, along with the other PE students at the school, in October of 2014 as a part of the required PE curriculum. Once all students were assessed, the PE teacher recorded the scores into STI-Now, the school system's electronic grade book as mandated by the state of Alabama. The PE teacher assigned each participant an identification code; using direct coding, and maintained this list in the researcher's locked filing cabinet. The PE teacher labeled a 5x7 index card with the participant's identification code, this was known as their fitness card. After allocating each participant a fitness card, the PE teacher recorded each participant's APFA results. The researcher reviewed the fitness cards with the participant-coding list to ensure accuracy.

Results from the APFA were categorized as Needs Improvement (N), Healthy (H), or High Fitness Zone (HFZ); therefore these data were analyzed as ordinal data. According to Lomax (2012), ordinal data "is determined by the relative size or position of individuals or objects with respect to the characteristic being measured" (p. 10).

Body Composition

To evaluate participant body composition and address research question two, data were collected from anthropometric measures and the CDC's adolescent BMI calculator (http://apps.nccd.cdc.gov/dnpabmi/Calculator.aspx) for standing height while corrected BMI was reported using the equations found in Table 3.7 (See below). Height and weight data were measured during the participant's scheduled PE class. Each participant stepped behind a privacy screen during all anthropometric data collection. The participants removed any loose clothing prior to stepping on the weight scale. The PE teacher recorded their weight, in pounds, and their height, in centimeters, to the nearest tenth. The PE teacher recorded the participant's anthropometric data on their fitness card. The PE teacher then delivered the fitness cards to the researcher. The researcher used the CDC's BMI calculator for adolescents by entering each participant's height and weight data. The researcher then used the participant's age and gender to determine the BMI category. These data were recorded on the participants' fitness cards and stored in the researcher's locked filing cabinet in a locked classroom within the school.

Table 3.7

Anthropometric Calculations for BMI (WHO, 2000)

Gender	Sitting-to-Standing Height Ratio (SH/S)	Observed BMI (BMI_{ob})	Estimated BMI (BMI_{es}) Equation at actual SH/S ratio	Corrected BMI (*c*BMI)
Male	Sitting height (cm)/standing height (cm)	Weight (kg)/[standing height (m)]^2	0.78(SH/S)-18.43	$BMI_{0.52}$ + (BMI_{ob}-BMI_{es})
Female	Sitting height (cm)/standing height (cm)	Weight (kg)/[standing height (m)]^2	1.19(SH/S)-40.34	$BMI_{0.52}$ + (BMI_{ob}-BMI_{es})

Physical Activity

To evaluate participant physical activity and address research question three, data were collected using both objective and subjective measures. Objective physical activity data were collected from ActiGraph accelerometers using ActiLife software. Participants wore the accelerometer on their right hip with an elastic waistband for seven consecutive days. Participants placed the accelerometer on their hip each morning when they woke up and took it off each night before going to sleep. Water activities such as bathing and swimming were excluded from accelerometer data collection, as the instrument should not be immersed in water. Participants were given an instruction sheet containing a general description of the device, instructions on how to wear it, frequently asked questions and answers, and contact information for the researchers.

ActiLife accelerometer software was used to collect physical activity data from each participant. Physical activity variables were expressed as mean counts per minute (cpm) to indicate average daily physical activity intensity levels as well as to determine the amount of time the participant spent in MVPA. Physical activity cut-off levels included the following categories: Sedentary: 0-100 cpm, Light: 101-2295 cpm, Moderate: 2296-4011 cpm, and Vigorous: 4012+ cpm, as recommended for adolescents by Evenson et al. (2008). Researchers have determined these physical activity thresholds more accurately classify physical activity intensities than others (Decelis, Jago, & Fox, 2014; Hallal, et al., 2013; Trost, Loprinzi, Moore, & Pfeiffer, 2011). To pinpoint participant intermittent physical activity levels common for adolescents, epoch length was set at 10 seconds. A valid day included at least 500 minutes per day of monitor wear; while periods of zero cpm over 90 minutes were removed as they were considered non-wear time (Decelis et al., 2014; Hallal et al., 2013; Saint-Maurice et al., 2014). Although there is no consensus on appropriate non-wear time, the researchers incorporated an extended non-wear time to account for periods of seated time spent in the classroom (Saint-Maurice et al., 2014). Participants who had at least three weekdays and one weekend day of valid data were included in the study (Saint-Maurice et al., 2014). ActiLife accelerometer software (http://support.theactigraph.com/dl/ActiLife-software) was used to collect data. Wear Time Validation followed recommended settings from Choi (2011) where a non-wear period included a minimum length of 90 minutes, a small window length of 30 minutes, and a spike tolerance of 2 minutes.

After wearing the accelerometer for seven consecutive days, each participant returned the device and completed a Physical Activity Questionnaire for Adolescents (PAQ-A) during their PE class while being supervised by their PE teacher. The PE teacher reviewed the questionnaire and explained each type of item and response the participant would encounter. The PE teacher was available for questions throughout the questionnaire; however, the PE teacher kept all responses at a minimum and directed the participants to use their best judgment. The questionnaire took approximately 20 minutes to complete. When all participants had completed their questionnaire, the PE teacher delivered the results to the researcher where they were then properly labeled with the participant's identification code, organized, and stored in a locked filing cabinet. According to Richardson, Cavill, Ellis, and Roberts (2011), the PAQ-A provides consistently high validity and a moderate reliability.

Subjective physical activity was reported through the PAQ-A, a 7-day physical activity recall formulated for adolescents. There were eight items on the questionnaire and each item was either given a 5-point Likert scale for responses, multiple response options for the participant to identify their physical activity, their overall intensity, and duration from the previous seven days. The data stemming from this instrument were analyzed as interval data. The researcher employed construct validity to determine if the questionnaire measured any underlying psychological construct, such as a particular feeling toward physical activity, accurately (Popham, 1995; Salkind, 2007). The questionnaire may have had the potential to unfairly discriminate or cause a disparate impact against certain groups of students, as they had not had the proper education to adequately respond to the items on the questionnaire.

Data Analysis Procedures

The following statistical analyses were used to answer the three research questions: participant descriptive statistics, Path Analysis, and MANOVA. Logarithmic transformations were to be used if skewed distributions were evident among variables. Statistical analyses were conducted using the SPSS statistical package 17.0 and significance was determined at $p < .05$.

Research Questions 1 and 3: Path Analysis

To determine the extent to which physical fitness, physical activity, and academic achievement are related, accelerometer data, APFA score results, and Explore results were analyzed through a type of Structural Equation Modeling known as Path Analysis. Path analysis is a causal model, rooted in theory from prior research, where independent variables have an effect on a dependent variable. Path analysis allows researchers to simultaneously model multiple regression relationships at once (Tabachnick & Fidell, 2013). All measured variables were continuous and measured on an interval scale and were represented by squares and rectangles on the path diagram. An exogenous variable, similar to an independent variable, gives an effect, or has an effect on another variable. The exogenous variables included the four APFA components (cardiovascular fitness, muscular strength, abdominal strength, flexibility) and both objective and subjective physical activity data. An endogenous variable, similar to a dependent variable, receives the effect. Reading and math achievement served as the endogenous variables for the path diagram. Mediating variables receive and give effects from other variables. Gender and socioeconomic status were entered into the path diagram as mediating variables. Path coefficients, or correlation coefficients, are the direct effect of one variable's effect on another. The standardized path coefficients indicate the amount of change in the endogenous variable for one standard unit change in the exogenous variable. A direct effect is indicated in the path diagram using a direct arrow. An indirect effect is the effect of one variable on another, but through a mediating variable. The total effect is the sum of the direct and indirect effects. The path diagram changes with each stage of the path analysis. Prior to the statistical analysis, the data were examined for model assumptions- independence, homoscedasticity, normality, linearity, and non-collinearity.

Figure 1 Path Analysis Diagram

Research Question 2: MANOVA

To determine the extent to which BMI classification and academic achievement were related, BMI levels and Explore test results were analyzed. Body composition results were analyzed as interval data. A One-Way MANOVA was conducted to examine the differences between the four groups (underweight, normal weight, overweight, obese) on the two dependent variables (reading achievement, math achievement). The Hotelling T^2 post-hoc test procedure was implemented to locate the differences between specific groups on the two dependent variables individually.

Prior to the analysis, the data were examined for univariate and multivariate outliers as well as multivariate normality and homogeneity of the variance/covariance matrix. First, the data were examined for missing values, outliers, and normality for each group. The assumption of normality was examined through histograms, the evaluation of kurtosis, skewness and, more formally, through the Shapiro-Wilk test. Multivariate outlier analysis was analyzed separately for each group on the combined dependent variables using Mahalnobis Distance test. Data were tested for equality of the covariance matrix through Bartlett's Test, or Box's M.

Internal Validity

During the research study, special care was taken by the researcher to ensure validity, reliability, dependability and bias. The data collection methods described in this chapter were followed precisely and kept organized and confidential throughout the study. The data collection setting remained the same throughout the project. Selecting the appropriate number of subjects and participants was an important part of maintaining dependability within this project. Equity audits were in place to ensure equity within the research and the possibility of bias was minimized throughout the study.

The quantitative data gathering method that served as the study's dependent variable was a nationally recognized achievement assessment (Act's Explore®). The researcher chose to employ a standardized assessment to decrease bias and offensiveness often evident among teacher-prepared assessments (Popham, 1995). The test could be unfair if it discriminates against a specific subgroup because of the language used in the questions (Popham, 1995). In addition, a disparate impact may be evident among learners who do not score well on the test, meaning that the test is not unfair or biased, but that certain groups of learners may not have received the tools they needed to be successful on the test (Popham, 1995).

The proposed study was first approved by Columbus State University faculty and by the administrative faculty at the school where the study was completed. Eisner (1991) calls the faculty review process consensual validation, an agreement among competent others that the description, interpretation, evaluation and thematic are right. The formation of this proposed study was compared to available literature on physical fitness, body composition, and physical activity as an academic achievement correlates. Denzin and Lincoln (1998) describe this cycling back as epistemological validation, where the reader is shown evidence of consistency with the theoretical perspectives used in the review of the literature.

External Validity

According to Eisner (1991), structural corroboration exists when the confluence of evidence comes together to form a compelling whole. The researcher demonstrated credibility through structural corroboration, fairness and precision in this study. The researcher used multiple data sources and the alignment of each source provided evidence of structural corroboration. Opposing points of view on the association between physical fitness, body composition, and physical activity and academic achievement were stated in the review of the literature. These examples of opposition exhibited the fairness of the study. Data collection and analysis methods remained precise in order to present strong evidence and ensure a tight argument and a coherent case (Eisner, 1991).

Limitations

There may be design issues with this study that should be taken into account when interpreting the results of this study. Although the PE teacher and junior high counselor received training and instructions on precise data collection methods, the reliability of the data collection was unknown. Consequently, systematic bias may be compromised due to inconsistent data quality. Possible limitations of this study included the parents that did not agree to permit their child to participate in the study. The school in the study was a school with a mostly White population, thus limiting the data from participants with various ethnic backgrounds.

Delimitations

The researcher elected to limit the scope and define the boundaries of this study by choosing to investigate the relationship between physical fitness, physical activity, and academic achievement among a convenience sample of 8^{th}- grade students in Alabama. These participants were selected based on their enrollment in the researcher's mathematics course as this was the most convenient population to which the researcher could gain access. The researcher chose not to use a larger sample, i.e. all 8th -grade students in the school district, due to a limited number of accelerometers and the limited time of the school year (spring) in which the study was being held. Each participant in the study wore the accelerometer for seven days; consequently, the researcher chose to limit the number of participants to allow adequate time for analyzing the results of the study. The researcher chose to limit the study by only focusing on the math and reading scores from the Explore test instead of including the science or composition scores. The researcher chose to set forth these particular boundaries because the studies included in the review of literature focused mainly on math and reading assessments to define academic achievement. The researcher also chose to use the APFA as opposed to the President's Challenge or other physical fitness assessments because the participants in the study were mandated by the state of Alabama to take the APFA as part of the physical education course requirement. The results of this study could be generalizable to educators who teach physical education, math, or reading at the middle school level in the state of Alabama.

Implications

Given the pressure educators and school officials have experienced in order to demonstrate learning for all students, the researcher anticipated adding to the growing body of evidence pinpointing the significant association between physical fitness and academic achievement. In addition, significant findings resulting from this study could be used as further evidence highlighting the importance of daily physical activity and physical fitness in the health and well being of school aged children. The researcher also aimed to provide evidence of the importance of PE in helping children meet physical activity guidelines.

Summary

The framework for the study was built upon Ames' (1992) Achievement Goal Theory (AGT) due to its unique approach to understanding student motivation and achievement in both academic courses and physical activity (Xiang, Bruene, & McBride, 2004). Achievement goal theorists suggest that individuals determine personal goals in achievement settings, such as school and sports, as they believe goals have a purpose (Soares, Lemos, & Almeida, 2005; Weinberg & Gould, 2003). The researcher aimed to determine the extent of the relationship between physical fitness, body composition, physical activity, and academic achievement among 8^{th}- grade students in Alabama by incorporating a quantitative research design. The study contained two dependent variables, math and reading Explore test scores, and three independent variables, physical fitness results, BMI category, and physical activity levels. To determine the extent of the relationship between physical fitness and physical activity levels on the combined dependent variables (research questions 1 and 3), path analysis was implemented. To determine the extent of the relationship between each BMI category on the combined dependent variables, a MANOVA was employed. Equipment used in the study included APFA results, digital weight scales, stadiometers, ActiGraph accelerometers, PAQ-A, and Explore reading and math test results. Data collection procedures included receiving Explore test scores from the junior high counselor when the test results were returned to the school, receiving APFA scores, height, and weight measures from the physical education teacher, downloading accelerometer device data from the participants at the conclusion of their seven days of wear time, and a completed PAQ-A. The researcher implemented participant descriptive statistics, Path Analysis, and a One-way MANOVA in order to analyze the data.

CHAPTER FOUR: REPORT OF DATA AND DATA ANALYSIS

Introduction

The researcher sought to establish the extent of the relationship between physical fitness, body composition, physical activity, and academic achievement among eighth- grade students in Alabama by incorporating a quantitative research design. The study encompassed two dependent variables, math and reading Explore test scores, and three independent variables, physical fitness scores, BMI category, and physical activity rankings. To address research questions one and three and to establish the extent in which physical fitness, physical activity, and academic achievement were related, accelerometer data, APFA score results, and Explore results were analyzed through a type of Structural Equation Modeling known as Path Analysis. The researcher chose to implement the path analysis as it was a causal model that allowed the researcher to simultaneously model multiple regression relationships at once.

To determine the extent to which BMI classification and academic achievement were related, BMI levels and Explore test results were analyzed. A One-Way MANOVA was conducted to assess the differences between the four groups (underweight, normal weight, overweight, obese) on the two dependent variables. Equipment used in the study included APFA results, digital weight scales, stadiometers, ActiGraph accelerometers, PAQ-A, and Explore reading and math test results. Data collection procedures incorporated receiving Explore test scores from the junior high counselor when the test results were returned to the school, receiving APFA scores, height, and weight measures from the physical education teacher, downloading accelerometer device data from the participants at the conclusion of their seven days of wear time, and a completed PAQ-A.

The findings from this study have been organized and examined by research question. Tables and figures have been implemented to illuminate the researcher's quantitative data in the most effectual manner. Chapter four closes with an inclusive summary of the quantitative results.

Findings

Research question 1, 'To what extent is there a relationship between Alabama Physical Fitness Assessment (APFA) scores and Explore test scores among eighth- grade students?' and research question 3, 'To what extent is there a relationship between physical activity levels (both objective and subjective measures) and Explore test scores among eighth grade students?' were initially analyzed. Data were collected based on 48 students' physical activity data, APFA score results, and Explore results. Prior to the statistical analysis, 12 participants were removed from the study. These participants were excluded due to lack of required data, lost or missing device necessary for data analysis, or according to wear time validation settings. Wear time validation, analyzed through ActiLife accelerometer software, shadowed recommended settings from Choi (2011) where a non-wear period included a minimum length of 90 minutes, a small window length of 30 minutes, and a spike tolerance of 2 minutes. A valid day consisted of a minimum of 500 minutes per day of monitor wear; while periods of zero cpm over 90 minutes were removed as they were considered non-wear time (Decelis et al., 2014; Hallal et al., 2013; Saint-Maurice et al., 2014). Exclusion depictions are shown in table 4.1. Participants' mean age was 13.75 years and, out of the 36 participants, 62% qualified for free lunch based on their family income level.

Table 4.1

Participant Exclusion Depictions

Participant Number	Reasoning
3	Wear Time Validation
7	Wear Time Validation
11	Unable to retrieve accelerometer data
18	Participant request
19	Wear Time Validation
21	No Explore Scores
24	Band student, no APFA scores
37	Lost device
39	Damaged device
45	Band student, no APFA scores
46	Lack of battery life to retrieve data
48	Lost device

Participant physical fitness was measured using the APFA and the results for the sample population can be seen in Table 4.2. Continuous score results from each APFA fitness component, except flexibility, were categorized into three health-related fitness zones: Needs Improvement Zone (N), Healthy Fitness Zone (H), and High Fitness Zone (HFZ) (APFA, 2011). According to APFA scoring regulations, flexibility scores were recorded in the needs improvement or healthy fitness zones only.

Table 4.2

APFA Score Results

Fitness Zone	Cardiovascular Fitness (PACER)		Flexibility		Abdominal Strength		Muscular Strength	
	Male	Female	Male	Female	Male	Female	Male	Female
Mean	33.41	22.19	27.53	38.08	65.41	52.73	19.71	14.88
N	70.6%	53.8%	11.8%	0%	17.6%	19.2%	29.4%	34.6%
H	23.5%	42.3%	88.2%	100%	0%	15.4%	52.9%	46.2%
HFZ	5.9%	3.8%	NA	NA	82.4%	65.4%	17.6%	19.2%

To evaluate participant physical activity and address research question three, data were collected using both objective and subjective measures. Objective physical activity data were collected from ActiGraph accelerometers using ActiLife software. ActiGraph accelerometer data can be seen in Table 4.3.

Table 4.3

Average Length of Time Spent in Each Physical Activity Category (in minutes)

	Sedentary	Light	Moderate	Vigorous	Total MVPA	% in MVPA	Avg. MVPA per day
Male	5718.7	1282.8	184.3	85.7	270.0	3.7%	40.0
Female	5291.4	1006.7	130.3	60.6	190.9	3.2%	30.5
Overall	5477.6	1127.0	153.9	71.5	225.4	3.4%	34.6

Subjective physical activity was reported through the PAQ-A, a self-administered questionnaire used to evaluate physical activity of adolescents through a seven-day physical activity recall (Saint-Maurice et al., 2014). The questionnaire, only to be used during the school year, contained nine items (only eight assessed) that asked participants to check a list of activities for frequency of participation on a 5-point Likert scale ranging from *low physical activity* to *high physical activity* (Saint-Maurice et al., 2014). The average of all eight items constituted the PAQ-A summary score (Saint-Maurice et al., 2014). A larger PAQ-A number, near four or five, represented increased physical activity intensity or duration, while a number closer to 1 or 2 represented low physical activity intensity or duration. Results from the PAQ-A are shown in Table 4.4. The researcher gathered information from the questionaire on the type and context of physical activity performed over the previous seven days, whereas strictly objective data does not explain.

Table 4.4

PAQ-A Results

PAQ-A Item	Male	Female	Overall
PA in spare time	1.56	1.60	1.58
PA during PE	4.14	4.52	4.35
PA at lunch	1.24	1.24	1.24
PA after school	3.33	2.64	2.96
PA in the evening	3.43	2.72	3.04
PA over the weekend	3.10	2.80	2.93
Overall PA	2.86	2.84	2.85
PA per day	3.20	3.12	3.16

The data (N = 36) were analyzed through simultaneous multiple regression analysis exhibited using Path Analysis. Reading and math achievement served as the endogenous variables for the path diagram. The mediating variables, variables that give and receive effects, included the four APFA components (cardiovascular fitness, muscular strength, abdominal strength, flexibility) and both objective and subjective physical activity data. Gender and socioeconomic status entered the path diagram as exogenous variables. The results were analyzed using α= .05. Prior to the analysis, the data were examined for model assumptions – independence, homoscedasticity, normality, linearity and noncollinearity. The results indicated that all model assumptions were satisfied.

Three stages of path analysis were used in the study. The first stage of path analysis examined the effect of students' gender and socioeconomic status (SES) on cardiovascular fitness (CV fitness), muscular strength, abdominal strength, flexibility, physical activity (accelerometer) data, and PAQ-A summary data. The second stage of path analysis examined the individual effect of students' CV fitness, muscular strength, abdominal strength, flexibility, physical activity (accelerometer) data, and PAQ-A summary data on each other. This resulted in six path analysis stages of regression analysis. Lastly, the third stage examined the effect of students' gender, socioeconomic status (SES), CV fitness, muscular strength, abdominal strength, flexibility, physical activity (accelerometer) data, and PAQ-A summary data on math achievement, then on reading achievement.

The correlation matrix of the relationship between each variable included in the study can be seen in Table 4.5. The following variables showed a significant relationship with one another: AB strength and CV fitness, Muscular strength and CV fitness, Muscular strength and AB Strength, PA and AB Strength, Gender and both CV fitness and Flexibility, PAQ-A and PA, Gender and PAQ-A, and Math and Reading Achievement.

Table 4.5

Correlation Matrix

	SES	CV Fitness	Flexibility	AB Strength	Muscular Strength	Physical Activity	PAQ-A	Gender	Math Scores	Reading Scores
SES	1.00									
CV Fitness	.55	1.00								
Flexibility	.73	.14	1.00							
AB Strength	.94	.45**	.28	1.00						
Muscular Strength	.99	.66**	.07	.37*	1.00					
Physical Activity	.613	.31	.15	.37*	.03	1.00				
PAQ-A	.03	.11	.08	.01	.08	.54**	1.00			
Gender	.22	.41*	.62**	.19	.23	.23	.26	1.00		
Math Scores	.54	.18	.00	.12	.25	.05	.00	.04	1.00	
Reading Scores	.17	.17	.25	.13	.13	.07	.08	.02	.54**	1.00

**Correlation is significant at the 0.01 level
*Correlation is significant at the .05 level

Results of the stage one path analysis showed $R^2_{CVFIT} = .17$; $F_{2,31} = 3.19$, $p = .05$. The combined variables, SES and gender, could account for 17% of the variance in CV fitness, which was statistically significant. The results could be represented with this equation: CV fitness = .02(SES) + .41(gender). The effect of gender to CV fitness was statistically significant. For every one standard unit increase in gender, there was a .41 standard unit increase in CV fitness, when holding SES constant. Therefore, the effect of the independent variables on gender differed based on which level of the moderator variable (gender) held; males in the study were coded as (1) and females as (2). The effect of SES was not significant.

Additional results of the stage one path analysis showed $R^2_{FLEXIBILITY} = .384$; $F_{2,31} = 9.65$, $p = .001$. The combined variables, SES and gender, could explain 38% of the variance in flexibility, which was statistically significant. The results could be represented with this equation: Flexibility = .08(SES) + .63(Gender). The effect of gender on flexibility was statistically significant. For every one standard unit increase in gender, there was a .63 standard unit increase in flexibility, when holding SES constant. The effect of SES and gender on the additional mediating variables (Ab Strength, Muscular Strength, PA, and PAQ-A) was not significant. Statistics for each variable in Stage 1 are displayed in Table 4.6.

Table 4.6

Path Analysis Stage 1: Results

Exogenous Variable	Mediating Variable	β	*t*	*p*
SES	CV Fitness	.02	.10	.92
	Flexibility	.08	.53	.60
	AB Strength	.03	.17	.87
	Muscular Strength	.05	.28	.78
	PA	.03	.18	.86
	PAQ-A	.03	.17	.87
Gender	CV Fitness	.41	2.44	.02*
	Flexibility	.63	4.37	.00**
	Ab Strength	.20	1.11	.28
	Muscular Strength	.24	1.37	.18
	PA	.03	1.48	.15
	PAQ-A	.27	1.51	.14

**Correlation is significant at the 0.01 level
*Correlation is significant at the .05 level

Results from stage two of the path analysis showed $R^2_{CVFIT} = .54$; $F_{5,28} = 6.50$, $p < .001$. Flexibility, AB strength, muscular strength, PA, and PAQ-A could explain 54% of the variance in CV fitness, which was statistically significant. The results could be represented with this equation: CV fitness = .032(flexibility) + -.092(AB strength) + .619(muscular strength) + .316(PA) + .114(PAQ-A). The effect of muscular strength was statistically significant. For every one standard unit increase in muscular strength, there was a .619 standard unit increase in CV fitness, when holding all other variables constant. The effects of flexibility, AB strength, PA, and PAQ-A were not significant.

Results of the stage two path analysis also showed $R^2_{ABSTRENGTH} = .38$; $F_{5,28} = 3.50$, $p < .05$ The variables, CV fitness, flexibility, muscular strength, PA, and PAQ-A, could explain 38% of the variance in AB strength, which was statistically significant. The results could be represented with this equation: AB strength = .123(CV fitness) + .197(flexibility) + .290 (muscular strength) + .451 (PA) + .288(PAQ-A). The effect of PA to AB strength was statistically significant. For every one standard unit increase in PA, there was a .451 standard unit increase in AB strength, when holding all other variables constant. The effects of CV fitness, flexibility, muscular strength, and PAQ-A were not significant.

Results of the stage two path analysis also showed $R^2_{MUSC.STRENGTH} = .51$; $F_{5,28} = 5.93$, $p = .001$ The variables, CV fitness, flexibility, AB strength, PA, and PAQ-A, could explain 51% of the variance in muscular strength, which was statistically significant. The results could be represented with this equation: muscular strength = .650(CV fitness) + .048(flexibility) + .229 (AB strength) + .364(PA) + .207(PAQ-A). The effects of CV fitness and PA to muscular strength were statistically significant. For every one standard unit increase in CV fitness, there was a .650 standard unit increase in muscular strength, when holding all other variables constant. For every one standard unit increase in PA, there was a .364 standard unit increase in muscular strength, when holding all other variables constant. The effects of flexibility, AB strength, and PAQ-A were not significant.

Additionally, results of stage two path analysis showed $R^2_{PA} = .51$; $F_{5,28} = 5.80$, $p = .001$. The variables, CV fitness, flexibility, AB strength, muscular strength, and PAQ-A, could explain 51% of the variance in PA, which was statistically significant. The results could be represented with this equation: PA = .336(CV fitness) + .013(flexibility) + .360(AB strength) +.368(muscular strength) + .527(PAQ-A). The effects of CV fitness, AB strength, and PAQ-A to PA were statistically significant. For every one standard unit increase in CV fitness, there was a .336 standard unit increase in PA, when holding all other variables constant. For every one standard unit increase in AB strength, there was a .360 standard unit increase in PA, when holding all other variables constant. For every one standard unit increase in PAQ-A, there was a .527 standard unit increase in PA, when holding all other variables constant. The effects of flexibility and muscular strength to PA were not significant.

Results of the final portion of stage two path analysis showed $R^2_{PAQ\text{-}A} = .370$; $F_{5,28} = 3.29$, $p < .05$. The variables, CV fitness, flexibility, AB strength, muscular strength, and PA, could explain 37% of the variance in PAQ-A, which was statistically significant. The results could be represented with this equation: PAQ-A = .156(CV fitness) + .064(flexibility) + .294(AB strength) +.268(muscular strength) + .676(PA). The effect of PA to PAQ-A was statistically significant. For every one standard unit increase in PA, there was a .676 standard unit increase in PAQ-A, when holding all other variables constant. The effects of CV fitness, flexibility, AB strength, and muscular strength to PA were not significant. Table 4.7 shows the results of stage 2 of the path analysis.

Table 4.7

Path Analysis Stage 2: Results

Mediating Variable	Mediating Variable	β	*t*	*p*
Flexibility	CV Fitness	.032	.238	.813
Ab Strength		.092	.565	.576
Muscular Strength		.619	4.341	.000**
PA		.316	1.823	.079
PAQ-A		.114	.713	.482
CV Fitness	Flexibility	.063	.238	.813
Ab Strength		.292	1.309	.201
Muscular Strength		.091	.352	.727
PA		.025	.097	.924
PAQ-A		.093	.411	.684
CV Fitness	AB Strength	.123	.565	.576
Flexibility		.197	1.309	.201
Muscular Strength		.290	1.413	.169
PA		.451	2.327	.027*
PAQ-A		.288	1.610	.119
CV Fitness	Muscular Strength	.650	4.341	.000***
Flexibility		.048	.352	.727
Ab Strength		.229	1.413	.169
PA		.364	2.081	.047
PAQ-A		.207	1.281	.211
CV Fitness	PA	.336	1.823	.079
Flexibility		.013	.097	.924
AB Strength		.360	2.327	.027*
Muscular Strength		.368	2.081	.047*
PAQ-A		.527	3.940	.000***
CV Fitness	PAQ-A	.156	.713	.482
Flexibility		.064	.411	.684
AB Strength		.294	1.610	.119
Muscular Strength		.268	1.281	.211
PA		.676	3.940	.000***

***Correlation is significant at the .001 level
**Correlation is significant at the 0.01 level
*Correlation is significant at the .05 level

Results of the stage three path analysis showed $R^2_{MATH} = .08$; $F_{8,25} = .268$, $p = .971$. The effects of CV fitness, flexibility, AB strength, muscular strength, PA, and PAQ-A were not statistically significant in the model. Similarly, results of the stage three path analysis showed

$R^2_{READING} = .21$; $F_{8,25} = .85$, $p = .568$. The effects of CV fitness, flexibility, AB strength, muscular strength, PA, and PAQ-A were not statistically significant in the model.

To answer research question two and determine the extent to which body composition and academic achievement are related, BMI levels and Explore test results were analyzed on 47 students. Participant BMI groups are identified in Table 4.8.

Table 4.8

BMI Results

	Normal Weight (N = 25)		Over Weight (N = 12)		Obese (N = 10)	
Overall	53.2%		25.5%		21.3%	
	Male	Female	Male	Female	Male	Female
Overall	36%	64%	42%	58%	50%	50%
Caucasian	67%	81%	60%	86%	80%	100%
African American	33%	13%	40%	14%	0%	0%
Hispanic	0%	6%	0%	0%	20%	0%

A One-Way MANOVA was conducted to examine the differences between the three groups (normal weight, overweight, obese) on the two dependent variables (reading achievement, math achievement). A fourth BMI Level, underweight, was eliminated, as there were no students classified as underweight in the study.

Prior to the analysis, the data were examined for univariate and multivariate outliers as well as multivariate normality and homogeneity of the variance/covariance matrix. First, the data were examined for missing values, outliers, and normality for each group. The assumption of normality was examined through histograms, the evaluation of kurtosis, skewness and, more formally, through the Shapiro-Wilk test. Multivariate outlier analysis was analyzed separately for each group on the combined dependent variables using Mahalnobis Distance test. Data were further tested for equality of the covariance matrix through Bartlett's Test, or Box's M.

The two primary dependent variables of interest in this study (reading achievement and math achievement) were examined for their compliance with the assumptions underlying the multivariate analysis to be conducted. All variables were examined separately for BMI group: normal weight (N=25), overweight (N=12), and obese (N=10). The evaluation of missing values for the grouped data revealed no missing values. Based on the absence of a missing value, it was determined that group membership did not have a material impact on the likelihood of responding to the variables. Univariate outliers were examined within each group. The results revealed no outliers for any group on either variable (all $z < 3.30$). No multiple outliers for any group were found; therefore, it was determined that transformation of variables would not be necessary. The assumption of normality was examined through histograms, the evaluation of kurtosis, skewness, and more formally, through the Shapiro-Wilk test.

For the normal weight group, the histogram revealed that the variable math achievement approximated a normal distribution with skewness (Sk = .598) and kurtosis (K= 1.346) values. The Shapiro-Wilk test for normality indicated that normality was upheld for this variable ($p > .025$). The histogram revealed that the variable math achievement approximated a normal distribution, although peaked. Although variable reading achievement approximated a slightly skewed (Sk = .981) and peaked distribution (K= 2.404), the Shapiro-Wilk test for normality indicated that normality was upheld for this variable ($p > .025$).

For the overweight group, the histogram revealed that the variable math achievement approximated a normal distribution (Sk = .017) and kurtosis (K= 1.603). The Shapiro-Wilk test for normality indicated that normality was upheld for this variable. The histogram revealed that the variable reading achievement approximated a normal distribution and skewness (*Sk* = .834) and kurtosis (*K*= .224) were well within acceptable limits. The Shapiro-Wilk test for normality indicated that normality was upheld for this variable ($p > .025$).

For the obese group, the histogram revealed that the variable math achievement approximated a normal distribution and skewness (*Sk* = 1.572) and kurtosis (*K*= 4.348) were not within acceptable limits (< 1.0). The Shapiro-Wilk test for normality indicated that normality was upheld for this variable. The histogram revealed that the variable reading achievement approximated a normal distribution and skewness (*Sk* = .169) and kurtosis (*K*= 1.277) were well within acceptable limits. The Shapiro-Wilk test for normality indicated that normality was upheld for this variable ($p > .025$). Academic achievement outcomes according to BMI group can be seen in Table 4.9.

Table 4.9

BMI Academic Achievement Outcomes

BMI Group	Mean Reading Achievement	Mean Math Achievement
Normal Weight	14.560 ± 3.110	14.480 ± 2.960
Overweight	14.583 ± 4.757	14.000 ± 3.357
Obese	14.100 ± 3.414	15.300 ± 2.584
Total	14.468 ± 3.574	14.532 ± 2.962

Multivariate outlier analysis was analyzed separately for the three groups on the combined dependent variables. Mahalnobis distance revealed that there was no outlier that needed to be removed. All values were within acceptable limits ($\chi^2 < 13.816$). Box's test did support the equality of covariance matrix between the groups, multivariate $F_{(6,\ 8791.435)} = .864$, $p = .521$.

The results of the one-way MANOVA were analyzed at $\alpha = .05$ and revealed $\lambda = .953$, $F_{(4,86)} = .519$, $p = .722$; $\eta^2 = .047$. Based on these results, there was not a statistical difference between the three group means on the combination of dependent variables. In addition, 5.2% of the variance in this combined dependent variable was attributed to group membership. Post Hoc procedures were not necessary as there were no significant differences among group means.

Summary

Data were collected based on 48 students' physical activity data, APFA score results, and Explore results to answer Research Questions 1 and 3. These data were used to determine the extent to which physical fitness, physical activity, and academic achievement may be related. The data were analyzed through a type of Structural Equation Modeling known as Path Analysis through multiple regression analyses. Reading and math achievement served as the endogenous variables for the path diagram. The mediating variables included the four APFA components (cardiovascular fitness, muscular strength, abdominal strength, flexibility) and both objective and subjective physical activity data. Accelerometer data recorded objective physical activity, while the PAQ-A was used to measure subjective physical activity. Gender and socioeconomic status entered the path diagram as exogenous variables.

During the initial stage of the path analysis, the researcher found SES and gender could account for 17% of the variance in CV fitness and 38% of the variance in flexibility, which was statistically significant. When analyzed further, the individual effect of gender to CV fitness was statistically significant, while the effect of SES was not. Likewise, the effect of gender on flexibility was statistically significant, while SES was not. Neither gender nor SES had a statistically significant impact on AB Strength, Muscular Strength, PA, and PAQ-A.

The researcher found that CV fitness, flexibility, muscular strength, PA, and PAQ-A could explain 38% of the variance in AB strength, which was statistically significant. The effect of PA to AB strength was statistically significant, while the effects of CV fitness, flexibility, muscular strength, and PAQ-A were not. In addition, CV fitness, flexibility, AB strength, PA, and PAQ-A could explain 51% of the variance in muscular strength, which was statistically significant. The effects of CV fitness and PA to muscular strength were statistically significant, while the effects of flexibility, AB strength, and PAQ-A were not. Moreover, the researcher discovered that CV fitness, flexibility, AB strength, muscular strength, and PAQ-A could explain 51% of the variance in PA with the effects of CV fitness, AB strength, and PAQ-A to PA being the only statistically significant variables. Approximately 37% of the variance in PAQ-A could be attributed to CV fitness, flexibility, AB strength, muscular strength, and PA. Only the effect of PA to PAQ-A was statistically significant.

During the final stage of the path analysis, the researcher found that the effects of CV fitness, flexibility, AB strength, muscular strength, PA, and PAQ-A were not statistically significant in the model. Similarly, the effects of CV fitness, flexibility, AB strength, muscular strength, PA, and PAQ-A were not statistically significant in the model.

To answer Research Question 2, BMI levels and Explore test results were analyzed on 47 students in order to determine the extent to which BMI classification and academic achievement were related. A One-Way MANOVA was conducted to examine the differences between the three groups (normal weight, overweight, obese) on the two dependent variables (reading achievement, math achievement). A fourth BMI Level, underweight, was eliminated, as there were no students classified as underweight in the study. Using the results stemming from the one-way MANOVA, the researcher found the group means were equal; there was no statistical difference between the three group means on the combination of dependent variables. In addition, 5.2% of the variance in this combined dependent variable was attributed to group membership.

CHAPTER FIVE: SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Introduction

In this chapter, the findings from chapter four are analyzed and discussed in the following sections: Summary of the Study, Implications, Conclusions, and Recommendations for Future Research. Within the Summary of the Study, the researcher has presented findings that either aid in proving, disproving, or changing what was stated in chapter two, Review of Literature. Based on the results, the researcher has provided insight and information to answer each research question. In the Implications section, the researcher identified practical, research, and theoretical possibilities stemming from the results of this study, as well as a discussion of what the research implies and strengths and weaknesses of the study. The researcher detailed conclusions of the study by examining how the individual results of this study function together to benefit students in Alabama, followed by recommendations for future research.

Summary of the Study

The purpose of this correlational study was to determine the extent of the relationship between physical fitness, body composition, physical activity, and academic achievement. School leaders have justified the reduced time for physical activity and physical education as they take away from classroom instruction time; yet, national assessment outcomes have indicated the condition of education in America has failed to measurably improve student achievement (NCES, 2013a, NCES, 2013b; Wittberg et al., 2010). An additional public health concern, increased sedentary lifestyles and unhealthy-weight conditions among American children and adolescents, may be the antagonist to student academic success (Blom et al., 2011; Castelli et al., 2007; 2011, CDC, 2013; Hillman et al., 2009; Ogden et al., 2012; Sabia, 2007).

The researcher incorporated a quantitative design to examine these relationships in an eighth-grade student sample from a high school in Alabama. The study contained two dependent variables, math and reading Explore scores, and nine independent variables, physical fitness results (cardiovascular fitness, flexibility, abdominal strength, and muscular strength), BMI category (healthy weight, overweight, and obese), and Physical Activity (objective and subjective measures). Data were analyzed using a form of Structural Equation Modeling known as Path Analysis to answer research questions one and three. A Multivariate Analysis of Variance (MANOVA) was used to determine the extent of the relationship between body composition and reading and math scores, research question two. Equipment used in the study included APFA results, digital weight scales, stadiometers, ActiGraph accelerometers, PAQ-A, and Explore reading and math test results. Data collection procedures included receiving Explore test scores from the junior high counselor when the test results were returned to the school, receiving APFA scores, height, and weight measures from the physical education teacher, downloading accelerometer device data from the participants at the conclusion of their seven days of wear time, and a completed PAQ-A. The researcher implemented the following research questions in order to guide the study:

1. To what extent is there a relationship between Alabama Physical Fitness Assessment (APFA) scores and Explore test scores among eighth grade students?
2. To what extent is there a relationship among BMI classifications (underweight, normal weight, overweight, and obese) and Explore test scores among eighth grade students?
3. To what extent is there a relationship between physical activity levels (both objective and subjective measures) and Explore test scores among eighth grade students?

The ACT Explore test, based on the ACT College Readiness Standards and Common Core State Standards, was comprised of four major assessments: English, mathematics, reading, and science. Scores for each test ranged from one to 25 and benchmarks were given for each subject to indicate whether the student's score received was *Below*, *At*, or *Above* the benchmark. Explore benchmarks for eighth-grade were: English-13, Math-17, Reading-16, and Science-18. The overall mean for the reading assessment among the participants in this study was 14.47. This mean was below the Explore benchmark of 16 for the eighth-grade reading assessment. The overall mean for the math assessment among the participants in this study was 14.53. This mean was also below the Explore benchmark of 17 for the eighth-grade the math assessment. These findings corroborate academic achievement assessments that have indicated Alabama eighth graders consistently lag behind their national and international peers. Scores on the 2013 NAEP, the nation's educational report card, revealed that 75% of Alabama eighth graders scored below the proficient level in reading with a score that was also below the national average (NCES, 2013b). Moreover, approximately 80% of Alabama's eighth-grade students scored at or below the basic level for mathematics and, out of the 50 states and the District of Columbia, Alabama's eighth- grade students' mathematics score ranked at the lowermost end at number 50 (NCES, 2013b). Eighth-grade students in Alabama have not shown gains on the mathematics or reading portion of the NAEP since 2007 (NCES, 2013b). Similarly, in 2011, Alabama eighth- graders scored below both the U.S. national average and Trends in International Mathematics and Science Study (TIMSS) scale score average in mathematics (Aud et al., 2013, Provasnik et al., 2012).

Research Question 1: Physical Fitness and Academic Achievement

Participant physical fitness was measured using the APFA and body composition. The APFA was used to systematically evaluated student health and fitness by focusing on aerobic cardiovascular endurance, muscular strength and endurance, abdominal strength and endurance, and flexibility (APFA, 2011). Continuous score results from each APFA fitness component, except flexibility, were categorized into three health-related fitness zones: Needs Improvement

Zone (N), Healthy Fitness Zone (H), and High Fitness Zone (HFZ) (APFA, 2011). The researcher found on the cardiovascular fitness portion of the APFA approximately 71% of males and 54% of females in the study performed in the needs improvement category. The majority of the participants scored within the healthy range of the flexibility, abdominal strength, and muscular strength portions of the APFA.

After analyzing the results stemming from the path analysis (simultaneous multiple regression analysis), the researcher discovered that gender could account for 17% of the variance in cardiovascular fitness. The researcher also concluded that gender could account for 38% of the variance on the participants' flexibility. Specifically, female participants had increased cardiovascular fitness and flexibility measures than male participants in the study.

Research Question 2: Body Composition and Academic Achievement

To evaluate participant body composition and identify their BMI category, weight (measured to the nearest pound), standing height (measured to the nearest centimeter), and seated height (measured to the nearest centimeter) were collected. The researcher chose to implement seated height measurements instead of standing height in an attempt to improve the accuracy of participant body composition results. Researchers Abou-Hussein, Abela, and Savona-Ventura (2011), stated, " using the standing height alone to calculate the BMI may overestimate or underestimate the number of individuals that are overweight and obese" (p. 242). Examining participant body composition results, the researcher found that approximately 46% of the participants in this study were categorized as either overweight or obese. The researcher additionally found that the majority of participants in the overweight category were female (58%), while the participants in the obese category were evenly distributed among males and females.

The physical fitness results stemming from this study correlate to national health assessments, such as the National Health and Nutrition Examination Survey (NHANES) and the National Survey of Children's Health (NSCH). Researchers with the 2011 NHANES found that approximately 32% of children 2 to 19 years old were overweight or obese with nearly 17% of those students categorized specifically as obese. Researchers conducting the 2011 NSCH found that 7 out of the 10 states with the highest childhood obesity rates were in the South (National Survey of Children's Health [NSCH] (2011). Additionally, researchers of the CDC's Youth Risk Behavior Surveillance System (YRBSS) found 13% of high school students were obese and 15% were overweight in 2011 (CDC, 2012). The 2011 YRBSS also revealed student Alabama students' obesity levels were highest in the nation and their overweight prevalence was higher than the median (CDC, 2012).

The researcher additionally discovered the majority of participants that were either overweight or obese were female, 55%, while 45% were male; contrasting the 2011 YRBSS findings that revealed approximately 10% of high school females and 16% of high school males were obese. The prevalence of obesity was more than double for Caucasian and Hispanic males as compared to Caucasian and Hispanic females on the YRBSS, while the opposite was true for this study, as the researcher found a higher prevalence of obesity in Caucasian females and Hispanic males. Additionally, researchers with the 2011 YRBSS found the prevalence of obesity to be higher among African American females than African American males, although in this study African American males had a higher overweight prevalence than females (CDC, 2012). There were no African American male participants in the obese category in this study.

Research Question 3: Physical Activity and Academic Achievement

To evaluate participant physical activity and address research question three, data were collected using both objective and subjective measures. Objective physical activity data were collected from ActiGraph accelerometers using ActiLife software. According to researchers, accelerometry is presumed to be the most objective measure of gross body movement in physical activity research (Ekelund, Tomkinson, & Armstrong, 2011; Hallal et al., 2013; Saint-Maurice, Welk, Beyler, Bartee, & Heelan, 2014). After examining accelerometer data, the researcher found that the average length of time spent in each physical activity category decreased for males and females as the intensity of the activity increased (from sedentary to vigorous). Overall, participants spent more time in sedentary activities than light, moderate, and vigorous activities combined. Male participants spent 3.7% of time in MVPA while female participants spent 3.2% of their time in MVPA. Additionally, male participants spent approximately 40 minutes per day in MVPA while females spent approximately 31 minutes per day in MVPA. Both male and female participants fell below the federal government-issued physical activity guidelines of 60 minutes or more of physical activity daily (Borrud, Chiappa, Burt, et al., 2014; USDHHS, 2008). Authorities of the Alabama State Department of Education and the CDC indicated that Alabama youth were inactive when compared to other states (APFA, 2011, p. 2). This researcher found corroborating data.

After analyzing the results stemming from the path analysis (simultaneous multiple regression analysis), the researcher discovered the effects of increased participant cardiovascular fitness and objective physical activity, statistically increased participant muscular strength. Participants with increased objective physical activity data had statistically significant increased on abdominal strength.

Subjective physical activity was gathered through the PAQ-A, a 7-day physical activity recall formulated for adolescents. According to Biddle, Gorely, Pearson, and Bull (2011) the PAQ-A was one of the most suitable self-report measures found in their systematic review of self-reported physical activity instruments. Biddle et al. (2011) describe the PAQ-A as “simple to complete, well used, and time efficient” (p. 7). There are eight items on the questionnaire and each item is either given a 5-point Likert scale for responses multiple response options for the participant to identify their physical activity, their overall intensity, and duration from their previous seven days.

Item 1 of the PAQ-A instructed the participants to identify which physical activity they participated in during their spare time in the past seven days. The questionnaire listed skipping, rowing/canoeing, in-line skating, tag, walking for exercise, bicycling, jogging or running, aerobics, swimming, baseball, softball, dance, football, badminton, skateboarding, soccer, street hockey, volleyball, floor hockey, basketball, ice skating, cross-country skiing, ice hockey/ringette, and other as physical activity options. Males and females reported similar responses of approximately 1.6 out of 5, a low physical activity score. This score indicated the participants engaged in only a selected number of the activities approximately one to two times in the previous seven days. Item 2 of the PAQ-A instructed participants to indicate, in the previous 7 days, during their physical education (PE) classes, how often were they very active (playing hard, running, jumping, throwing). Their answer choices ranged from 0 (I don’t do PE) to 5 (Always). Male participants reported a mean score of 4.14 and females reported a similar mean score of 4.52. Item 2 had the highest male, female, and overall mean score on the PAQ-A.

Item 3 instructed participants to indicate, in the previous seven days, what they normally did at lunch (besides eating lunch). Their answer choices ranged from 0 (sat down: talking, reading, doing schoolwork) to 5 (ran and played hard most of the time). Male and female participants reported the same mean score of 1.24, indicating they mostly sat down and stood around/walked some. Item 4 instructed participants to show in the previous seven days, on how many days *right after school*, did they do sports, dance, or play games in which they were very active? Answer choices ranged from 0 (none) to 5 (5 times last week). Male participants reported a mean score of 3.33, while female participants reported a mean score of 2.64.

Item 5 instructed participants to indicate, in the last seven days, on how many *evenings* did they do sports, dance, or play games in which they were very active. Answer choices ranged from 0 (none) to 5 (6 or 7 times last week). Male participants reported a mean score of 3.43, while female participants reported a mean score of 2.72. Item 6 instructed participants to indicate *on the last weekend*, how many times did they do sports, dance, or play games in which they were very active? Answer choices ranged from 0 (none) to 5 (6 or more times). Male participants reported a mean score of 3.10, while female participants reported a mean score of 2.80.

Item 7 instructed participants to indicate which *one* of the following described them best for the last seven days. Answer choices were: 'All or most of my free time was spent doing things that involve little physical effort,''I sometimes (1 - 2 times last week) did physical things in my free time (e.g., played sports, went running, swimming, bike riding, did aerobics),' 'I often (3 - 4 times last week) did physical things in my free time,' 'I quite often (5 - 6 times last week) did physical things in my free time,' and 'I very often (7 or more times last week) did physical things in my free time.' Male and female participants responded with a similar mean score of 2.85, a medium frequency value.

Item 8 instructed participants to mark how often they did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day in the previous week. Answer choices ranged from 0 (none) to 5 (very often) for each day of the week. Male participants reported a mean score of 3.20, while female participants reported a mean score of

3.12. Item 9, not included on the PAQ-A summary score, asked participants (yes or no) if they were sick during the previous week, or if anything prevented them from doing their normal physical activities. No participant responded ‘yes’ to item 9.

The researcher found the self-reported physical activity measures stemming from the PAQ-A corroborated with the 2011 YRBSS. Researchers with the 2011 YRBSS reported that students in the state of Alabama self-reported that 17% (23% of females and 12% of males) did not participate in at least 60 minutes of physical activity on any day during the seven days before the survey (CDC, 2013).

After analyzing the results stemming from the path analysis (simultaneous multiple regression analysis), the researcher discovered that increased abdominal strength and subjective physical activity measures were statistically significant in their relation to objective physical activity measures. Similarly, subjective physical activity was the only statistically significant predictor of objective physical activity measures, highlighting the ability for adolescents to adequately self-report their physical activity intensity and duration. Results from the PAQ-A were statistically significant to physical activity levels measured by the accelerometer. The researcher was able to substantiate research findings stating the PAQ-A has been shown to exhibit consistent validity even when compared to direct measures of physical activity, such as the doubly labeled water (Biddle et al., 2011).

Implications

In this section, the researcher describes what could happen as a result of this study and discussed the implications of the research. Theoretical and practical implications are described, as well as the strengths and weaknesses of the research study.

Theoretical Implications

Advocates of the Achievement Goal Theory (AGT), the theoretical framework upon which this study was built, suggested that individuals, motivated by psychological needs, determine personal goals in achievement settings, such as school and sports, as they believe goals have a purpose (Soares, Lemos, & Almeida, 2005; Weinberg & Gould, 2003). Individuals are motivated to accomplish their goals according to preconceived notions of the effort and ability necessary to achieve the goal. According to supporters of the AGT, increasing student motivation towards a physically fit and healthy lifestyle may result in the combination of mastery and performance goal orientations (Gao, Lodewyk, & Zhang, 2009). In support of this theory, Taras (2005) found that when children engage in physical activities that promote cooperation, sharing, and learning to follow rules, they are able to transfer these skills into the classroom. Researchers (Oketayo et al. 2010) stated that high levels of physical fitness were significantly associated with better school attendance, fewer disciplinary incidents and better academic performance. Although researchers have indicated improved cognitive performance among adolescents with higher levels of physical fitness, this researcher could not support the literature nor uphold the theory (Blom et al., 2011; Castelli, et al., 2007; Chomitz et al., 2009; Santiago et al., 2013). Results of the current study did not significantly relate increased physical fitness to academic achievement; therefore, student motivation toward a physically fit and healthy lifestyle may not always carry over in the classroom setting and vice versa.

According to backers of the AGT, students could be encouraged to become physically fit through teacher incentives and learning the importance of maintaining a healthy lifestyle. Consistent with AGT, researchers Aberg et al. (2009) revealed the significant relationship between fitness and cognition was not due to family or genetic factors, but primarily caused by environmental factors. Contrasting this theory, this researcher could not pinpoint significant associations between socioeconomic status and academic achievement; however, Blom et al. (2011) discovered that gender, race, socioeconomic status, and physical fitness were all significantly related to academic achievement, specifically, females, high socioeconomic status, and increased number of healthy fitness zones achieved were all predictors of increased academic achievement. In addition, Blom et al. (2011) found that students with low socioeconomic status and students with few healthy fitness zones achieved were more likely to be absent eight or more times than their peers while boys and students with low socioeconomic status were twice as likely to receive disciplinary action than their peers. In conjunction with the AGT, Aberg et al. (2009) and Blom et al. (2011) identified cooperating factors that have the ability to veer a student toward academic success or failure and the effect physical fitness had on both.

AGT researchers have also suggested that highly cognitive tasks are necessary to maintain the interests and consequently, the performance, of students in academic courses and physical activities. Exploring this theory, Best (2012) examined the immediate effects of physical activity on children's executive functioning by implementing physical activity (PA) tasks that required cognitive engagement versus repetitive tasks, such as treadmill walking or cycling. Best (2012) utilized *Exergames*, videogames that stimulated a physically active gaming experience (Best, 2012). Contrasting AGT, Best (2012) demonstrated compelling evidence that physical activity can immediately enhance executive functions through exercise, without the need for cognitive engagement. Consistent with Donnelly et al. (2009) and Vazou et al. (2012), Best (2012) successfully evidenced that physical activities have the ability to stimulate executive functions to improve student cognition, engagement, and behavior.

In addition, upholders of the AGT posit that goals focused on achievement activities expand student competency and that through mastery involvement, not performance, students exhibit increased intrinsic motivation. Implications resulting from this theory are supported by the positive effects Best (2012) found between PA and interference scores. Best (2012) determined that physical activity increased the participant's persistence, an indication of increased intrinsic motivation, to visuospatial conflict (Best, 2012, p. 1507). Consistent with Vazou et al. (2012), the noteworthy increase in physical activity frequency, especially on the weekends, may indicate increased intrinsic motivation and competence for physical activities. The researcher revealed physical activity results due to objective and subjective, hat most participants in the study had increased physical activity during their PE class and spent most of their weekend in sedentary activities. This may be due to lack of participant intrinsic motivation to be physically active in their spare time. Likewise, this lack of intrinsic motivation may also explain the lack of academic motivation, as evidenced by consistent low achievement scores. As promoters of the AGT suggest, motivation and the desire to learn are necessary for achievement goal setting. Accordingly, increased physical activity and physical fitness may provide the motivation for those who are not academically motivated (Xiang et al., 2004).

Practical Implications

As a result of critical findings during this study, the researchers discerned further evidence highlighting the importance of daily physical activity and physical education in the health and well- being of school-aged children. Researchers highlight the momentous need for improved PE guidelines and programs, especially in the south. Those of particular importance in aiding children to meet physical activity guidelines and maintain a healthy lifestyle into adulthood, such as parents, educators, school health officials, and policy makers should be informed of the vital need for MVPA at home and in schools. As investigators revealed, schools provide an ideal place for prevention and/or intervention as students spend most of their waking hours at school and receive the bulk of their physical activity from PE. Continued support for increased physical activity involvement and the promotion of physical education classes is vital to combating the growing tendency among modern societies for children to participate in sedentary activities, further increasing their risk for cardiovascular diseases. Physical education is key in providing society with future generations of healthy individuals. After identifying the sustainability of positive effects stemming from increased levels of physical activity, Donnelly et al. (2009) affirmed the evidence gained from this study has the potential to "profoundly impact school administration and teachers and their perception of PA in the classroom" (Donnelly et al., 2009, p. 340).

Strengths and Weaknesses

One of the strengths of the study included the researcher's ability to identify relationships between objective and subjective measures of physical activity. After analyzing the results derived from the path analysis, the researcher discovered that increased abdominal strength and subjective physical activity measures were statistically significant in their relation to objective physical activity measures. Similarly, subjective physical activity was the only statistically significant predictor of objective physical activity measures. Results from the PAQ-A were statistically significant to physical activity levels measured by the accelerometer. These results further validating findings by researchers who stated the PAQ-A has been shown to exhibit consistent validity. Future research investigations that involve only one measure of physical activity (objective or subjective) will be aided by the evidence that the two measures are significant predictors of one another. An additional strength of the study is the evidence connecting gender to cardiovascular fitness and flexibility, specifically among females.

This researcher also pinpointed the inability for increased physical activity to hinder academic achievement, adding to the literature stating that increased physical activity does not diminish academic achievement. This is especially significant for school leaders and policy makers when faced with the decision to pull students from PE for math or reading remediation.

One weakness of the study occurred due to the small sample population. Although several students stated they wanted to be a part of the study, most never returned their permission form. This may indicate that parents did not agree to permit their child to participate in the study. Additionally, after watching their peers wear the accelerometer and hearing their complaints, many students stated they did not want the hassle of wearing the accelerometer; they were afraid they would lose the device, and/or they thought seven days was too long. Having a larger population and a more random sampling procedure could counteract negative student feedback prior to beginning the study. Due in part to the population of the school, an additional weakness in the study was its lack of diversity among participants. The school in the study was a school with a mostly White population, thus limiting the data from participants with various ethnic backgrounds.

Conclusions

Improved overall health, which in turn affects school performance and future education attainment, could result in a healthier and more successful adulthood for American students. In an effort to combat low levels of academic achievement and high levels of obesity among Alabama adolescents, the goal for this study was to identify possible correlations between the two to aid and/or lead preventative programs. Based on the literature, it was hypothesized in the original path analysis model that physical fitness and physical activity would be related to math and reading achievement; however, this was not the case. No variable in the study was found to have a statistically significant relationship with either academic achievement variable. These results may have failed to reach significance due to the study's small sample size. Comparable studies with larger sample sizes (in both the hundreds and thousands) have been found significant among physical fitness, physical activity and academic achievement.

Authorities of the USDHHS stated there is a direct correlation between physical activity and health among children and adolescents (USDHHS, 2008). For instance, children who participate in regular vigorous exercise develop strong hearts, lungs, bones, and muscles and reduce their risk for heart disease, type II diabetes, cancer, and obesity (Berg, 2010). The researcher revealed that the majority of male and female participants scored within the needs improvement category on the cardiovascular fitness portion of the APFA, an indication the participant might be at risk for health-related problems. Participants in this study had objectively-reported and self-reported amounts of physical activity less than physical activity guidelines issued by the federal government. It is critical to note the participants, male and female, reported on the PAQ-A Likert scale that they were *almost always* very active (playing hard, running, jumping) during their PE class at school. Due to the statistically significant correlation discovered between subjective and objective physical activity measures, the importance of PE classes is highlighted. This is additionally imperative, as the majority of Alabama students have been consistently identified as overweight, obese, or at risk for health-related problems. Unfortunately, physical education classes have been deemed trivial in comparison to core classes over the past decade due to budget cuts and an increased pressure to demonstrate high levels of academic achievement for all learners. The insignificant reputation PE classes have maintained is also evident as long as there is no federal law that requires American schools to provide physical education to students. Due to the lack of incentives for states or schools to offer physical education programs, school systems may freely choose to meet minimum standards and as a result, the majority of Alabama high school students were not scheduled for physical education classes and the negative health consequences are evident.

Recommendations for Future Research

Based on the results from this study, future investigations should consider sample size, using more than one school and including diverse and/or underrepresented populations, longitudinal explorations among body composition, and the implementation of common physical education guidelines and policies. Despite the vast amount of literature accompanying physical fitness and physical activity alongside improved academic achievement, the researcher was unable to report significant findings.

Based on the literature and the results of this study, the researcher recommends future investigation to track longitudinal shifts in adolescent body composition. Exploring long-term body composition alterations, or shifts, may prove more valuable than a one-time calculation of adolescent BMI. Datar and Sturm (2006) found that students, especially girls, with a shift in overweight status were most at risk of negative school outcomes than any other group of students (based on BMI groups). Moreover, students that remained in the normal weight category, over the course of four years, demonstrated superior school outcomes than students that became or remained overweight. The researchers emphasized the importance of examining data longitudinally as students that were never overweight and those students that became overweight would be categorized in the same group as they were both not overweight at the baseline, although they exhibited drastic changes in overweight status and school outcomes over the course of four years. The researchers highlighted significance in exploring the shift in body composition and school outcomes (Datar & Sturm, 2006). The body changes that encompass adolescence are constantly varying among each individual child so that a one-time calculation may miss the mark.

The researcher additionally recommends future physical activity research explore the use of total step count and/or total volume of physical activity rather than time spent in specific physical activity categories, such as MVPA. Researchers Bassett, Troiano, Mcclain, and Wolff (2015) advocate the use of accelerometers to measure total volume of physical activity as it incorporates all physical activity intensities rather than focusing only on specific categories, thus conceivably neglecting existing significant associations. Consequently, some researchers have suggested that sedentary behavior is related to risk factors for cardiovascular disease regardless of physical activity levels (Healy, Matthews, Dunstan, Winkler, & Owen, 2011; Koster et al., 2012). This research may be misleading, as the studies did not account for all physical activity intensities (Bassett et al., 2015). Had the researchers accounted for light physical activity, it is possible they would have discovered the significant role of physical activity in combatting risk factors for cardiovascular disease, as researchers have shown significant inverse associations between sedentary behavior and LPA (Bassett et al., 2015; Healy et al., 2011). Supporting this theory, Maher, Olds, Mire, and Katzmarzyk (2013) found that after accounting for all physical activity intensities, significant associations between sedentary behavior and health variables were nonexistent. An additional avenue to research could focus on the role of objectively measured inactivity and its effect on the dependent variables.

Lastly, further research studies are recommended that aid in endorsing a positive and constructive social change towards improved physical education programs. Research that strengthens the push for common physical education guidelines and policies across all states is necessary to boost awareness of the importance of an active lifestyle. Cultivating efforts to improve student fitness and health fulfills the overall purpose of all schools, which is to educate students to become healthy, productive citizens who are able to make significant contributions in an ever-changing society.

References

Abel, M. G., Hannon, J. C., Sell, K., Lillie, T., Conlin, G., & Anderson, D. (2008). Validation of the Kenz Lifecorder EX and ActiGraph GT1M accelerometers for walking and running in adults. *Applied Physiology, Nutrition & Metabolism*, *33*(6), 1155-1164. doi:10.1139/H08-103 p77

Aberg, M. A., Pedersen, N. L., Toren, K., Svartengren, M., Backstrand, B., Johnsson, T., …& Kuhn, H.G. (2009). Cardiovascular fitness is associated with cognition in young adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, *106*, 20906–20911. Retrieved from http://www.pnas.org/content/early/2009/11/25/0905307106.full.pdf+html on June 3, 2014.p1,4,7,31,35,36,63,64,118

Abou-Hussein, S. S., Abela, M. M., & Savona-Ventura, C. C. (2011). Body Mass Index adjustment for sitting height for better assessment of obesity risks in Maltese women. *International Journal Of Risk & Safety In Medicine*, *23*(4), 241-248. p75,76,111

Active Living Research (2012). Increasing physical activity through recess. *Research Brief.* Retrieved from http://www.activelivingresearch.org/files/ALR_Brief_Recess.pdf

Active Living Research (2013). Do short physical activity breaks in classrooms work? Retrieved from: http://www.rwjf.org/en/research-pub-lications/find-rwjf-research/2013/02/ do-short-physical-activity-breaks-in-class-rooms-work-.html 16

Alabama Physical Fitness Assessment (APFA) 2011 p17,20,22,23,64,70,71,72,73,74,93,110

Alatupa, S., Pulkki-råback, L., Hintsanen, M., Ravaja, N., Raitakari, O.T., Telama, R., … Keltikangas-järvinen, L. (2010). School performance as a predictor of adulthood obesity: A 21-year follow-up study. *European Journal of Epidemiology, 25*(4), 267-74. doi:10.1007/s10654-010-9428-6 p39

American Alliance for Health, Physical Education, Recreation, and Dance [AAHPERD]. (2004). No child left behind forum of NCLB on Health Education, February 20 and 21, 2004. AAPHERD Headquarters. Retrieved from http://www.aahperd.org/aahperd/nclb/NCLB%Implications. P9

American Cancer Society (2012). *Cancer Facts and Figures, 2012.* Atlanta, GA: American Cancer Society. P2,7

American Heart Association [AHA]. (2006). Issue Brief – relationship between physical education and academic performance. Retrieved from http://www.americanheart.org/presenter.jhtml?identifier=3012923. P9

*American Academy of Pediatrics (2003). Policy Statement: Prevention of Pediatric

Overweight and Obesity. *Pediatrics, 112*(2), 424-430.

Ames, C. (1992). Classroom: Goals, structures, and student motivation. *Journal of Educational Psychology, 84,* 261-271.

*Andersen, L. B. (2011). Physical activity, fitness and health in children. *Scandinavian Journal of Medicine and Science in Sports, 21*, 155-156. doi: 10.1111/j.1600-0838.2011.01302.x

Anzman, S.L. & Birch, L.L. (2009). Low inhibitory control and restrictive feeding practices predict weight outcomes. *Journal of Pediatrics*, *155*(5), 651-656. P49

Aud, S., Wilkinson-Flicker, S., Kristapovich, P., Rathbun, A., Wang, X., & Zhang, J. (2013). *The Condition of Education 2013* (NCES 2013-037). U.S. Department of Education, National Center for Education Statistics. Washington, DC. Retrieved March 26, 2014 from http://nces.ed.gov/pubsearch. P2,7,9,10,11,12,13,14,16,61,64,110

*Baddeley, A. (1992). Working memory. *Science*, *255*, 556-559.

*Banich, M.T. (2009). Executive function: The search for an integrated account. *Current Directions in Psychological Science*, *18*, 89-94. doi: 10.1111/j.1467-8721.2009.01615.x

Barlow, S.E., & the Expert Committee (2007, Supplement December). Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*, *120*, S164-S192. P24

Bassett, D.R., Troiano, R.P., Mcclain, J.J., & Wolff, D.L. (2015). Accelerometer-based physical activity: Total volume per day and standardized measures. *Medicine and Science in Sports and Exercise*, (*47*)4, 833-838. doi: 10.1249/MSS.0000000000000468 124,125

Batterink, L., Yokum, S., & Stice, E. (2010). Body mass correlates inversely with inhibitory control in response to food among adolescent girls: An fMRI study. *NeuroImage, 52*(4), 1696-1703. doi: 10.1016/j.neuroimage.2010.05.059 p49

Berg, K. (2010). Justifying physical education based on neuroscience evidence. *Journal of Physical Education, Recreation, and Dance, 81*(3), 24-46. P3,4,116,19,122

Berger, K. S. (2009). The developing person through childhood and adolescence. New York, NY: Worth Publishers. P8

Berzin, S., O'Brien, K., Frey, A., Kelly, M.S., Alvarez, M.E., & Shaffer, G.L. (2011). Meeting the social and behavioral health needs of students: Rethinking the relationship between teachers and school social workers. *Journal of School Health*, *81*(8), 493-501. doi: 10.1111/j.1746-1561.2011.00619.xp9

Best, J.R. (2012). Exergaming immediately enhances children's executive function. *American Psychological Association*, *48*(5), 1501-1510. doi:
10.1037/a0026648p1,7,57,59,60,61,62,118,119

Bhattacharya J., & Currie, J. (2000, May). *Youths at nutritional risk: Malnourished or misnourished?* (Working Paper No. 7686). doi: 10.3386/w7686. Retrieved from National Bureau of Economic Research website: http://www.nber.org/papers/w7686p46

Biddle, S. H., Gorely, T., Pearson, N., & Bull, F. C. (2011). An assessment of self-reported physical activity instruments in young people for population surveillance: Project ALPHA. *International Journal of Behavioral Nutrition & Physical Activity, 8*(1), 1-9. doi:10.1186/1479-5868-8-2p78,114,117

Bisset, S., Fournier, M., Pagani, L., & Janosz, M. (2013). Predicting academic and cognitive outcomes from weight status trajectories during childhood. *International Journal of Obesity*, *37*, 154-159. doi: 10.1038/ijo.2012.106 p46,47,48,56,62,63

Bize, R., Johnson, J.A. and Plotnikoff, R.C. (2007). Physical activity level and health-related quality of life in the general adult population: A systematic review. *Preventive Medicine, 45,* 401-415. doi:10.1016/j.ypmed.2007.07.017p4,16

*Blair, C. (2013). Executive functions in the classroom. Morton JB, topic ed. In: Tremblay RE, Boivin M, Peters RDeV, eds. *Encyclopedia on Early Childhood Development* [online]. Montreal, Quebec: Centre of Excellence for Early Childhood Development and Strategic Knowledge Cluster on Early Child Development; 2013:1-7. Retrieved from http://www.child-encyclopedia.com/documents/BlairANGxpl-Cognitive_stimulation.pdf

Blair, C. & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and Psychopathology*, *20*, 899-911. doi: 10.1017/S0954579408000436p57

Blom, L.C., Alvarez, J., Zhang, L., Kolbo, J., (2011). Associations between health-related physical fitness, academic achievement and selected academic behaviors of elementary and middle school students in the state of Mississippi. *The Journal of Research in Health, Physical Education, Recreation, Sport, and Dance, 6*(1), 13-19. Retrieved from: http://search.proquest.com/docview/917531839?accountid=10196 P1,7,25,29,30,61,62,108,117,118

Borrud, L., Chiappa, M.M., Burt, V.L., Gahche, J., Zipf, G., Dohrmann, S.M., & Johnson, C.L. (2014). National Health and Nutrition Examination Survey: National Youth Fitness Survey plan, operations, and analysis, 2012. National Center for Health Statistics. *Vital* *and Health Statistics*, *2*(163). Retrieved from http://www.cdc.gov/nchs/data/series/sr_02/sr02_163.pdf p19,113

*Borrud, L. G., Flegal, K. M., Looker, A. C., Everhart, J. E., Harris, T. B., & Shepherd, J. A. (2010). Body composition data for individuals 8 years of age and older: U.S. population, 1999–2004. *Vital and Health Statistics*. *Series 11, Data from the National Health Survey, (250), 1-87.*

*California Department of Education. (2005). A study of the relationship between physical fitness and academic achievement in California using 2004 test results. Sacramento, CA: Author.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports*, *100*(2), 126–131. P6

Castelli, D.M., Hillman, C.H., Buck, S.M., & Erwin, H.E. (2007). Physical fitness and academic achievement in third and fifth-grade students. J*ournal of Sport and Exercise Psychology*, *29*(2), 239-252. Retrieved from: p1,3,7,25,28,29,33,35,39,61,62,63,108,117 http://fitnessforlife.org/AcuCustom/Sitename/Documents/DocumentItem/7336.pdf

Cawley, 2004 p.46

Center for Education Policy (2007). *Choices, Changes, and Challenges: Curriculum and Instruction in the NCLB Era*. Washington, D.C.: Author.p2,9

Centers for Disease Control and Prevention [CDC] (2011) Active Living Research p16

Centers for Disease Control and Prevention [CDC] (2009). Body mass index: Considerations for practitioners. Retrieved from: http://www.cdc.gov/obesity/downloads/bmiforpactitioners.pdf p23,24

Centers for Disease Control and Prevention [CDC] (2010). *The association between school-based physical activity, including physical education, and academic performance.* Atlanta, GA: U.S. Department of Health and Human Services.p6,19

Centers for Disease Control and Prevention [CDC] (2012). Youth Risk Behavior Surveillance-United States, 2011. MMWR 2012; 61(No. SS-04): [1-162]. P4,18,19,61,112,113

Centers for Disease Control and Prevention [CDC], Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion (2013). Healthy weight: Assessing your weight: BMI: About BMI for children and teens. Retrieved from http://www.cdc.gov/healthyweight/assessing/bmi/childrens_BMI/about_childrens_BMI.html?mobile=false p1,2,3,7,17,18,20,24,61,64,76,108,116

Chaddock, L., Erickson, K.I., Prakash, R.S., VanPatter, M., Voss, M.W., Pontifex, M.B., Raine, L.B., ... & Kramer, A.F. (2010). Basal ganglia volume is associated with aerobic fitness in preadolescent children. *Developmental Neuroscience*, *32*, 249-256. doi: 10.1159/000316648 p31

Chaddock, L., Hillman, C.H., Pontifex, M.B., Johnson, C.R., Raine, L.B., & Kramer, A.F. (2012). Childhood aerobic fitness predicts cognitive performance one year later. *Journal of Sports Sciences*, *30*(5), 421-430. doi: 10.1080/02640414.2011.647706

p36,37,38,39

Chen, A., & Ennis, C. D., (2004). Goals, interests, and learning in physical education. *Journal of Educational Research*, *97*, 329-353. P67

Choi (2011) p92

Chomitz, V.R., Slining, M.M., McGowan, R.J., Mitchell, S.E., Dawson, G.F., & Hacker, K.A. (2009). Is there a relationship between physical fitness and academic achievement? Positive results from public school children in the northeastern United States. *Journal of School Health, 79*(1), 30-37. P1,7,25,26,27,30,33,62,63,117

Clemes, S.A., Matchett, N., & Wane, S.L. (2008). Reactivity: An issue for short-term pedometer studies. *British Journal of Sports Medicine*, *42*(1), p55

Coe, D., Pivarnik, J.,Womack,C.,Reeves,M. & Malina, R. (2006). Effect of physical education and activity levels on academic achievement in children. *Medicine & Science in Sports and Exercise*, *38*(8), 1515-1519. doi: 10.1249/01.mss.0000227537.13175.1b p4,50,51,52,62,63

Colcombe, S.J., Kramer, A.F., Erickson, K.I., Scalf, P., McAuley, E., Cohen, N.J., ...& Elavsky, S. (2004). Cardiovascular fitness, cortical plasticity, and aging. *Proceedings of the National Academy of Sciences, USA, 101*(9), 3316-3321. P4,57,58

Creswell, J. W. (2003). Research design: Qualitative, quantitative, and mixed methods approaches. (2nd ed.). Thousand Oaks, CA: Sage. P65

Datar, A. & Sturm, R. (2006). Childhood overweight and elementary school outcomes. *International Journal of Obesity*, *30*(9), 1449-1460. doi: 10.1038/sj.ijo.0803311 p39,40,41,42,43,44,46,49,56,62,63,64,124

Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, *44*, 2037-2078.

*Davis, C. L., Pollock, N. K., Waller, J. L., Allison, J. D., Dennis, B. A., Bassali, R., . . . Gower, B. A. (2012). Exercise dose and diabetes risk in overweight and obese children: A randomized controlled trial. *Journal of the American Medical Association, 308*, 1103–1112.

Davis, C. L., Tomporowski, P. D., Boyle, C. A., Waller, J. L., Miller, P. H., Naglieri, J.A., & Gregoski, M. (2007). Effects of aerobic exercise on overweight children's cognitive functioning: A randomized controlled trial. *Research Quarterly for Exercise and Sport, 78*(5), 510-519. Retrieved from http://search.proquest.com/docview/218505006?accountid=10196 p57

Davis, C.L., Tomporowski, P.D., McDowell, J.E., Austin, B.P., Miller, P.H., Yanasak, N.E., ... & Naglieri, J.A. (2011). Exercise improves executive function and achievement and alters brain activation in overweight children: A randomized, controlled trial. *Health Psychology*, *30*(1), 91-98. doi: 10.1037/a0021766p1,7,58,59,62

Davis, J. & Bauman, K. (2013). *School enrollment in the United States: 2011*. Retrieved from U.S. Census Bureau website: http://www.census.gov/prod/2013pubs/p20-571.pdf p1

Decelis, A., Jago, R., & Fox, K. (2014). Physical activity, screen time and obesity status in a nationally representative sample of Maltese youth with international comparisons. *BMC Public Health*, *14(*664). doi:10.1186/1471-2458-14-664

Denzin, N., & Lincoln, Y. (1998). The fifth moment. In N. Denzin & Y. Lincoln (Eds.), *The landscape of qualitative research: Theories and issues* (pp. 407-430). Thousand Oaks, CA: Sage Publications. P87

Diamond, A. (2006). The early development of executive functions. In E. Bialystok & F. I. M. Craik (Eds.), *Lifespan Cognition: Mechanisms of Change* (pp. 70–95). New York: Oxford University Press. Retrieved from: p31 http://www.devcogneuro.com/Publications/Lifespan%20Cognition%20chapter.pd f

Donnelly, J.E., Greene, J.L, Gibson, C.A., Smith, B.K., Washburn, R.A., Sullivan, D.K., … & Williams, S.L. (2009). Physical Activity Across the Curriculum (PAAC): A randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. *Preventive Medicine, 49*, 336–34

p1,7,50,55,56,57,61,62,63,119,120

Drid et al 2013 p47,48,62

Eisner, E. (1991). *The enlightened eye.* New York: MacMillan.p87,88

Ekelund, U., Tomkinson, G., & Armstrong, N. (2011). What proportion of youth are physically active? Measurement issues, levels, and time trends. *British Journal of Sports Medicine, 45*(11), 859-865. doi: 10.1136/bjsports-2011-090190 p23,24

Esmat, T. (2012). Measuring and evaluating body composition. ACSM: Retrieved from: http://www.acsm.org/access-public-information/articles/2012/01/12/measuring-and-evaluating-body-composition on May 19, 2014.p23,24

Esteban-Cornejo, I., Tejero-González, C., Martínez-Gómez, D., Cabanas-Sánchez, V., Fernández-Santos, J., Conde-Caveda, J., & ... Veiga, O. (2014). Objectively measured physical activity has a negative but weak association with academic performance in children and adolescents. *Acta Paediatrica*, doi: 10.1111/apa.12757

Etnier, J.L., Nowell, P.M., Landers, D.M., & Sibley, B.A. (2006). A meta-regression to examine the relationship between aerobic fitness and cognitive performance. *Brain Research Reviews*, *52*(1), 119-130. P63

Evenson, K.R., Catellier, D.J., Gill, K., Ondrak, K.S., & McMurray, R.G. (2008) Calibration of two objective measures of physical activity for children. *Journal of Sports Science, 26*(14), 1557–1565. doi: 10.1080/02640410802334196 p82

Everhart, Dimon, Stone, Desmond, & Casilio 2012 p50

Fairclough, S. & Stratton, G. (2005). Physical activity levels in middle and high school physical education: A review. *Pediatric Exercise Science, 17*, 217-236.p4

Faith, M.S. & Hittner, J.B. (2010). Infant temperament and eating style predict change in standardized weight status and obesity risk at 6 years of age. *International Journal of Obesity*, *34*(10), 1515-1523. P49,63

Fedewa, Alicia L., Ahn, Soyeon (2011)The Effects of Physical Activity and Physical Fitness on Children's Achievement and Cognitive Outcomes: A Meta-Analysis p1,3,4,7,16,50,51,62,63

Francis, L.A. & Susman, E.J. (2009). Self-regulation and rapid weight gain in children from age 3 to 12 years. *Archives of Pediatrics and Adolescent Medicine*, *163*(4), 297-302. P4,49

*Freedman, D.S., Mei, Z., Srinivasan, S.R., Berenson, G.S., & Dietz, W.H. (2007) Cardiovascular risk factors and excess adiposity among overweight children and adolescents: the Bogalusa Heart Study. *Journal of Pediatr*ics, *150*(1), 12-17.

Gao, Z., Lodewyk, K. R., & Zhang, T. (2009). The role of ability beliefs and incentives in middle school students' intention, cardiovascular, fitness, and effort. *Journal of Teaching Physical Education*, *29*(1), 3-20. P66,117

Glatthorn, A.A., Boschee, F., & Whitehead, B.M. (2009). *Curriculum leadership: Strategies for development and implementation*. Thousand Oaks, California: SAGE Publications, Inc. p9,8,16

Going, S., Lee, V., Blew, R., Laddu, D., & Hetherington-Rauth, M. (2014). Top 10 research questions related to body composition. *Research Quarterly for Exercise and Sport, 85*(1), 38-48. Retrieved from http://search.proquest.com/docview/1520304340?accountid=10196 p23,24

*Gray, J., Yeo, G.S., Cox, J.J., Morton, J., Adlam, A.L., Keogh, J.M., et al. (2006). Hyperphagia, severe obesity, impaired cognitive function, and hyperactivity associated with functional loss of one copy of the brain-derived neurotrophic factor (BDNF) gene. *Diabetes*, *55*(12), 3366-3371.

Graziano, P.A., Calkins, S.D., & Keane, S.P. (2010). Toddler self-regulation skills predict risk for pediatric obesity. *International Journal of Obesity*, *34*(4): 633-641. P4,49

Green, G., & Reese, S.A. (2006). Childhood obesity: A growing phenomenon for physical educators. *Education*, *127*(1), 121-124. Retrieved from: http://www.projectinnovation.biz/education.htm p20

Gurley-Calvez, T. & Higginbotham, A. (2010). Childhood obesity, academic achievement, and school expenditures. *Public Finance Review*, *38*(5), 619-246. doi: 10.1177/1091142110375682

*Haga, M. (2009). Physical fitness in children with high motor competence is different from that in children with low motor competence. *Physical Therapy*, *89*(10), 1089-97. Retrieved from http://search.proquest.com/docview/223114780?accountid=10196

Hallal, P. C., Reichert, F. F., Clark, V. L., Cordeira, K. L., Menezes, A. B., Eaton, S., & ... Wells, J. C. (2013). Energy expenditure compared to physical activity measured by accelerometry and self-report in adolescents: A validation study. *Plos One*, *8*(11), 1-7. doi:10.1371/journal.pone.0077036 p77,82,92,113

Healy, Matthews Dunstan, Winkler, & Owen 2011 p124,125

Hillman, C.H., Erickson, K.I., & Kramer, A.F. (2008). Be smart, exercise your heart: Exercise effects on brain and cognition. *Neuroscience*, *9*, 58-65. doi: 10.1038/nrn2298 p31

Hillman, C.H., Kamijo, K., & Scudder, M. (2011). A review of chronic and acute physical activity participation on neuroelectric measures of brain health and cognition during childhood. *Preventive Medicine*, *52*, S21-S28. doi: 10.1016/j.ypmed.2011.01.024p57,64

Hillman, C.H., Buck, S.M., Themanson, J.R., Pontifex, M.B., & Castelli, D.M. (2009a). Aerobic fitness and cognitive development: Event-related brain potential and task performance indices of executive control in preadolescent children. *Developmental Psychology*, *45*(1), 114-129. doi: 0.1037/a0014437p4,7,31,32,33,35,38,59,61,68

Hillman, C.H., Pontifex, M.B., Raine, L.B., Castelli, D. M., Hall, E.E., & Kramer, A.F. (2009b). The effect of acute treadmill walking on cognitive control and academic achievement in preadolescent children. *Neuroscience*, *159*, 1044-1054.p1,7

Hoffman, D. J., Policastro, P., Quick, V., & Lee, S. K. (2006). Changes in body weight and fat mass of men and women in the first year of college: A study of the "freshman 15". *Journal of American College of Health*, *55*(1), 41-45.p39

*Institute of Medicine. (2007). *Preventing Childhood Obesity: Health in the Balance.* Washington, D.C.: The National Academies Press.

Jennings, J. (2012, January). Reflections on a half-century of school reform: Why have we fallen short and where do we go from here? Retrieved from http://www.cep-dc.orgp2,8,9

*Kamijo, K., Pontifex, M.B., O'Leary, K.C., Scudder, M.R., Wu, C.T., & Hillman, C.H. (2011). The effects of an afterschool physical activity program on working memory in pre-adolescent children. *Developmental Science*, *14*(5), 1046-1058.

*Kamijo, K., Khan, N.A., Pontifex, M.B., Scudder, M.R., Drollette, E.S., Raine, L.B., … & Hillman, C.H. (2012). The relation of adiposity to cognitive control and scholastic achievement in preadolescent children. *Obesity*, *20*(12), 2406-2411.

Kramer, A. F., & Hillman, C. H. (2006). Aging, physical activity, and neurocognitive function. In E. Acevado and P. Ekkekakis (Eds.), *Psychobiology of physical activity* (pp. 45–59). Champaign, IL: Human Kinetics. 931

Kim, J., & So, W. (2013). Association between overweight/obesity and academic performance in South Korean adolescents. *Central European Journal of Public Health*, *21*(4), 179-183.p44,45,46,62,

*Koster, A., Caserotti, P., Patel, K.V., Matthews, C.E., Berrigan, D., Van Domelen, D.R., . . . Harris, T.B. (2012). Association of sedentary time with mortality independent of moderate to vigorous physical activity. *PLOS ONE*, *7*(6), e37696. doi: 10.1371/journal.pone.0037696 124

Kowalski, K., Crocker, P., & Donen, R. (2004) *The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual*. College of Kinesiology, University of Saskatchewan: Saskatoon. Retrieved from: http://www.performwell.org/index.php?option=com_mtree&task=att_download&link_id=297&cf_id=24

Kristjánsson, Á. L., Sigfúsdóttir, I. D., Allegrante, J. P., & Helgason, Á. R. (2009). Adolescent health behavior, contentment in school, and academic achievement. *American Journal of Health Behavior, 33*(1), 69-79. Retrieved from p43,44,62 http://search.proquest.com/docview/211895766?accountid=10196

Labban, J.D., & Etnier, J.L. (2011). Effects of acute exercise on long-term memory. *Research Quarterly for Exercise and Sport*, *82*(4), 712-721.p3

Lomax, R. G. & Hahs-Vaughn, D. L. (2012). An Introduction to Statistical Concepts (3rd ed.).

New York: Routledge. P80

London, R. A., & Castrechini, S. (2011). A longitudinal examination of the link between youth physical fitness and academic achievement. *The Journal of School Health, 81*(7), 400-408. doi:10.1111/j.1746-1561.2011.00608.x p4,39

Lucio, R., Rapp-Paglicci, L., & Rowe, W. (2011). Developing an additive risk model for predicting academic index: School factors and academic achievement. *Child and Adolescent Social Work Journal*, *28*(2), 153-173. doi: 10.1007/s10560-010-0222-9 p8

Luepker, R.V., Perry, C.L., McKinlay, S.M., Nader, P.R., Parcel, G.S., Stone, E.J., … & Johnson, C.C. (1996). Outcomes of a field trial to improve children's dietary patterns and physical activity. The Child and Adolescent Trial for Cardiovascular Health. CATCH collaborative group. *Journal of American Medical Association, 275*(10), 768–778. 16

Maayan, L., Hoogendoorn, C., Sweat, V., & Convit, A. (2011). Disinhibited eating in obese adolescents is associated with orbitofrontal volume reductions and executive dysfunction. *Obesity*, *19*(7), 1382-1387. P49

Maher, C., Olds, T., Mire, E., & Katzmarzyk, P.T. (2013). Reconsidering the sedentary behavior paradigm. *PLOS ONE*, *9*(1): e86403. doi:10.1371/journal.pone.0086403 125

Martin, L. T., & Chalmers, G. R. (2007). The relationship between academic achievement and physical fitness. *Physical Educator, 64*(4), 214-221. Retrieved from http://search.proquest.com/docview/233003006?accountid=10196 p27,28,62

McDaniel, R. (2012). Physical and cognitive development of adolescents. Retrieved from http://www.ehow.com/about_6668490_physical-cognitive-development-adolescents.html p8

Mead, T. P., Roark, S., Larive, L. J., Percle, K. C., & Auenson, R. N. (2013). The facilitative effect of acute rhythmic exercise on reading comprehension of junior high students. *Physical Educator*, *70*(1), 52-71. Retrieved from http://search.proquest.com/docview/1430245592?accountid=10196 p3,4

Mei, Z., Grummer-Strawn, L.M., Pietrobelli, A., Goulding, A., Goran, M.I., & Dietz, W.H. (2002). Validity of body mass index compared with other body-composition screening indexes for assessment of body fatness in children and adolescents. *American Journal of Clinical Nutrition, 75*(6), 978-985. P24

Mond, J.M., Stich, H., Hay, P.J., Kraemer, A. & Baune, B.T. (2007). Associations between obesity and developmental functioning in pre-school children: a population-based study. *International Journal of Obesity*, *31*(7), 1068-1073. P49

Morrow, J.R., Jackson, A.W., Disch, J.G., & Mood, D.P. (2005). Measurement and Evaluation in Human Performance (3rd edition). Champagne, IL: Human Kinetics. P75

*Murray R. Response to 'Parents' Perceptions of Curricular Issues Affecting Children's Weight in Elementary Schools. *Journal of School Health, 77*(5), 223-230, 2007.

National Association for Sport and Physical Education & American Heart Association [NASPE] (2012). 2012 Shape of the Nation Report: Status of Physical Education in the USA. Reston, VA: American Alliance for Health, Physical Education, Recreation and Dance. P2,3,19,20,21,23

National Center for Education Statistics [NCES] (2013a). *The Nation's Report Card: A First Look: 2013 Mathematics and Reading* (NCES 2014-451). Institute of Education Sciences, U.S. Department of Education, Washington, D.C. Retrieved from http://nces.ed.gov/nationsreportcard/subject/publications/main2013/pdf/2014451.pdf p7,10,11,61,108

National Center for Education Statistics [NCES] (2013b). *The Nation's Report Card: A First Look: 2013 Mathematics and Reading* (NCES 2014-451). Institute of Education Sciences, U.S. Department of Education, Washington, D.C. Retrieved from http://nationsreportcard.gov/reading_math_2013/#/state-performance

p2,7,10,11,61,64,108,110

National Survey of Children's Health [NSCH] (2011). Overweight and physical activity among children: A portrait of states and the nation 2009. Health Resources and services Administration, Maternal and child Health Bureau. Retrieved from http://www.cdc.gov/nchs/slaits/ nsch.htm p 18,112

Nihiser, A.J., Lee, S.M., Wechsler, H., McKenna, M., Odom, E., Reinold, C.,…. Grummer-Strawn, L. (2007). Body mass index measurement in schools. *Journal of School Health*, *77*, 651-671. Retrieved from: www.cdc.gov/healthyyouth/npao/publications.htm#10 p24

Ogden, C.L., Carroll, M.D., Kit, B.K., & Flegal, K.M. (2012). Prevalence of obesity and trends in body mass index among U.S. children and adolescents, 1999-2010. *Journal of the American Medical Association, 307*(5), 483-490. P2,7,18,61,108

Ogunsile, S. E. (2012). The effect of dietary pattern and body mass index on the academic performance of in-school adolescents. *International Education Studies, 5*(6), 65-72. Retrieved from http://search.proquest.com/docview/1447233970?accountid=10196 p39

Oketayo, O.O., Ojo, J.O., Inyang, E.P., Adewodi, R.A., Akinluyi, F.O., & Akinnubi, R.T. (2010). The effect of body weight, body fat and body mass index on adolescents' academic performance. *Nature and Science, 8*(6), 36-42. P25,39,117

Onchwari, G., & Keengwe, J. (2011). Examining the relationship of children's behavior to emotion regulation ability. *Early Childhood Education Journal*, *39*, 279-284. doi:

10.1007/s10643-011-0466-9 p8

Organization Economic Co-operation and Development [OECD]. (2013). PISA 2012 assessment and analytical framework: Mathematics, reading, science, problem solving and financial literacy. OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264190511-en

P2,12,14,15,16

Organization Economic Co-operation and Development. (2010). Lessons from PISA for the United States. Retrieved from http://www.oecd.org/pisa/46623978.pdf p14

*Pauli-Pott, U., Albayrak, Ö.Hebebrand, J. & Pott, W. (2010). Association between inhibitory control capacity and body weight in overweight and obese children and adolescents: dependence on age and inhibitory control component. *Child Neuropsychology*, *16*(6), 592-603.

Piché, G., Fitzpatrick, C., & Pagani, L.S. (2012). Kindergarten self-regulation as a predictor of body mass index and sports participation in fourth grade students. *Mind, Brain, and Education*, *6*(1), 19-26.p49

Pontifex, M. B., Raine, L. B., Johnson, C. R., Chaddock, L., Voss, M. W., Cohen, N. J., ... Hillman, C.H. (2011). Cardiorespiratory fitness and the flexible modulation of cognitive control in preadolescent children. *Journal of Cognitive Neuroscience, 23*(6), 1332–1345.

Popham, W. (2008) (1995). *Classroom assessment: What teachers need to know* (5th ed.).

p31,33,34,35

Boston: Pearson, Allyn, & Bacon. P83

Provasnik, S., Kastberg, D., Ferraro, D., Lemanski, N., Roey, S., & Jenkins, F. (2012). *Highlights From TIMSS 2011: Mathematics and Science Achievement of U.S. Fourth- and Eighth-Grade Students in an International Context* (NCES 2013-009

Revised). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC. Retrieved from http://nces.ed.gov/pubs2013/2013009rev.pdf p2,7,12,13,64,110

Reinert, K.R., Poe, E.K., & Barkin, S.L. (2013). The relationship between executive function and obesity in children and adolescents: A systematic review. *Journal of Obesity*, *2013*(820956). Retrieved from http://dx.doi.org/10.1155/2013/820956p47,63,64

Richardson, D., Cavill, N., Ellis, L., & Roberts, K. (2011). Measuring diet and physical activity in weight management interventions: A briefing paper. Oxford: National Obesity Observatory. P83

Riggs et al 2010 url p76,80

Riggs, N.R., Blair, C.B., & Greenberg, M.T. (2004). Concurrent and 2-year longitudinal relations between executive function and the behavior of 1st and 2nd grade children. *Child Neuropsychology*, *9*, 267-276. doi: 10.1076/chin.9.4.267.23513 p57

Riggs, N.R., Huh, J., Chou, C.P., Spruijt-Metz, D., & Pentz, M.A. (2012). *Journal of Behavioral Medicine*, *35*(6), 642-650. P49

Sabia, J. J. (2007). The effect of body weight on adolescent academic performance. *Southern Economic Journal*, *73*(4), 871-900. Retrieved from http://www.jstor.org.prox.lib.ncsu.edu/stable/20111933p7,39,46,48,49,61,108

Sabia, S., Kivimaki, M., Shipley, M. J., Marmot, M. G., & Singh-Manoux, A. (2009). Body mass index over the adult life course and cognition in late midlife: The Whitehall II Cohort Study. *American Journal of Clinical Nutrition*, *89,* 601–607. doi:10.3945/ajcn.2008.26482p47

Saint-Maurice, P. F., Welk, G. J., Beyler, N. K., Bartee, R. T., & Heelan, K. A. (2014). Calibration of self-report tools for physical activity research: the Physical Activity Questionnaire (PAQ). *BMC Public Health, 14*(1), 103-121. doi:10.1186/1471-2458-14-461p77,82,92,94,95,113

Salkind, N. (2007). *Statistics for people who (think they) hate statistics (Excel 2nd Ed).* Thousand Oaks, CA: SAGE. P80,83

*Sallis, J.F., McKenzie, T.L., Kolody, B., Lewis, M., Marshall, S. & Rosengard, P. (1999). Effects of health related physical education on academic achievement: Project SPARK. *Research Quarterly for Exercise and Sport, 70*, 127-134.

Santiago, J.A., Roper, E.A., Disch, J.G., Morales, J. (2013). The relationship among aerobic capacity, body composition, and academic achievement of fourth and fifth grade Hispanic students. *Physical Educator, 70*(1), 89-105. Retrieved from http://search.proquest.com/docview/1430245307?accountid=10196

p1,7,25,30,39,62,63,117

*Shimon, J.M. (2011). *Introduction to teaching physical education: Principles and strategies*.	Champaign, IL: Human Kinetics.

Shoval, 2011 p50

Soares, I., Lemos, M. S., & Almeida, C. (2005). Attachment and motivational strategies in adolescence: exploring links. *Adolescence, 40*(157), 129-154. P65,89,117

Stanek, K.M., Strain, G., Devlin, M., Cohen, R., Paul, R., Crosby, R.D., …Gunstad, J. (2013). Body mass index and neurocognitive functioning across the lifespan. *Neuropsychology, 27*(2), 14-151.p47

Strong, W. B., Malina, R. M., Blimkie, C. R., Daniels, S. R., Dishman, R. K., Gutin, B., & ... Trudeau, F. (2005). Original Article: Evidence Based Physical Activity for School-age Youth. *The Journal of Pediatrics, 146,* 732-737. doi:10.1016/j.jpeds.2005.01.055p19

Syväoja, H.J., Kantomaa, M.T., Ahonen, T., Hakonen, H., Kankaanpää, A., & Tammelin, T.H. (2013). Physical activity, sedentary behavior, and academic performance in Finnish children. *Medicine and Science in Sports and Exercise, 45*(11), 2098-2104.

p1,7,50,52,53,54,62,63

Tabachnick, B. & Fidell, L. (2013). Using multivariate statistics (6th ed.). Upper Saddle River, New Jersey: Pearson Education, Inc. p84

Taras, H. (2005). Physical activity and student performance at school. *Journal of School Health, 75* (6), 214-218. doi: 10.1111/j.1746-1561.2005.00026.x p25,46,48,117

*Taras, H., & Potts-Datema, W. (2005). Obesity and students' performance at school. *Journal of School Health*, *75,* 291-295. http://dx.org/doi: 10.1111/j.1746-1561.2005.00040.x

Togo, F., Watannabe, E., Park, H., et al. (2008)). How many days of pedometer use predict the annual activity of the elderly reliably? *Medicine and Science in Sports and Exercise*, *40*(6), 1058-1064. p55

Tomporowski, P.D. (2003). Effects of acute bouts of exercise on cognition. *Acta Psychologica*, *112*, 297-324. Retrieved from: http://www.markantoffice.com/transfer/2002-Effects_of_acute_bouts_of_exercise_on_cognition.pdf p63

Tomporowski, P.D., Davis, C.L., Miller, P.H. & Naglieri, J.A. (2008). Exercise and children's intelligence, cognition, and academic achievement. *Educational Psychology Review*, *20*(2), 111-131. P3,4,16,31

*Trasande, L., & Chatterjee, S. (2009). The impact of obesity on health service utilization and costs in childhood. *Obesity, 17*(9), 1749-1754.

Trost, S.G., Loprinzi, P.D., Moore, R., & Pfeiffer, K.A. (2011) Comparison of accelerometer cut points for predicting activity intensity in youth. *Medicine and Science in Sports and Exercise, 43*(7), 1360-1368. doi: 10.1249/MSS.0b013e318206476e p82

*Trudeau, F., & Shephard, R. (2008). Physical education, school physical activity, school sports and academic performance. *International Journal of Behavioral Nutrition and Physical Activity, 5*(10). doi: 10.1186/1479.

Trudeau, F., & Shephard, R. J. (2010). Relationships of physical activity to brain health and the academic performance of school children. American Journal of Lifestyle Medicine, *4*(2), 138-150. doi: 10.1177/1559827609351133. 17

Trust for America's Health and Robert Wood Johnson Foundation. (2011). *F as in Fat: How Obesity Threatens America's Future — 2011*. Retrieved from http://www.tfah.org/report/88/ p25

U.S. Department of Health and Human Services [USDHHS]. (2008). 2008 Physical activity guidelines for Americans. Washington, D.C. p3,7,19,113,122

United Health Foundation, American Public Health Association and Partnership for Prevention. (2009). America's Health RankingsTM –2009 edition. Minnetonka, MN: Author. p17

*Vail, K. (2006). Mind and body. *Education Digest, 71*(8), 13-19.

Van Dusen, D.P., Kelder, S.H., Kohl, H.W., Ranjit, N., & Perry, C.L. (2011). Associations of physical fitness and academic performance among schoolchildren. *Journal of School Health, 81*(12), 733-741. P1,7,25,26,30,33,39,44,46,48,49,62,63

*Vanhelst, J., Béghin, L., Duhamel, A., Bergman, P., Sjöström, M., & Frédéric Gottrand, F. (2012). Comparison of uniaxial and triaxial accelerometry in the assessment of physical activity among adolescents under free-living conditions: the HELENA study. *BMC Medical Research Methodology, 12*(1), 26-31. doi:10.1186/1471-2288-12-26

Vawter, D. (2010). Mining the middle school mind. *Education Digest, 75*(5), 47-49. P4

Vazou, S., Gavrilou, P., Mamalaki, E., Papanastasiou, A., & Sioumala, N. (2012). Does integrating physical activity in the elementary school classroom influence academic motivation? *International Journal of Sport and Exercise Psychology*, *10*(4), 251-263.

p1,50,56,61,119

Verdejo-García, A., Pérez-Expósito, M., Schmidt-Río-Valle, J., Fernández-Serrano, M.J., Cruz, F., Pérez-García, M., ... & Campoy, C. (2010). Selective alterations within executive functions in adolescents with excess weight. *Obesity*, *18*(8), 1572-1578. p49

Wagner, D. R., & Heyward, V. H. (1999). Techniques of body composition assessment: A review of laboratory and field methods. *Research Quarterly for Exercise and Sport, 70*(2), 135-149. Retrieved from http://search.proquest.com/docview/218501343?accountid=10196 p23

Wang, F. & Veugelers, P.J. (2008). Self-esteem and cognitive development in the era of the childhood obesity epidemic. *Obesity Reviews*, *9*(6), 615-623. doi: 10.1111/j.1467-789X.2008.00507.x p39

Wang, Y., Beydoun, M.A., Liang, L., Caballero, B., & Kumanyika, S.K. (2008). Will all Americans become overweight or obese? Estimating the progression and cost of the U.S. obesity epidemic. *Obesity*, *16*(10), 2323-2330.p2,17

*Wang, Y, et al. (2011). Trends and racial/ethnic disparities in severe obesity among U.S. children and adolescents, 1976-2006. *International Journal of Pediatric Obesity*, *6*(1), 12-20. doi: 10.3109/17477161003587774.

Washington, T. D. (2009). Psychological stress and anxiety in middle to late childhood and early adolescence: Manifestations and management. *Journal of Pediatric Nursing, 24*(4), 302-313. doi: 10.1016/j.pedn.2008.04.011 p8

Welk, G.J. & Meredith, M.D. (2008). *Fitnessgram/Activitygram Reference Guide*. Dallas, TX: The Cooper Institute. Retrieved from http://www.cooperinst.org/products/grams/documents/FITNESSGRAM_ReferenceGuide.pdf p25,46

Weinberg and Gould, 2003 p65,66,89,117

Wittberg, R., Cottrell, L.A., Davis, C.L., & Northrup, K.L. (2010). Aerobic thresholds associated with fifth grade academic achievement. *American Journal of Health Education, 41*(5), 284-291. p2,3,7,9,31,61,108

*Wittberg, R.A., Northrup, K.L., & Cottrell, L. (2009). Children's physical fitness and academic performance. *American Journal of Health Education*, *40*, 30-36.

*World Health Organization [WHO] (2000). *Obesity: Preventing and managing the global epidemic*, *Report of a WHO Consultation*, WHO Technical Report Series 894: Geneva.

Woolard, D. (2008). Achievement goal theory. Retrieved October 5, 2014 from http://www.drwoolard.com/miscellaneous/target_goal_theory.htm p65

Xiang, P., Bruene, A., & McBride, R. E. (2004). Using achievement goal theory to assess an elementary physical education running program. *Journal of School Health*, *74*(6), 220-

225. Retrieved on October 5, 2014, from http://search.epnet.com/login.aspx?direct=true&db=tfh&an=10877915 p65,66,67,89,119

Yang, Y. & Raine, A. (2009). Prefrontal structural and functional brain imaging findings in anti-social, violent, and psychopathic individuals: A meta-analysis. *Psychiatry Research*, *174*(2), 81-88. doi: 10.1016/j.pscychresns.2009.03.012p57,59,64

Yu, C.C.W., Chan, S., Cheng, F., Sung, R.Y.T., & Hau, K.T. (2006). Are physical activity and academic performance compatible? Academic achievement, conduct, physical activity, and self-esteem of Hong Kong Chinese primary schoolchildren. *Educational Studies*, 32, 331-341. p50

Yusuf, M. A., & Adigun, J. T. (2010). Influence of school, sex, location and type on students' academic performance. *International Journal of Education and Science*, *2*(2), 81-85. p39

Appendix A

Consent Form from Cooperating Institution

The image part with relationship ID rId16 was not found in the file.

Appendix B

Research Participant Flyer

RESEARCH PARTICIPANTS NEEDED

PURPOSE:	The purpose of this project is to determine the extent of the relationship between physical fitness, body composition, physical activity, and academic achievement among eighth grade students in Alabama.
ELIGIBILITY:	Participants must be eighth grade students enrolled in regular physical education (PE) classes at Beulah High School.
BENEFITS:	Participants will benefit from the study by receiving information regarding the participant's physical fitness, physical activity, and academic achievement.
COMPENSATION:	No compensation for the participants.
CONTACT:	Principal Investigator, Jessica O'Neal baker_jessica3@columbusstate.edu. If you have questions about your rights as a research participant, you may contact Columbus State University Institutional Review Board at irb@columbusstate.edu.

Additional information about this research project will be given at the Informational Meeting to be held on ________________at the Beulah High School Media Center at 5:30 pm CST.

Appendix C

The image part with relationship ID rId16 was not found in the file.

The image part with relationship ID rId16 was not found in the file.

Appendix D

PAQ-A

The image part with relationship ID rId16 was not found in the file.

The image part with relationship ID rId16 was not found in the file.

The image part with relationship ID rId16 was not found in the file.