2015

Relationships Between Specific Health-Related Fitness Components and Standardized Academic Achievement Tests

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Walden University
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Abstract

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by

Tona De Aune Wilson

MA, San Diego State University, 2003

BHS, University of Arizona, 1997

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Health Psychology

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Abstract

In an attempt to meet monetary-driven mandates to improve student achievement test scores, administrators are replacing physical education activities with subject matter classes in many American schools. This practice negates the positive contributions of physical activity to academic performance and student fitness. Guided by self-efficacy theory, this study assessed the impact of optimal versus minimal physical fitness state on student academic achievement. The study sample included 5,416 9th grade students from the same school district who completed a minimum of 5 of the 6 components of the FITNESSGRAM tests, and who also completed the math and English language arts (ELA) portions of the California Standards Test. The independent variables were optimal and minimal physical fitness based upon completing 6 or 5 FITNESSGRAM components, respectively. Analyses included independent samples *t* tests, ANOVA, and Dunnet's *C* test to detect differences in mean academic scores with gender and ethnicity as covariates. Optimally fit students had significantly higher ($p < 0.05$) scores in math and ELA tests relative to minimally fit students. Female academic test scores tended to be higher than male scores in both academic tests. School officials, when contemplating curricular programs devoid of a physical education component, might judiciously reassess the positive effects of physical fitness upon academic achievement and the associated biopsychosocial benefits for their students. Physically fit and academically enriched students may provide a foundation for positive social change directed at engendering a healthier, motivated, and productive citizenry.

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Dedication

Education has always been an important principle in our family. As a middle school and high school student, I remember trying to think of what I wanted to do with my life, and it was always engrained in my sister's and my minds by our parents that no matter what we wanted to do, we would earn our degrees and pursue our education to the fullest. I used to wonder if we would ever not be in school. But as I pursued my degrees, I learned that if we cease to learn, we cease to live. Learning is a part of our nature and if we can take our passion, learn more about it, become an educated expert at it, and be employed for it, we are not just making a living; we have made a life.

When I graduated high school, my dad reminded me that this was only the beginning of a very long educational journey. When I graduated with my first bachelor's degree, I was sure that I was ready to change the world, but I returned to school to become a physical education teacher. I was reminded again that there could be more. I went on to earn my Master's Degree with the help of my dad as a mentor, editor, and makeshift statistician. Still, I knew I could learn more in order to make the difference I knew I was created to make. I went on to earn my National Board of Professional Teaching Standards certificate in young adult and adolescent physical education. There was still more to learn. A doctorate in the field of Health Psychology would give me the tools and talent to make that difference. Again, my dad was there and ready to help. Therefore, this manuscript, as well as my entire education and the success I have had because of it, is dedicated to my father, Ronald W. Hilwig, DVM, Ph.D. I hereby bestow this Ph.D. *honoris causa* in the field of Health Psychology to my Dad, the greatest man I know. I love you, Dad. Thank you for your diligence and confidence in me.

Acknowledgements

The making of a doctorate: It takes fortitude, perseverance in the face of adversity, tears of frustration, tears of joy, sleep loss, hair loss, trichotillomania, mania in general, red wine, white wine, chocolate, even chocolate red wine…. But mostly, it takes a behind the scenes team to back it all up and make it all happen.

Meet Team Tona:

<u>My students at LHS, past and present</u>: Each have looked up to me and viewed me as a role model, especially Vladimir, who cited my graduate papers in his college projects.

<u>My colleagues at LHS, Patty and Sharon</u>: Both repeatedly reminded me that the finish line was coming and to quit dwelling on how close I thought I was to the starting line.

<u>Keith</u>: Meltdown manager in maintaining my sanity during the academic coursework portion of this journey. Motivation coach, self-efficacy coach, sport psychology coach.

<u>Barb and Pat</u>: Both gave me advice on research, writing, and all academic matters.

<u>Dion</u>: Assertiveness and self-esteem coach when there were snags in the process.

<u>Mike</u>: Sideline coach, 24-hour coffeehouse study-buddy and the "athletic trainer" who put me back together whenever I was blindside tackled on the dissertation gridiron.

<u>Dr. Carmoney, Dr. Cox, and Dr. Perry</u>: Dissertation committee, mentors, and advocates.

<u>My sister, Kara</u>: Personal coach who makes me think I can do anything, encourages me to take the bull by the horns and to take risks.

<u>My Mom</u>: Number one cheerleader and fan, fierce prayer warrior.

<u>My Dad</u>: Number one coach, editor, and the reason this champion arose.

<u>God</u>: The one who put the members of this team in my path, who has shown me my purpose, given me my gift, my tools, and my talents.

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Chapter 1: Introduction to the Study

The beneficial associations between physical fitness and cognitive performance are not recent discoveries. Physical exercise has been advocated as a means of maintaining a sound body and an active mind since the ancient times of Aristotle, Hippocrates, and Homeric Greeks (Van Dalen, 1971; Zollinger, 1928). Balke and Ware (1959) reported a high positive correlation between physical fitness levels in airmen and their scores in cognitive tests. Ismail and Gruber (1967) employed a battery of fitness tests designed to predict and improve intelligence quotient (IQ). No changes in IQ were found, although a large improvement in student academic achievement was observed after physical training. Many authors have subsequently reported positive relationships among student physical fitness, physical activity, and academic achievement (California Department of Education [CDE], 2003; Carlson et al., 2008; Chomitz et al., 2009; Cooper, Bandelow, Nute, Morris, & Nevell, 2012; Davis, Tomporowski, Boyle, Waller, Miller, Nagligeri et al., 2007; Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Grissom, 2005; Hill, Williams, Aucott, Thompson, & Mon-Williams, 2011; Hillman, Erickson, & Kramer, 2008; Roberts, Freed, & McCarthy, 2010; Wittberg, Cottrell, Davis, & Northrup, 2008; Wittberg, Northrup, & Cottrell, 2010).

Some authors found no significant relationships between physical fitness and academic performance, however none have reported negative effects of physical fitness upon academic performance. Researchers such as Martin and Chalmers (2007) cite differences in study design and trial populations, making reliable comparisons among studies difficult, and standardization impossible.

Physical fitness tests are given yearly in most schools, and some districts include the physical fitness test results in their Academic Performance Index. Districts utilize a variety of standardized physical fitness tests; the FITNESSGRAM is utilized in most states. Nationwide, students must pass five of the six components of the FITNESSGRAM physical fitness test to be considered physically fit. The groups for this study consisted of students designated as *optimally fit*, by passing all six FITNESSGRAM physical fitness tests, and students deemed *minimally fit*, as having one weakness in the FITNESSGRAM test. Each weakness category within the minimally fit group, as well as the optimally fit group with no weakness was compared with academic achievement *t* scores in math and English language arts (ELA). The study was designed to identify which particular components of physical fitness have the most effect upon each topic area of academic achievement. The statistical tests included independent samples *t*-test and analysis of variance among the specific physical fitness groups, and calculated *t* scores in the academic achievement areas of math and ELA. The particular method of analyses employed in this study has not been used previously in similar studies, and should contribute additional data to the existing body of literature regarding student academic achievement and physical fitness. The results of this study may contribute to positive social change by assisting in the development of quality, daily physical education curricula that maximizes the positive effects of physical fitness upon student academic achievement and cognitive functions. Conventional descriptive statistics including central tendency, standard deviation and variance were also utilized.

This chapter provides a brief background of the existing literature on the subject of student achievement and physical fitness, followed by the statement of the problem that was examined in the study. The subsequent sections include the purpose of the study, research questions and hypotheses. The theoretical and conceptual framework and the nature of the study are then explained. A definition of terms used throughout this manuscript is provided. Assumptions, scope, delimitations, and limitations follow the definitions section. The significance of the study is presented, followed by a summary of the chapter.

Background

There is not absolute agreement among researchers regarding causal or correlational relationships between student academic achievement and physical fitness. However, some researchers agreed that physical fitness improved certain cognitive functions as well as scores on some content areas of academic achievement tests (Castelli, Hillman, Buck and Erwin, 2007). The single component of physical fitness that consistently had a negative effect upon academic achievement was a body mass index (BMI) in the overweight or obese range; aerobic capacity had the most consistent positive effect (Castelli, et al, 2007; Van Deusen, Keldter, Kohl, Ranjit, & Perry, 2011).

Some of the discrepancies among study results were attributed to differences in research design, test administration, study populations, statistical analyses, or other distant or subjective factors that may affect physical or mental performance. There was agreement among researchers, authors, and administrators that additional, more elaborative, and more suitable standardized data collection techniques are recommended in order to understand the intricacies among these interrelationships (Sallis, 2010).

Administrators in the California Department of Education (CDE) released a press report in 2003 revealing the results of a study conducted by Grissom and the CDE.

Physically fit fifth, seventh, and ninth grade students performed better in academic achievement tests than their physically unfit peers (CDE, 2003). Grissom repeated the same study in 2004 with similar results (2005). Prior to these studies, Dwyer, Sallis, Blizzard, Lazarus, & Dean (2001) utilized similar methods in a multi-district study in Australia and obtained similar results. These authors agreed that math scores have the highest correlation with fitness in all achievement test scores. The correlation was greater in females than in males. The authors also indicated that BMI in the "healthy zone" and high-level cardiovascular fitness were positively correlated with mean academic achievement scores. Wittberg, Cottrell, Davis, & Northrup (2010) reported that children who scored higher in cardiovascular fitness also scored significantly higher on all academic achievement tests. Castelli et al. (2007) showed that higher academic achievement scores are most associated with healthy BMI and higher aerobic fitness. Chomitz, Slining, McGowan, Mitchell, Dawson, and Hacker (2009) calculated that the odds of passing the English portion of the academic achievement test increased by 20% and the odds of passing the math test increased by 25% for each fitness component test passed. Roberts et al. (2010) determined that for each additional minute slower than the aerobic fitness standard in the mile run, math achievement test scores decreased by 1.1 percentage points and reading decreased by 1.9 percentage points. Students with BMI in the overweight or obese categories scored significantly lower in all academic achievement tests (Roberts et al., 2010).

As evidence developed, scientists employed more comprehensive statistical methods to more fully analyze the relationships among the components of physical fitness and academic achievement. Van Deusen et al. (2011) studied the relationship trends over time and showed that these relationships remained from third grade through eleventh grade. These trends peaked from late middle school to high school. Unexpectedly, the authors also discovered that excessively low BMI was associated with low academic achievement as well.

London and Castrechini (2011) studied the age-related trends in the fitness-achievement relationships using yearly declines or improvements in performance as variables. Students who passed two consecutive years of fitness tests consistently scored higher on academic achievement tests. Students who did not pass the first year, but passed the second year, had increased academic percentiles in the second year. Students who passed the fitness tests the first year, but not the second, scored lower in academic percentiles the second year.

Davis et al. (2007) studied the cognitive effects of aerobic conditioning in students with overweight to obese BMI. The students were placed in a high exercise, low exercise, or no exercise group and underwent a two-week training program. Cognitive tests were administered to all participants at the end of the trial period. Students in the high exercise group performed significantly better on cognitive tests than students in the low exercise or no exercise groups. Wittberg et al. (2008) attempted to identify an aerobic threshold in physical fitness that could explain the augmentation of scores in academic achievement tests. The authors found that shorter times for completion for a mile run, an indicator of better aerobic capacity, augment achievement test scores for boys. A similar achievement augmentation was observed in the Progressive Aerobic Cardiovascular Endurance Race (PACER) test in girls. Students who accrued more than a particular number of laps in the progressive endurance lap test achieved significantly higher scores in achievement tests.

Whereas Kwak et al. (2009) reported that recurring bouts of vigorous physical activity increase the executive functioning of students, especially boys, Labelle, Bosquet, Mekary, and Berher (2013) found that acute bouts of vigorous physical activity leads to a short term decline in executive function during exercise. The decline is significantly less in physically fit individuals.

The study methods and the results of the studies concerning relationships have been criticized because of difficulties of assigning causality or contribution to specific variables. Moreover, standardization of study protocols and analyses was not achieved (Martin & Chalmers, 2007). The method of inquiry in the present study utilized a different perspective by which to evaluate various combinations of components of physical fitness and their relationships with scores on the various subject areas in the academic achievement test. All possible combinations of five of the six successfully passed physical fitness components were studied relative to their effect upon achievement test scores.

Statement of the Problem

As academic administrators and policymakers remove physical education programs and other opportunities for participation in physical activities, they fail to acknowledge, and disregard the importance of, physical fitness in student health and achievement. The No Child Left Behind (NCLB) policy of 2001 was enacted to increase student performance and school accountability (Jennings & Renter, 2006). The policy re-directed resources toward academic core classes, specifically math and English, to the detriment of physical education and health classes, music, and the arts. Many school district administrators opted for more classroom time by elimination of other activities such as recess or physical education classes (Cawelti, 2006; Hardman & Marshall, 2005; Sallis, 2010; Smith & Lounsbery, 2009). Teaching positions were redistributed from physical education, art, and music programs to core programs to improve the student-teacher ratio in academic core classes. Physical education and fine arts programs were reduced or transitioned to after school and off-campus options. As a result, the student-teacher ratio in physical education classes nearly doubled in some districts, leaving little opportunity for teaching quality physical education (Smith & Lounsbery, 2009). Other districts opted for waivers allowing certain extracurricular activities unrelated to physical education standards and activity levels to count as valid physical education credit (Hardman & Marshall, 2005; Sallis, 2010).

Even though childhood obesity and inactivity have become serious public health concerns, school district administrators have not effectively utilized the school curricula to help thwart these issues. Administrators and teachers are more impacted by the repercussions of not meeting Academic Yearly Progress (AYP) or improving their Academic Performance Index (API) scores and continue to place emphasis upon classroom time and core content classes (Cawelti, 2006).

Kwak et al. (2009) reported in their review of literature that taking time away from academic classes for physical activity does not adversely affect academic achievement. Although causality or definitive reasoning for the association between academic achievement and physical fitness has not been established, it is commonly accepted that improved academic achievement may be partially enhanced through quality physical education programs.

Members of the National Association for Sport and Physical Education (NASPE) advocate for quality daily physical education programs for all students. They have also stated that reducing physical education in schools is detrimental to the health of the nation's students, their capacity to learn, and the economic health of the nation as a whole (National Academy for Sports and Physical Education, 2013).

Researchers have not isolated a specific causation or correlation between student achievement and physical fitness, and call for further and more elaborate study of the subject (Martin & Chalmers, 2007). The statistical methodology in this study has not been previously employed and should provide insight as to the relationship between student academic achievement and various aspects of physical fitness.

Purpose of the Study

The purpose of this study was to quantitatively investigate how optimal and minimal physical fitness relates to the CST achievement test performance in math and ELA. The statistical method by which the variables were studied has not been utilized and will add to the current interpretations regarding the relationship between student academic achievement and physical fitness.

The dependent variables consisted of the academic raw scores in math and ELA converted to *t* scores. The independent variable was physical fitness level, either optimal or minimal, as met by the FITNESSGRAM tests. Optimal physical fitness is described as passing all six FITNESSGRAM tests with no weakness. Minimal fitness level is described as passing any five of the six FITNESSGRAM tests and was also subcategorized by the specific test weakness.

Research Questions and Hypotheses

The study addressed the following two questions:

Research Question 1: Are there significant differences in academic achievement in the areas of math and/or ELA between optimal and minimal physical fitness levels?

H_o: There are no differences in math and ELA test scores between optimal and minimal fitness groups.

H_a: There is a difference in math and ELA test scores between optimal and minimal fitness groups.

Research Question 2: If H_a is true, are there significant differences in academic achievement in the areas of math and/or ELA within the minimal fitness group based on any specific weakness?

H_o: There are no differences among weakness groups.

H_a: There is at least one difference among weakness groups.

Theoretical and Conceptual Framework

Bandura's (1977) social cognitive theory (SCT) provided the theoretical foundation for the study. Social cognitive theory purports that human achievement depends on interactions among one's behaviors, personal factors such as thoughts and beliefs, and environmental conditions (Bandura, 1977). The SCT incorporates overlapping and reciprocal psychosocial aspects of healthy behavior. Social cognitive theory recognizes the interrelationships among self-efficacy, outcome-expectations, goals, and impediments (Bandura, 2004). Both academic achievement in the classroom and physical fitness success in the physical education environment are influenced by various psychosocial situations. It is through these social interactions, external stimuli, and the internal cognitive responses that students are reinforced, either positively or negatively, for learning. Through the subsequent reward and reinforcement, either intrinsic or extrinsic, the student becomes motivated to achieve (Reeve, 2009). The specific component of the SCT relating directly to the present study is the self-efficacy theory (SET). Self-efficacy is a situation-specific form of self-confidence; it is the belief that one is competent and can do what needs to be done in a particular situation. Self-efficacy affects the person's choice of task, the effort put forth, the persistence given, and the final outcome (Wigfield & Eccles, 2002). Self-efficacy develops, and can be modified, through four major sources, including past performance accomplishments, vicarious experiences, verbal persuasion, and emotional arousal (Van Der Roest, Kliener, & Kliener, 2011). These aspects are inherent and an intrinsic part of both the classroom and physical education settings (Smith & Lounsbery, 2009).

The SET was chosen to describe the relationship between academic achievement and physical fitness, stemming from the likelihood that past mastery, vicarious experiences, verbal persuasion, and emotional arousal contribute to both physical and academic aspects of achievement, and enhances the physical fitness-academic performance relationship via the mechanisms of task-carryover (Tollefson, 2000) and improved self-image (Van Der Roest et al., 2011). For example, the aspect of task-carryover, when relating task difficulty and past performance, links a cognitive task with a physical task if the student equates the degree of difficulty and effort necessary for completing a new task with past performance on another or similar task. Through vicarious arousal, a student might observe a peer with whom he or she feels equal in skill and intellect. As the students observe a competent peer, they may feel a higher sense of self-efficacy in performing the same task. Positive verbal persuasion and emotional arousal from teachers, self and peers may develop competence for the given task, and a sense of increased self-efficacy. The complementary relationship of self-efficacy with the more global self-esteem enhances subsequent task mastery, which might then radiate into other challenges in the student's existence (Van Der Roest et al., 2011). These theories are explained in Chapter 2.

Nature of the Study

In this study I utilized the results of the 2012 FITNESSGRAM data, and the 2011-2012 school year CST academic testing results from freshmen in 40 schools within the same school district. The population was convenience-based and only evaluated ninth grade student data, as it is the only high school grade tested via FITNESSGRAM. The sample contained only the students who passed at least five of the six FITNESSGRAM tests, and who had completed both the math and English language arts portions of the CST. Students are not considered physically fit according to the FITNESSGRAM criteria unless they meet the Healthy Fitness Zone (HFZ) in at least five of the six fitness standards. The FITNESSGRAM data was first categorized into optimal and minimal fitness levels according to the FITNESSGRAM test criterion, then, subcategorized within the minimal fitness group based on the specific fitness test weakness. Comparisons of the calculated CST *t* score means were made among fitness level and academic test groups. The first tier of data analysis utilized the independent samples *t*-test in order to analyze differences in academic achievement *t*-score means between the optimal fitness group and the minimal fitness group. The second tier, contingent upon a difference in *t* score means, further delineated the differences among the levels within the minimal fitness group. This evaluation method employed a new perspective that has not previously been utilized in order to demonstrate which fitness components are most associated with higher academic achievement in minimally fit students.

The dependent variables included the two content areas of ELA and the math subtests (comprised of the subtests of geometry, algebra 1, or algebra 2, contingent on which class the student is taking at the time) for the 2011-2012 CST academic achievement test. The independent variable was physical fitness level based on minimal test criteria set forth by the FITNESSGRAM. Distant variables and covariates included gender and ethnicity. According to the G*Power analysis program, an online tool for researchers to calculate the sample sizes necessary for a preferred effect size, the data from at least 1900 participants must be analyzed in order to give the desired effect size of at least 0.80 with a confidence interval of 0.95 (Faul, Erdfelder, Lang, & Buchner, 2009).

Data were collected, with the permission from the school district, using the DataDirector student database. Individual student data remained anonymous by using a regenerated four digit number as the participant identifier. Students' CST academic achievement raw scaled scores in each math and ELA test were collected. Each CST math subtest was scored differently; therefore, the raw scores were converted to *z*-scores for standardized representation, and then recalculated to *t* scores with a scale from one to 100 and a mean of 50 and a standard deviation of 10 for simpler comparison. English scores were also converted in this manner. FITNESSGRAM test scores were described as pass or fail. Data were analyzed using the IBM Statistics Program Version 21.0.0 (IBM Corp, 2012).

Definition of Terms

The following terms are used throughout this manuscript:

Academic achievement: Outcomes on standardized achievement tests measuring specific academic skill areas, such as reading and mathematics (Malecki & Elliot, 2002).

Aerobic capacity: Estimated maximal oxygen uptake by working muscles. The ability of the cardiorespiratory system to efficiently deliver oxygen to working muscles (Welk, Laurson, Eisenman, & Cureton, 2011); synonymous also with cardiorespiratory fitness, cardiovascular fitness.

Body composition: The proportion of fat-free mass such as muscle, bone, vital organs, and tissues to fat mass in the body (California Department of Education [CDE], 2006)

Body mass index: The ratio of a person's body weight in kilograms to the square of their height in meters. It is utilized as an indicator of body fatness for most people (Centers for Disease Control and Prevention, 2011).

The California Standards Test (CST): The standardized academic test administered to ninth grade students in the sample schools. Students take various tests from grade two through eleven in math, science, English language arts (writing and reading), and social science (San Diego Unified School District, 2013).

Health-related physical fitness: Consists of aerobic capacity, body composition, flexibility, muscle strength, and muscle endurance. Achievement of healthy levels of these five components is associated with a positive state of well-being with a low risk of premature health problems and adequate energy to participate in a variety of physical activities (CDE, 2006).

Healthy Fitness Zone (HFZ): The minimum criterion-referenced standard necessary to be considered physically fit in the FITNESSGRAM physical fitness test. The zone represents the average range of scores that offer protection against diseases that result from sedentary living (CDE, 2006)

FITNESSGRAM: A criterion-referenced, comprehensive fitness battery for youth created by the Cooper Institute. FITNESSGRAM includes a variety of physical fitness tests designed to assess the five components of health-related fitness. The six testing components of FITNESSGRAM include aerobic capacity, BMI, upper and lower body flexibility, muscle strength and endurance, abdominal strength, and trunk strength (Welk & Meredith, 2009).

Flexibility: The ability to move joints of the body through a normal range of motion (CDE, 2006)

Max heart rate (Max HR): The maximal sustainable heart rate in beats per minute (BPM) according to a person's age, gender, and physical fitness level (Karvonen & Vuorimaa, 1988).

Muscular endurance: The ability to sustain a working muscle contraction repetitively over time without tiring. The ability to hold one contraction for an extended period of time (CDE, 2006)

Minimal fitness: The designation given to students who successfully complete any five of a possible six components of the FITNESSGRAM

Muscular strength: The ability to exert maximum force for one repetition (CDE, 2006).

Optimal fitness: The designation given to students having no weaknesses in the physical fitness test, who successfully complete all six of a possible six components of the FITNESSGRAM.

Progressive Aerobic Cardiovascular Endurance Run (PACER): A multistage 20-meter shuttle-run of progressive intensity. The time limit to cross the 20-meter mark becomes shorter at each level completed. The result is represented as the number of laps successfully completed (Meredith & Welk, 2010).

Standardized Testing and Reporting Program (*STAR):* The program committee oversees the degree to which students are learning in California schools. It is used to evaluate how students and schools are performing each year. Students take tests from grade two through eleven in math, science, English language arts (writing and reading), and social science (San Diego Unified School District, 2013).

Trunk strength (core strength): The musculoskeletal fitness of the abdominal muscles, hamstrings, and back extensors together (Meredith & Welk, 2010).

Upper body strength: The musculoskeletal fitness of the arms, chest, and back together (Meredith & Welk, 2010).

VO2 max: The measured or estimated maximal oxygen uptake by working muscles. The ability of the cardiorespiratory system to efficiently deliver oxygen to muscles working at a maximum level (Welk, Laurson, Eisenmann, & Cureton, 2011).

Assumptions

I assumed only trained faculty administered fitness and academic tests to the students evaluated and results were reported accurately. I also assumed that students applied their best effort to all physical fitness and academic achievement tests. Data were collected via convenience sample, wherein many other teachers or administrators were responsible for test administration and grading rather than the current author, assuming no significant administration and grading variations.

Scope and Delimitations

The study examined ninth grade students who passed at least five of six FITNESSGRAM tests and took both math and English portions of the CST in a large San Diego, California school district between March and May of 2012. Only ninth grade students were chosen, as the FITNESSGRAM is only administered during the ninth grade. Passing fewer than five test components results in a failing overall score. The study was purposefully limited to a single cooperative school district to ensure ready access to data and to minimize variability among districts relative to differences in administrative policies and willingness to provide data, as well as to minimize the potentially wide disparities in student and environmental demographics among the various districts. Data were collected and analyzed, and conclusions made from these data were therefore specific for that single district. Although a small proportion of students in the district were used in the study, it may not precisely translate to generalizability for other school districts, counties, or states.

Limitations

Limitations in this study design included the small sample size of 5,416 students relative to the total district student population of over 132,000. Additionally, the district limited the data to subjective information derived from the test database. No qualitative or socioeconomic data were allowed to be collected in this study in order to protect student privacy. Inter-rater variability or consistency has not been specifically studied or reported for either the CST or the FITNESSGRAM. Each test is standardized over many years, and the tests have been repeatedly authenticated by user groups and researchers since the inception (Welk & Meredith, 2008). The reliability of the CST test scores is based upon having only objective responses to the test questions. The reliability of the FITNESSGRAM scores is predicated upon the above-mentioned limitations of unavoidable individual subjective assessment of performance of some of the physical test components. Only one school district participated in this study, therefore cross-district variability was not a factor. Face validity and reliability were maintained through the above-mentioned assumptions and limitations.

Significance of the Study

This study adds to the body of knowledge concerning minimal and optimal physical fitness, and scores received in the two subject areas of math and ELA in the academic achievement tests, will contribute to positive social change by increasing awareness regarding the relationship between student achievement and physical fitness. This information may allow policymakers and administrators to concurrently promote and develop a school curriculum that increases student academic achievement and student physical fitness. The specific methods of statistical analyses used in this study may clarify which components of minimal physical fitness positively influence academic achievement outcomes.

This information may provide district and school administrators, policy makers, and teachers with validation that physical education programs serve important functions in student academic achievement. Concerns of poor student academic achievement and increasing childhood obesity may both benefit from school curricula that include regular physical activities as a component of each school day.

Summary

Many researchers and authors have shown positive relationships among academic achievement, cognitive skills, and physical fitness. Childhood obesity and inactivity have resulted in widespread and increasing health-related problems and decreasing academic and cognitive functional performance in children. The purpose of this study was to quantitatively investigate how optimal and minimal physical fitness relate to CST academic achievement test performance in math and ELA in ninth grade students who successfully completed the FITNESSGRAM in a California school district. The dependent variables were the CST math and ELA scores converted to *t* scores. The independent variable was physical fitness level as met by the FITNESSGRAM tests. The theoretical applications of this study focused on the SCT as well as a subset of it, specifically the self-esteem theory.

The results of the study may add to the growing body of knowledge regarding the relationship between student physical fitness and academic achievement. Specific data on student subjective characteristics such as self-esteem were not available for this study, as per the policy of the school district being studied. Rather, a supposition was made that the students in the present study were representative and typical, in these respects, of those assessed in previous studies, which developed the tenets of the SET (Bandura, 1977, 2011; Van der Roest et al, 2011; Wigfield & Eccles, 2002), as well as previous authors' works that examined the SET and its association with physical activity and physical fitness (Katula & McAuley, 2001; Manley et al, 2013; McAuley, Courneya, & Lettunich 1991).

The next section of this manuscript contains a pertinent review of the literature regarding the relationships among physical fitness and academic achievement or cognitive functions. Relationships among physical fitness, physical activity and classroom achievement are discussed, as well as contrasting findings, possible cognitive effects of exercise and obesity on the brain, as well as physical education in the United States.

Chapter 2: Review of the Literature

Introduction

The purpose of this study was to quantitatively investigate how optimal and minimal physical fitness relate to the California Standards Test (CST) academic achievement test performance in math and ELA in ninth grade students. The vast majority of the authors who have studied the relationship between physical fitness and academic achievement found a positive association between physical fitness and achievement (California Department of Education [CDE], 2003; Carlson et al., 2008; Chomitz et al., 2009; Cooper, Bandelow, Nute, Morris, & Nevell, 2012; Davis, Tomporowski, Boyle, Waller, Miller, Nagligeri et al., 2007; Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Grissom, 2005; Hill, Williams, Aucott, Thompson, & Mon-Williams, 2011; Hillman, Erickson, & Kramer, 2008; Roberts, Freed, & McCarthy, 2010; Wittberg, Cottrell, Davis, & Northrup, 2008; Wittberg, Northrup, & Cottrell, 2010).. Others found no relationship; yet none have found a detrimental relationship (Martin & Chalmers, 2007).

This chapter begins with the research strategies and key words used when exploring the relationships between physical fitness and academic achievement. Next, the theoretical foundation and conceptual framework of the study are explained. The following sections review the pertinent literature beginning with an American history of physical fitness in physical education, and a review of literature involving physical fitness, physical activity, and classroom achievement, including some contrasting findings and negative results. Next, pertinent literature regarding physical activity and classroom performance are presented, followed by cognitive evidence regarding the possible effects of cardiovascular exercise and obesity upon the brain. Finally, a discussion of the issues regarding physical education in present-day America concludes the review. A brief summary of the literature completes the chapter and introduces the ensuing chapter.

Literature Search Strategy

Literature citations were obtained from peer-reviewed journal articles, the EBSCO database and library, Google Scholar, and personal subscriptions to American Physiological Association (APA), publications, including *Health Psychology, Journal Watch: Psychiatry,* and *Sport, Exercise, & Performance Psychology*. Search terms included *physical fitness and academic achievement*, *physical fitness testing and achievement testing*, and *FITNESSGRAM and academic achievement testing*. The scope of the literature included student academic achievement and physical fitness, the cognitive benefits of physical fitness, neurobiological effects of physical fitness, the history of physical fitness and academic achievement in schools, and physical fitness throughout history.

Theoretical Foundation and Conceptual Framework

Bandura's social cognitive theory (SCT; 1986) provided the theoretical foundation for this study. Bandura posited that human achievement depends upon interactions among an individual's behaviors, personal factors such as thoughts and beliefs, and environmental conditions. Good and Brophy (1995), citing the original work of Bandura (1986), described learning as being mediated through five basic cognitive skills: symbolization, vicarious learning, forethought, self-regulation, and self-reflection. The specific component of the SCT related directly to the present study is the self-efficacy theory (SET; Bandura, 1977). Wigfield and Ecles (2001) described self-efficacy as a situation-specific form of self-confidence, with the belief that competent individuals can do what needs to be executed for a particular situation in order to be successful. They also stated that self-efficacy influences the person's choice of task, the effort put forth, the persistence given, and the final outcome. Bandura (2004) explained that, "self-efficacy influences behavior both directly and via influence on other determinants" (p. 145). He also proposed that higher self-efficacy results in the setting of loftier goals, and more determination to attaining those goals.

Several authors have expressed self-efficacy as a developed phenomenon that may be modified through four major sources including past performance accomplishments, vicarious experiences, verbal persuasion, and emotional arousal (Van Der Roest, Kliener, & Kliener, 2011). Others explained that these aspects were inherent and integral parts of both the classroom and physical education settings (Smith & Lounsbery, 2009). Manley et al. (2013) studied the effects of physical activity, aerobic fitness, and BMI on self-efficacy in middle school children using a pedometer intervention program. The authors concluded that post-program self-efficacy levels increase from pre-program levels, especially in individuals who also achieved greater cardiovascular fitness. The authors also reported positive correlations between physical activity and self-esteem, as well as between cardiovascular fitness and self-esteem. They reported a negative relationship between elevated BMI and self-efficacy. The intervention group had small, but significant, improvements in self-efficacy, cardiovascular fitness, and BMI level, suggesting that increasing student physical fitness may help to increase student self-efficacy.

McAuley, Courneya, and Lettunich (1991) examined the effects of acute and long-term exercise on self-efficacy using specific physical fitness tasks in order to test for commonality of effects. The authors found that there were some specific aspects of carryover between tasks. For example, sit-up self-efficacy, a component of muscular strength rather than cardiovascular endurance, increased independently from the increase attributable to training with a specific cardiovascular task-oriented goal.

Katula and McAuley (2001) affirmed an evolving body of evidence regarding physical activity, physical fitness, and self-efficacy, acknowledging the reciprocal relationships among these factors. The authors employed a 20-week exercise program designed to increase all aspects of health-related physical fitness including aerobic capacity, BMI, flexibility, muscle strength, and muscle endurance. Physical fitness tests for each aspect were given at five-week intervals, the results shared with participants, and a self-efficacy scale was given after feedback was given. It was shown that self-efficacy increases incrementally with increases in physical fitness, and that there was some task-carryover between physical fitness aspects. The authors posited that self-efficacy is considered to be both a determinant and a consequence of physical activity and fitness. For example, as physical fitness levels increase, self-efficacy toward physical fitness combined with task carryover and past mastery experiences might materialize into other academic missions, increasing the likelihood of better academic performance. Other authors have noted neurochemical changes associated with increased self-efficacy. Van Der Roest et al. (2011) indicated that dopamine, serotonin, increased alpha wave activity, and the amino acid, glutamine are additional variables on general self-efficacy. The study authors recognized that these variables, by their contributions to long-term memory and decreased stress and anxiety, are adjoined to SET's attributes of performance mastery and vicarious learning. The SET also advocated that individuals' past mastery of a similar task warranted their expectation of comparable task mastery in the future. Task-mastery increased self-efficacy, which in turn increased the more stable and global characteristic of self-confidence (Weinberg & Gould, 2007; Wigfield & Eccles, 2002).

The SET was chosen to describe the relationship between academic achievement and physical fitness, stemming from the likelihood that past mastery, vicarious experiences, verbal persuasion, and emotional arousal may contribute to both physical and academic aspects of achievement in the form of task-carryover (Tollefson, 2000) and improved self-image (Van Der Roest et al., 2011). For example, the aspect of task-carryover, when related to task difficulty and past performance, could be used to link a cognitive task with a physical task if the student equated the degree of difficulty and effort necessary for the new task with the past performance on a task the student had mastered previously.

American History of Physical Fitness in Physical Education

Many references, some as early as the fifth century BC, have been made relative to the importance and attention paid to physical fitness, healthy minds, and healthy bodies. Ancient philosophers, physicians, statesmen, military leaders, scholars, and rulers, including Hippocrates, Aristotle, Homer, Juvenal, among others, recognized that fitness and health were important, not only to individual esthetics, but also for such things as prevention and recovery from disease, physical development and maintenance, the welfare of society, preparedness for war, and even the preservation of civilization (Siedentop, 1991; Van Dalen, 1971).

Benjamin Franklin first advocated youth physical fitness for individual, as well as national safety, and welfare. Thomas Jefferson promoted physical exercise for the body and for, "giving boldness, enterprise, and independence to the mind" (Van Dalen, 1971, p. 375). The pre-World War I focus upon physical education was for relaxation and recreation; however, in the outbreak of war, attention was centered more upon military fitness training. The first military draft physical examinations revealed that one-third of men were unfit for military service because of poor physical condition and another one-third had unacceptable health-related deficiencies. This issue was a significant stimulus for governmental action to improve physical education. Hence, the National Committee on Physical Education was formed. Its objectives were the promotion of federal and state legislation requiring physical education for all schoolchildren and the acquisition of monetary assistance for state departments of education to develop statewide programs under trained leadership (Siedentop, 1991).

Cutler, Glaeser, and Shapiro (2003) and Buckett (2007) illustrated that changes beginning in the 1960's regarding food technologies and demographics altered eating habits and leisure time activities, thus increasing consumption of convenience foods and decreasing the traditional home prepared, sit-down meals. Other authors published their findings that family units became splintered owing to the varying demands upon time from employment and other obligations or activities, as well as the younger generations wanting more independence and self-indulgence (APA org, 2013; Buckett, 2003; Wang, Beydoun, Liang, Caballero, & Kumanyika, 2008). Americans began to neglect physical activity and healthful nutrition to give more attention to work-related activities and sedentary leisure time (Cutler, Glaeser, & Shapiro, 2003; Wang et al., 2008). Flegal, Carroll, Ogden, and Curtin (2010) reported that 68% of Americans were overweight or obese. Wang et al. (2008) predicted that, given the current trend, all Americans would be overweight or obese by the year 2048.

Physical Fitness, Physical Activity and Classroom Achievement

Authors of several studies have shown relationships among obesity, inactivity, physical fitness, cognitive health, and academic achievement. Balke and Ware (1959) first published empirical evidence regarding the positive effects of physical exercise upon brain function, revealing that physically fit airmen had an increased ability to concentrate and maintain flight endurance relative to their unfit counterparts. More recently, several authors reported positive associations among physical fitness, physical activity and cognitive ability and academic achievement. Some authors have shown detrimental cognitive effects during acute high intensity exercise (Labelle, Bosquet, Mekary, & Bherer, 2013), and only a few researchers have debated no relationships by the use of secondary analyses of other authors' data (Martin & Chalmers, 2007). Kwak et al. (2009) stated that his research did not show that increasing school time in physical education or activity negatively affected academic performance. No researchers indicated that physical fitness was associated with a decrease in academic achievement (Dwyer et al., 2001; Grissom, 2005).

Ismail and Gruber (1967) conducted a study exploring the relationship between motor ability and academic achievement. The primary aim of the authors was to develop a motor aptitude battery test that would predict intellectual achievement in pre-adolescents. They concluded that there is a significant relationship between intellectual achievement and certain physical performance abilities sufficient to predict academic achievement outcomes. The second aim for the study was the development of an academic achievement-enhancing physical education program based upon the results of their analyses. The authors found no correlation between the physical education program and changes in students' IQ; however, a large improvement was observed in certain subject areas of the academic achievement scores. This was the first study in which authors were able to suggest the possibility of an identifiable variable correlating physical activity and academic learning in children. Others have subsequently studied similar relationships among physical activity and physical fitness with academic achievement and cognition.

Dwyer et al. (2001) examined some of the relationships in a large-scale study of multiple physical activity and physical fitness variables with scholastic achievement. This study included 7,961 children aged 7-15 years old from several schools. Scholastic ability was placed in five categories: excellent, above average, average, below average and poor. Physical activity was measured through an activity grid survey, which queried students' perceived activity level while participating in their activities during lunchtime, after school and at other times. Data included time and intensity level while walking or bicycling to school, during physical education class, and during after school sports, if applicable. Data were also analyzed relative to personal abilities such as being able to play an instrument or a sport. Categorical responses were, "not at all", "can do about average", or "can do very well". Physical fitness measures were very comprehensive, including assessments of body composition, BMI, hand-grip strength, leg power and strength, core and trunk strength, anaerobic power, respiratory capacity, cardiovascular fitness, physical work capacity, and upper and lower body flexibility. The authors noted many physical fitness associations with academic standing. High BMI and body composition were negatively related to scholastic achievement. Students who achieved a faster time in the 50-meter run, who performed more sit-ups, and who leapt greater distance in the standing long jump performed better scholastically. Cardiovascular fitness, lower body strength, and core strength were the most major positive correlates. High BMI and body composition were highly correlated with lower scholastic achievement. The authors indicated that the weak to moderate correlations nonetheless indicated a discrete relationship between physical fitness and scholastic performance. The authors also asserted that there may be a slight, yet significant, causal connection between these variables, and that subsequent study was necessary to confirm any findings (Dwyer et al., 2001).

Grissom (CDE, 2003) studied the relationship between physical fitness and academic success by specifically comparing academic achievement benchmarks to physical fitness test success using the data from 884,715 students in the fifth, seventh, and ninth grades in all California public schools. The purpose was to assess the possibility of an explicit relationship between physical fitness and academic achievement. Students' reading and mathematics percentile scores were matched with their respective results on the FITNESSGRAM scores based upon the number of physical fitness test categories, of a possible six, the students reached the Healthy Fitness Zone (HFZ) or better. Students scored progressively lower in math and reading achievement tests as the number of attained HFZ standards in the FITNESSGRAM declined. Students who achieved the HFZ in five or more of the fitness tests scored much higher in math and reading achievement tests. The correlations were higher in math than in English, and these relationships were higher for female than male students. Further analysis of each fitness test showed high positive correlations among mean academic achievement scores and aerobic capacity, healthy BMI, and flexibility (Grissom, 2003).

Grissom repeated the same study in 2004, with validating results. The same relationships were observed, and further analysis showed stronger correlations for females than males and stronger correlations for higher SES students than for lower SES students (Grissom, 2005). Grissom commented that ANOVA results do not support evidence of causality, although it was possible that better health and living conditions contribute to higher levels of academic achievement, and were conditions worthy of further study.

Wittberg, Northrup, and Cottrel (2009) repeated this method when comparing academic achievement and physical fitness test results in a study group of 968 fifth grade students in West Virginia. Rather than utilizing percentile scores for academic achievement, the math, reading, science, social studies, and language, scores were classified into five categories: novice, partial mastery, mastery, above mastery, and distinguished. FITNESSGRAM scores were dichotomous as having "passed", or "not passed" the HFZ. The same six fitness categories were scored as in Grissom's (2003, 2005) studies. All children who scored in the HFZ for aerobic capacity and abdominal strength scored significantly higher on all academic achievement tests than those who were in the "not passed" zone. Mathematics scores were significantly higher for children who passed the upper body strength and flexibility tests. BMI had no correlations with achievement test scores due to the relative uniformity of healthy BMI in the test population.

Castelli, Hillman, Buck, and Erwin (2007) investigated these associations by comparing each physical fitness component with academic achievement in third- and fifth-grade students in four schools in an Illinois school district. Two schools were academically satisfactory and the other two were low-achieving. Correlation analyses revealed that cardiovascular endurance, core strength, and muscle strength were positively correlated with total academic achievement and math achievement, but unrelated to reading achievement, regardless of school academic standing. BMI was a negative correlate with all three academic achievement indicators in all schools as well.

Chomitz et al. (2009) utilized logistic regression analyses in attempts to predict the odds of students passing academic achievement tests based upon their physical fitness test results. Academic scores were placed in the three categories of advanced, proficient and needs improvement. Fitness scores were placed in dichotomous categories of "passed" and "not passed" for each of the six specific testing areas. Results indicated that the odds of passing the English portion of the academic achievement test increased by 20% for each fitness test passed, holding gender, ethnicity, weight status, grade, and SES constant. The odds for passing math increased by 24% for each fitness test passed. Consistent with previous findings by the CDE (2003), Grissom (2005), Castelli et al. (2007), and Wittberg et al. (2009), physical fitness had the greatest influence upon mathematics achievement test scores.

The former studies placed physical fitness testing results into dichotomous categories as, "passed", or "not passed". The HFZ is a large interval depending upon the specific test; students may have only just passed or failed. Other students may score in the middle of the interval, or score close to passing, or close to failing. Roberts, Freed, and McCarthy (2010) placed physical fitness scores into quintiles paired with academic achievement scores labeled as, “far below basic”, “below basic”, “basic”, “proficient”, or “advanced”. The pediatric BMI percentile norms were converted to *z* scores for more practical interpretation of normal distribution. Students who did not achieve a passing mile run time for the cardiovascular fitness test scored significantly lower in the math, reading, and language arts portion of the academic achievement tests. The authors confirmed that decreasing quintiles of aerobic fitness were associated with progressively lower math and reading scores. For each additional minute slower than the aerobic fitness standard for the mile run, reading decreased by 1.1 points, and math achievement decreased by 1.9 points out of a possible 99 total points. Increasing quintiles of BMI were correlated with progressively lower academic scores in each achievement test. Students with a BMI considered overweight or obese scored significantly lower in all academic achievement tests compared with students with healthy BMI.

Van Deusen, Keldter, Kohl, Ranjit, and Perry (2011) also utilized this method of placing fitness scores in quintiles in hopes of obtaining more information regarding trends in magnitude and direction of the associations among each FITNESSGRAM test score and academic achievement scores in math and reading. Data were collected from 254,745 students, in third through eleventh grades, in thirteen Texas school districts. Fitness level quintiles were categorized by age and a mixed effects regression analysis was calculated. Analyses regarding gender, grade, and dose-response with respect to fitness scores and academic scores were also completed. The authors found that for each quintile increase in cardiovascular fitness, there was greater improvement in academic achievement. It was noted in this study that five components of fitness had positive linear associations with academic achievement. The single exception was BMI. Body mass index trend data unexpectedly showed that excessively low BMI was also associated with lower academic scores, giving rise to the possibility that being underweight may result in poor academic achievement. The strength of association among fitness variables showed that cardiovascular fitness had the largest interquartile difference and effect size followed by abdominal strength, push-ups, flexibility, and trunk lifts. Another trend apparent in this study, attributable to the wide range of age groups, was that the association between cardiovascular fitness and academic achievement appeared to peak in late middle school through early high school. With the large age variation of the study population, it was concluded that physical fitness was significantly associated with higher academic achievement throughout adolescence.

Utilizing continuous variables for fitness test scores rather than the dichotomous "pass" or "no pass" levels, Eveland-Sayers, Farley, Fuller, Morgan, and Caputo (2009) studied the associations between academic achievement and physical fitness. The researchers chose objective and numerically continuous variables rather than categorical variables or percentiles in order to identify specific trends in the relationships. Pearson's product moment correlations were used with each fitness component. Only 54 BMI scores of the 137 participants were reported. A significant positive correlation was found between time for the mile run and math achievement scores, but not with reading scores. Contrary to other studies, BMI had no correlation with either math or reading achievement. A limitation of this study was that the BMI of all 54 students was within the healthy range, which may have accounted for differences in BMI significance from other published findings.

A longitudinal study performed by London and Castrechini (2011) followed students from 5th grade fitness testing and academic achievement results through 7th and 9th grade. The purpose of the study was to determine whether alterations in physical fitness test scores throughout ensuing years also translated to changes in academic achievement. Students were placed in four categories: those who passed the personal FITNESSGRAM for two consecutive years; those who did not pass for both years; those who passed the first year, but not the second; and those who did not pass the first year, but passed the second. Academic achievement test data were placed into percentiles. Students who passed both years of FITNESSGRAM consistently scored higher in academic percentiles than those who did not pass either year of FITNESSGRAM. Students who first passed, then did not pass declined in academic percentile from the prior year, whereas students who first did not pass but then passed the next year increased in academic percentile the second year. The average academic percentile point increase made by students moving from "not passing" the FITNESSGRAM to "passing" the FITNESSGRAM was 2.5 percentage points in math and 5 percentage points in the English language arts standardized achievement test. The longitudinal nature of the study suggested that the positive associations were constant over time.

The authors also noted that students who were physically unfit but academically successful were generally from more economically advantaged backgrounds; fit students who performed below basic or far below basic in academic tests generally were from more economically disadvantaged backgrounds (London & Castrechini, 2011). They also stated that Latino male students were more likely to have changed from passing the FITNESSGRAM to not passing, and performing less well in academic scores. Chomitz (2003, 2005) previously noted the possibility of SES being a confounder in the physical fitness-academic achievement connection.

Using physical activity intensity as a possible variable in the relationship between physical fitness and academic achievement, Kwak et al. (2009) analyzed the relationship between cardiovascular fitness and academic achievement using academic grades, pubertal phase, body composition via subcutaneous fat thickness, cardiovascular fitness, and physical activity intensity as variables. Physical activity was measured by an accelerometer worn by students and placed in categories based upon metabolic equivalents (METS) from moderate (3-6 METS) to vigorous (>6 METS). Cardiovascular fitness was directly measured by maximum power output in watts. Secondary variables measured by survey included distal factors such as mother's education level, family structure, and parental involvement. Analyzing by gender, authors found in the first step of linear regression that when placing academic achievement as the dependent variable, distal variables explained 16% of the variance with academic achievement. When adding primary variables, the variance increased to 26%, with only vigorous physical activity being associated (29% variance explained) with academic achievement, even after including cardiovascular fitness as a variable.

The same analysis in boys revealed that improved academic achievement was only associated with pubertal phase. The distal variables explained 24% of the variance in academic achievement; however, when adding proximal variables, the variance increased by only 2%. Cardiovascular fitness was associated with academic achievement, which explained 30% of the variance. The authors contended that activity levels were distantly associated in discrete manners between genders, and concurred with results of previous authors' studies (Kwak et al., 2009).

Davis et al. (2007) also recognized that BMI and cardiovascular fitness were the fitness components most related with student academic achievement. Ninety-four sedentary and overweight children (mean age 9.2 years, BMI > 85th percentile) were placed in one of three randomized study groups. The control group received no treatment, yet underwent baseline and final cognitive assessment testing. The low-intensity exercise group participated in a 20-minute exercise protocol with an average heart rate of 150 BPM or greater. The high-intensity exercise group participated in two exercise bouts of 20 minutes each with a short break between. Activities began with a five-minute warm-up, followed by running games, tag games, modified basketball, and soccer activities, none of which were competitive. The intervention lasted for 10 school days. The Cognitive Assessment System (CAS) was administered before and following exercise intervention. This test was chosen due to its well-documented validity and reliability regarding demographic variables and assessment of student performance in such things as planning, attention, and proficiency in simultaneous and successive processes. These processes required full executive function, a major factor in planning, organizing, self-monitoring, goal-directed behavior, and adjustments in behavior as stimuli change (Silver, 2011; Viadero, 2011). The high-intensity group made significant improvements in treadmill test times, while the low intensity and control groups did not. The high-intensity exercise group performed significantly better on the CAS compared with the control group. There was no statistical difference between either the control and low intensity groups, or the low intensity and high intensity groups.

Wittberg, Cottrell, Davis, and Northrup (2008) examined the correlation between aerobic fitness threshold and academic achievement using 1,941 fifth grade students, aged nine to 13 years. Academic achievement tests and the FITNESSGRAM aerobic capacity tests were analyzed for patterns regarding time and the number of PACER laps completed. The achievement test scores for each academic content area were classified into five categories: novice, partial mastery, mastery, above mastery, and distinguished. Fitness achievement was analyzed using the raw data variables on a continuous scale rather than the usual FITNESSGRAM "pass" or "no pass" criteria. Analyses showed that the higher PACER scores had a significant positive correlations with academic test scores in girls, but not boys. The mile run time had a significant positive correlation with academic test scores in boys, but not girls. There was an identifiable performance peak in the correlation data regarding the boys' mile run time, giving possible evidence for a threshold at nine minutes. Two performance peaks were found in the girls' PACER data. A sharp peak was seen at 12 laps, followed by a slow increase with subsequent completed laps culminating in a sharper peak at 30 laps completed. The authors theorized that varying athletic ability among children might have an impact upon motivation or self-efficacy to attain the HFZ.

Contrasting Findings and Negative Results

The aforementioned studies explained the relationships among components of physical fitness and academic achievement test scores. Whereas Kwak et al. (2009) concluded that exercise intensity might have been a distinct variable in this positive relationship between physical fitness and academic achievement, especially in boys, Labelle, Bosquet, Mekary, and Bherer (2013) found that acute bouts of cardiovascular exercise led to an immediate but temporary decline in executive control as a function of exercise intensity and physical fitness level. In this study, 37 adult participants (19 men and 18 women) were first given a baseline computerized modified Stroop task involving cognitive tasks such as denomination, inhibition and switching conditions. They were then assessed for cardiovascular fitness level via maximal graded exercise testing. Participants were placed in either high or low fitness categories based upon VO2 max norms and peak power output (PPO). The modified Stroop task was given during exercise bouts on a stationary bicycle ergometer at 40%, 60% and 80% of the participant's PPO ability. It was found that both lower and higher fit individuals experienced difficulty in the cognitive tests during exercise as exercise intensity increased. However, this observation was much less pronounced in higher fit individuals. Lower fit individuals showed a more prolonged reaction time and error rate in all categories than the higher fit individuals. Both groups' neurological performance abilities declined as exercise intensity reached 80% PPO capacity. Acute bouts of high intensity exercise had immediate inhibitory effects upon cognitive functioning. While Davis et al. (2007) and Kwak et al. (2009) affirmed that regular high intensity exercise enhanced the relationship between physical fitness and academic achievement, Labelle and colleagues (2013) reported that immediate, durational, and interim effects of acute bouts of high intensity exercise may cause an acute and temporary decline in cognitive function.

The positive relationships among components of physical fitness and scores on academic achievement tests cited in the literature are not without criticism. Martin and Chalmers (2007) reviewed many of the studies' statistical analyses and methodologies. The author challenged Grissom's studies (CDE, 2003; Grissom, 2005), stating that no standard deviation was given, no effect size was measured, and no statistical analyses were given in the press-release versions that were announced to the general media. The original documents did contain this information (CDE, 2003; Grissom, 2005). The author also argued that correct interpretation must consider the statistical significance, as well as the practical significance of the findings, mentioning that, "with large sample sizes, it is possible to calculate statistical significance on a result that has no practical significance" (p. 219). The author also claimed that the correlations found in Grissom's studies were, "…of little practical importance except in unusual circumstances, perhaps of theoretical values" (p. 224). Moreover, the author disputed the validity of the physical fitness tests and protocols, the comparison of raw scores vs. percentiles in academic tests, and that no district or state would demonstrate directly similar descriptive statistics. The two main premises of the review were that no causal links should be made between physical fitness and academic achievement, no matter the relationship strength, and that none of the data sets studied provided statistical evidence that would suggest that an increase in school physical education and physical fitness levels in students would attain higher academic achievement. Consequently, the authors assert that physical education programs should not be advocated as a means of increasing academic achievement.

Physical Activity and Classroom Performance

Most of the researchers who have studied the relationships between physical fitness and academic achievement cite cardiovascular fitness as a main variable. Moderate to vigorous physical activity requires a sustained cardiovascular effort of at least 65-85% of an individual's VO2 max. This type of activity, done on a regular basis, will create a training response in cardiovascular fitness and other aspects of physical fitness (Bryant & Green, 2009). Hill et al. (2010) studied the effects of purposeful physical exercise upon cognition, in primary school children using a teacher-led physical fitness program. Students (N = 1,224), aged eight to 11 years, from six elementary schools were placed in two groups. Group A received a 30-minute physical fitness program for one week, while group B did not. Both groups were given one test per day from a series of psychometric tests that placed high demand upon attention division and executive function. At the end of the first week of the trials, the entire battery of psychometric tests was given. The following week, the groups assumed opposite roles, and the study was repeated. It was found that group B scored significantly higher in mean overall psychometric performance by the end of the two-week testing period. Practice effects in the cognitive testing may have explained part of the improvement in week one; however, improvements occurred over and above cognitive practice effects in group B, which the authors attributed to the exercise intervention. The authors also posited that the results of this investigation confirm findings of other neurological studies (Kwak et al., 2009; Labelle et al., 2013), indicating that physical exercise influences cognition possibly by effecting arousal.

Researchers have also examined the effects of exercise bouts during various times of the day. Cooper et al. (2012) studied the effects of a mid-morning 10-minute exercise regimen on adolescents' cognitive functioning. Variables included blood glucose levels, mood inventory, and amount of breakfast eaten in addition to exercise as the independent variable. Dependent variables were the cognitive function tests including a visual search test, Stroop test, and Sternberg paradigm. Two groups were counter-balanced. One group was the testing group, the other the resting group for the first trial. The following trial, the groups were reversed. These tests were performed 30 minutes before and 45 minutes after the 10-minute exercise period, which was performed at 85% maximum heart rate. Overall, there were improvements in each aspect of cognitive function, particularly in response times. Participants received a healthy breakfast meal, regardless of their study group. According to the authors, glucose is the primary energy substrate used by the brain. The post-exercise group repeatedly showed higher blood glucose and plasma insulin levels, which led the authors to credit both mid-morning exercise and a healthy meal for the improvement in cognition.

Possible Effects of Cardiovascular Exercise and Obesity upon the Brain

Current researchers who have studied cognition in relation to cardiovascular fitness have indicated that exercised-induced neurological changes affect executive functioning. The changes were both neurotropic and morphological, causing alterations in blood flow to the particular area of the brain where executive functioning occurs. Hillman, Erickson, and Kramer (2008) summarized recent findings regarding aerobic fitness and brain function. Higher levels of physical fitness were related to larger brain volumes in areas related to key executive functions. There was increased cerebral blood volume in participants who were involved in exercise intervention trials. Authors studying exercise intervention in mice revealed that moderate to vigorous exercise increased cell proliferation and survival in the hippocampus and dentate gyrus areas of the brain, which are associated with episodic and long-term memory. The brains of mice that regularly exercised at high levels contained higher levels of neurotropic factors that specifically increased capillary bed genesis and other endocrine molecules that exclusively aided growth of new brain tissue (Silver, 2011; Viadero, 2011).

Studies have linked being overweight or obese to reduced brain volume in young adults as well as throughout adulthood. Guntstad et al. (2008) studied magnetic neuroimaging data of brain volume using a range of participants aged 17 to 79 years old, and BMI ranges from normal to overweight and obese. Neuroimaging was measured using magnetic resonance imaging (MRI) and three-dimensional figures were analyzed for volume. Obese participants had smaller areas of gray matter volume than normal or overweight participants after adjusting for age. Ward et al. (2005) also studied the effect of BMI on global brain volume. The authors indicated that elevated BMI was associated with reduced brain volumes, and that elevated diastolic blood pressure was associated with decreased global brain volume.

Areas of most volume loss in each study included the frontal, temporal, and parietal regions. These areas were found to be variably associated with executive function, long-term memory, recognitions of consequences from chosen action, long-term memory, and episodic memory. Raji et al. (2010) examined a five-year span of individual brain volume changes in 94 elderly humans. As much as a 4% loss in overweight subjects and an 8% loss in obese subjects was confirmed. Authors explained that normal human brain volume loss due to aging ranges from 0.5% to 1.0% in this time span; a loss of 4% is regarded as severe brain degeneration.

Physical Education in Present Day America

Authors utilizing national statistics and fitness testing data indicate that the youth of America are not physically fit (NASPE, 2013). Only 12.5% of elementary schoolchildren receive the NASPE standard of 200 minutes every 10 days with a physical education specialist. The NASPE requirement for middle and high school students of 400 minutes every 10 days is only being met by the 22% of the nation's middle and high schools (Carlson et al., 2008).

As of 2012, twenty-four states and 67% of school districts have no policies regarding time requirement mandates for physical education. Only 4% of public elementary schools in America meet the elementary physical education time requirement mandate (Rochman, 2011). Authors have shown that between the ages of 10 and 17 years, recreational activity levels drop by an average of 5% per year and that physically inactive children are more likely to remain inactive throughout their adult lives (CDC, 2013). Schools face increasing pressure to perform better academically since the enactment of the NCLB policy, having progressively replaced many physical activity opportunities and physical education classes with more core content time in classrooms (Catweli, 2006; Hardman & Marshall, 2005; Jennings & Renter, 2006; Rochman, 2011, Sallis, 2010; Smith & Lounsberry, 2009).

Most of the researchers who have explored the relationship between physical fitness and academic achievement note that there is likely no single correlation that either defines or explains a cause and effect relationship between academic achievement and physical fitness. Nonetheless, authors agree that there is a positive relationship among certain factors.

Summary

Sporadic promotion of physical fitness has been apparent in the literature from ancient times to the present. Reasons for maintaining fitness varied from personal satisfaction, to readiness for war, among others. The current national renewed interest in physical fitness began in the 1960's when increases in certain health problems were perceived. The health disparities were thought to be a result of changing demographics and advances in food technology. Many governmental and non-governmental agencies recognized that a growing number of Americans were overweight or obese, due in part to overeating and reduced participation in physical exercise. Programs were initiated to combat the decline in physical fitness with some success. Years later, the enactment of NCLB resulted in the dissipation of opportunities for physical activity for schoolchildren.

Many authors reported in numerous and varied studies that students who were physically fit attained higher test scores in some subject areas of standard academic achievement tests relative to their unfit counterparts. A consistent negative influence upon test scores was a high BMI. The cause-effect relationship between physical fitness and academic achievement has not been positively identified; some researchers site improved self-efficacy as both a determinant and a consequence of the relationship. Other authors posit that physiological alterations in the brain or endocrine system may contribute to these relationships as well as other cognitive functions such as improved long-term memory, reduced stress and anxiety, and improved executive skills.

Although the cause-effect relationship between physical fitness and academic achievement remains unsettled, most researchers and authors agree that certain positive relationships exist among some of the components of the physical fitness test and scores in certain subject areas of academic achievement tests. Researchers agree that additional and more intricate methods are required to more fully understand these relationships. The present study explored the relationships among optimal and minimal physical fitness, physical fitness weaknesses, and academic achievement.

The State Board of Education in California has established methods and criteria for the assessment of satisfactory student attainment in both physical fitness and academic achievement, namely the FITNESSGRAM and the CSTs. Working within the tenets and restrictions of these specifications, a previously unexplored method was utilized to evaluate possible relationships among physical fitness and academic achievement test scores in ninth grade students in a San Diego school district.

The following chapter describes the methodology utilized in the present study and in the manner in which optimal and minimal physical fitness was compared with standardized scores in math and ELA for any significant influence upon academic achievement. Descriptions and administration of each FITNESSGRAM test are discussed and the academic achievement tests are explained. Primary analysis compared the minimally and optimally fit groups with academic scores on the CST tests of math and ELA. Secondary analyses compared the different fitness test weaknesses within the minimally fit group, and further examined these differences within gender and ethnicity subgroups in order to determine factors that contributed to these differences.

Chapter 3: Research Method

Introduction

The purpose of this study was to quantitatively investigate how optimal and minimal physical fitness relate to the CST academic achievement test performance in math and ELA in ninth grade students. Optimal physical fitness is described as passing all six FITNESSGRAM tests with no weakness. Minimal fitness level is described as passing any five of the six FITNESSGRAM tests and was subcategorized by the specific test weakness.

Within this chapter, the Research Design and Rationale section includes the design plan as to how the interrelation(s) among the components of physical fitness and the scores on the subject areas of the academic achievement tests were assessed. The Methodology section explains the population and sampling protocols and the procedures for obtaining the data set. The Instrumentation and Operational Constructs section explains the testing instruments of the FITNESSGRAM and the CST. The variables in each testing instrument are defined and explained. The Data Analysis Plan clarifies the data evaluation procedures and the key parameters used in the process. The Ethical Procedures section describes the permission acquisition procedures and ethical concerns related to acquiring archival data. The summary reviews the major sections of the chapter and provides transition to the next chapter.

Research Design and Rationale

The dependent variables were the calculated *t* scores received in the ELA and each of the math portions of the academic achievement tests. The independent variable was physical fitness level, either optimal or minimal fitness. Physical fitness test components are judged as either "pass" or "fail" based upon the HFZ for the individuals. The statistical design was quantitative in nature, comparing optimal and minimal levels of physical fitness with calculated standardized *t* scores in math and ELA achievement tests. Primary calculations converted all subtest scores into *z* scores for a standardized representation, then to *t* scores scaled from one to 100 with a mean of 50 and a standard deviation of 10 for simple comparison. An independent samples *t* test was used to determine if there was a difference between the optimal and minimal fitness groups. Next, an ANOVA was utilized to ascertain whether there were differences within the minimally fit groups based upon fitness test weakness. Descriptive statistics, including the range, mean, and standard deviation were calculated for each independent variable. The statistical design was limited by the tenets and restrictions mandated by the policies of the members of the California Board of Education, as well as administrators in the school district in which the study was conducted. These policies included the requirement that students successfully complete at least five of the six components of FITNESSGRAM physical fitness test to receive a passing grade, thereby limiting the study to students who successfully passed the FITNESSGRAM. Likewise, the dependent variables were restricted to two content areas of the CST, as the achievement tests for ninth grade students are administered in math and ELA only. Prior researchers have not explored the various weaknesses within minimal physical fitness levels achieved in the FITNESSGRAM. This novel method of analysis has not been previously utilized in scientific research methods, and may provide new information concerning the relationships among physical fitness and academic achievement.

Methodology

The study sample consisted of ninth grade students, of either sex, from the same school district. Demographic data including gender and ethnicity were used as covariates in the secondary and post-hoc analyses. Nebulous factors such as motivation, personal pride, competitiveness, among other ill-defined or imprecise factors, were not included in the study because of the inability to accurately measure each or the effects upon performance or learning. It was assumed that students enlisted their best collective efforts in both the physical and the academic tests.

Population

The high school student population in the San Diego school district being studied totals 29,855 students in grades nine through twelve. (San Diego Unified School District, 2014). Only of 8,212 ninth grade students in the district took the FITNESSGRAM physical fitness test (California Department of Education, 2014), as the physical fitness test is only administered in the ninth grade year. The sample specifically included the 5,416 students who passed at least five of the six required physical fitness tests for the FITNESSGRAM and also completed both the math and ELA portions of the CST. The minimum sample size required in order to attain statistical significance was 1,900 students to attain statistical significance (Faul, Erdfelder, Lang, & Buchner, 2009). A full demographic description of this population as well as the sample is shown in Chapter 4.

Sampling Procedures

The data were queried from the DataDirector database from the school district in which the schools reside. Data were obtained anonymously using the students' matriculation numbers and then re-identified by a sequential, linear four-digit number.

Individual student data points included which five or six FITNESSGRAM components were successfully completed, the raw math scores in geometry, algebra 1, or algebra 2, and ELA raw scores on the CST test. Other data included sex, ethnicity, and English language level. The data were imported into SPSS for statistical analyses. The G*Power3 power analysis calculation program by Faul et al. (2009), indicated that the sample size must be at least 400 participants with 60-70 per group in order to generate the desired effect size of $\omega = 0.80$. The significance level was set as $p = .05$. The *F*-test was utilized to ascertain homogeneity of variance. Alternative tests included the Dunnets's *C* and the Levine's test if the variance proved to be non-homogeneous.

Data Collection Procedures

The archival student data were collected from the school district DataDirector database once the district research committee had granted permission. All necessary documents are located in the appendix section. There was no direct interaction with students; all data are available anonymously via public domain. Names of students were not used; a linear 4-digit number was the identifying attribute.

The sample was 5,416 ninth grade students from a San Diego school district. The target sample specifically included students in the district population who successfully passed at least five of six components of the required FITNESSGRAM tests, and who completed both the math and ELA portions of the CST. Standardized academic testing is done annually in May, and the FITNESSGRAM is done annually in March. The results contained in this study were taken from the 2011-2012 school year. Students who passed the minimum of five of the six physical fitness components of the FITNESSGRAM test were categorized as minimally fit and further categorized by the specific weakness the student exhibited in the six FITNESSGRAM tests. Students who passed each of the six FITNESSGRAM tests were categorized as optimally fit, synonymous with "no weakness" in various tables within the results section. Academic achievement raw scores were collected in the content areas of math, including the subtests of geometry, algebra 1, or algebra 2, and ELA. Raw scores of each test were converted to *z* scores, and then recalculated to *t*-score from one to 100, with a mean of 50 and standard deviation of 10. Comparisons of means were made among specific groups of fitness test results using the independent samples *t*-test and ANOVA testing.

Instrumentation and Operational Constructs

The two testing instruments used in this study are the Coopers Institute FITNESSGRAM (Welk & Meredith, 2008) and the CST (CDE Blueprints, 2013). The 2011 version of the FITNESSGRAM incorporated new criterion-referenced standards to improve test validity. The new standards were designed to account for the wide range of growth rates and physical differences between genders in children between the ages of nine and 14 years (Welk et al., 2011). The FITNESSGRAM has been widely utilized by schools and districts since 1994, and was adopted by the administrators of the California STAR program in 1997.

The six components of the FITNESSGRAM include the aerobic capacity, BMI, flexibility, upper body strength, trunk strength, and abdominal strength. The aerobic capacity component consists of three parts: the PACER test, the one-mile run test, and the Rockport one-mile walk test. Only one of these parts must be passed successfully in order to meet the HFZ in this component. The PACER test is a progressively difficult shuttle run in which students must achieve a minimum number of laps to pass, which is adjusted for the students age, gender and BMI. The one-mile run test is a measure of the time it takes a student to travel the distance of one mile. The completion time for passing must fall within the HFZ, which is adjusted for the individual's BMI, age and gender. The Rockport walk test may be utilized in lieu of the one-mile run when a student's BMI exceeds 35 and running is not recommended. The student walks one mile and is instructed not to run. Upon completion, the time is recorded and a one-minute heart rate is measured. The completion time for the mile, resting heart rate, age, gender, height and weight are used to calculate the HFZ the walk test.

The BMI is calculated based on the student's height and weight. The HFZ for this component is adjusted for the age and gender of the student. The flexibility component consists of two parts, one of which must be successfully completed to pass. The shoulder flexion test assesses the range of motion of the upper arm and shoulder girdle by testing the student's ability to touch the fingertips together behind the back by reaching over the shoulder with one arm, and behind the back with the other. The second maneuver, the Back-Saver Sit and Reach test, assesses the range of motion of the hamstring muscles, pelvis, and lower back. The test is administered on one leg at a time using a hamstring flexometer. The foot of the testing leg is placed at the base of the flexometer and the student is instructed to push the lever forward as far as possible without bending the knee. A passing score is adjusted for age and gender. In order to pass the flexibility portion of this test, only one of these tests must be completed successfully.

The upper body strength and endurance component of the FITNESSGRAM consists of four individual tests, only one of which must be successfully completed to pass. The HFZ for each test is adjusted for student age and gender. The push-up test is set to a standard cadence and students must keep the knees and stomach off the floor and be able to complete at least a full 90-degree range of arm motion. When the student is unable to maintain cadence, unable to complete at least 90-degrees of arm motion, or if a knee, the stomach, or chest touches the ground, the test is terminated. The flexed-arm hang is a static test of upper body strength and endurance. The student must maintain a vertical position while the chin is positioned above the bar for a minimum of eight seconds for females and 15 seconds for males. Another option for this portion of the test is the pull-up test, although this test is not used routinely because many students are unable to perform one pull-up (Meredith & Welk, 2010). The student must start from a hanging position, and then pull the body upward until the chin above the bar. The test is terminated when the participant can no longer perform the movement correctly. A fourth option for this portion of the test is the modified pull-up in which the bar is lowered to three feet off of the ground. The student starts the pull-up with the feet outstretched on the floor and body in a supine position, hanging from the arms. The student must pull the chin to within seven inches of the bar for the repetition to count.

The Trunk Lift test assesses the strength of the back extensors and the stability of the hamstring muscles. The student lies in a prone position on the floor with arms at the side. When cued, students are to lift the chin as high off of the ground as possible and to hold for measurement in inches from the ground to the bottom of the student's chin. A passing score is adjusted for age and gender.

The Abdominal Strength and Endurance test assesses the strength and endurance of the rectus abdominus and hip flexor muscles. The test is performed to a cadence and the student must lift the trunk high enough off the ground that the hands on the floor only advance exactly four inches forward. The test is terminated when the cadence is broken, form is no longer attainable, or the required extent of movement is not attained. The result is the number of successful repetitions and the HFZ is adjusted for age and gender.

The FITNESSGRAM for ninth graders is given during a three-week testing window in March of each school year. Students are encouraged to make multiple attempts in order to meet the testing criteria. The CST's are given in May of each year to all students except seniors. The tests are timed and make-up opportunities are allowed only for students who missed tests.

The CSTs are criterion-referenced tests that assess students' level of learning in the California content standards in ELA, mathematics, science, and social science. The tests students take depend on the level of the content area in which they are currently enrolled, and each subtest within content areas is scored differently. The tests are developed yearly by California educators and test developers, and are specifically designed to evaluate California students' achievement (SDUSD, 2013). Practice tests and sample questions are posted on the California Department of Education website, including the California standards that should be met by students in each topic area (CDE, 2013). Students are encouraged to practice tests outside of the classroom; however, teachers are not allowed to teach testing items in class.

Data Analysis Plan

The software used in statistical analyses was IBM SPSS Statistics Program version 21.0.0.0 (2012). Screening and cleaning procedures were utilized based upon the availability and reliability of student test score data. If data were missing in any specific testing area, the student's data were not included in the analyses.

Research Questions and Hypotheses

The research questions and hypotheses for this study were:

Research Question 1: Are there significant differences in academic achievement in the areas of math and/or ELA between optimal and minimal physical fitness levels?

H_o: There are no differences in math and ELA test scores between optimal and minimal fitness groups.

H_a: There is a difference in math and ELA test scores between optimal and minimal fitness groups.

Research Question 2: If H_a is true, are there significant differences in academic achievement in the areas of math and/or ELA within the minimal fitness group based on any specific weakness?

H_o: There are no differences among weakness groups.

H_a: There is at least one difference among weakness groups.

Statistical Tests

An independent samples *t*-test was first utilized in order to determine differences between optimal and minimal fitness regarding student academic achievement. Next, a one-way ANOVA test was utilized to test for differences among means within the minimal fitness group based upon the various weakness categories. The *F*-test was utilized to ascertain homogeneity of variance. Alternative tests included the Dunnet's *C,* and Levine's test if the variance was non-homogeneous. The confidence interval was set at $p = .05$. Covariates included gender and ethnicity.

Threats to Validity

Threats to validity include many uncontrollable aspects such as test administrator efficacy, students' motivation or health status, students' integrity during the test, and administrative integrity in reporting data, among others. Multiple test administrators test students; it is not possible to completely guarantee standardization of testing protocol and reporting.

External threats to validity may include, but are not limited to, interactional effects and differences in testing situations from student to student. Internal threats to validity also include, but are not limited to, differences in physical and cognitive maturation from student to student, as well as differences in physical characteristics such as body composition. Physical education programs and academic rigor differs from school to school and may also internally threaten validity. In order to account for this, it must be assumed that test administrators oversaw proper testing procedures, students applied their best efforts in all testing situations, and differences in curriculum and physical or cognitive attributes did not affect the outcome.

Ethical Procedures

The collected data remained anonymous personal identifiers were not used. It was collected via database query, and no students were contacted for any of the data collection. As per district privacy policy, variables such as SES and percent of free or reduced lunch programs were not used. District approval documentation and privacy policies are presented in the appendix section. The archival data are public domain and can be specifically viewed by each student and parent via the student's personal grade and transcript history account with the school district. The archival data are kept confidential and undistinguishable via the four-digit identification number given by the school district, and are saved in a portable hard drive for the required timeframe as per Walden University policy.

Summary

The purpose of this study was to quantitatively investigate how optimal and minimal physical fitness relate to the CST academic achievement test performance in math and ELA in ninth grade students. The independent variable consisted of the two levels of the successfully passed FITNESSGRAM test: Optimal fitness, as passing all fitness tests, and minimal fitness, as passing the minimum five tests. Minimal and optimal fitness groups were based on the physical fitness tests including aerobic capacity, BMI, flexibility, upper body strength and endurance, trunk strength, and abdominal strength. The minimal fitness level group was further categorized into the specific weakness, or test the student did not pass. The dependent variables were the calculated CST *t* scores in for math and ELA. Differences between groups and among weakness categories were analyzed by independent samples t-test and one-way ANOVA. The following chapter reports the results of this study.

Chapter 4: Results

Introduction

The purpose of this study was to quantitatively investigate how optimal and various aspects of minimal physical fitness relate to the CST academic achievement test performance in math and ELA in ninth grade students. Optimal physical fitness was described as passing all six FITNESSGRAM tests with no weakness. Minimal fitness level was described as passing any five of the six FITNESSGRAM tests, and was subcategorized by the specific test weakness. Students must successfully complete at least five of the six components of the FITNESSGRAM standardized physical fitness test to receive a passing score for physical fitness. The study sample was 5,416 ninth grade students of either sex from the same California school district who successfully passed at least five FITNESSGRAM tests.

The research sought to identify if there is a significant difference in academic achievement scores between optimally and minimally fit students, as well as any specific aspect within the minimal fitness group that may influence scores earned on the CST. The null hypothesis stated that there are no influential differences upon academic performance between optimal and minimal physical fitness in the FITNESSGRAM tests. The alternative hypothesis stated that there is a difference in academic performance between optimally fit and minimally fit students.

The second research question, contingent upon the alternative hypothesis being true, sought to identify which specific weakness categories within the minimally fit group may contribute negatively to academic performance. The null hypothesis stated that there were no differences in academic performance among weakness groups; the alternative hypothesis stated that there was at least one difference within weakness groups.

The Data Collection section includes the time frame and manner of data collection by the school district. Also included are the sampling procedures, the general population representation, and a statement of the external validity of the sampling. The basic univariate and covariate statistical analyses are briefly outlined. The Results section includes all univariate analyses, descriptive statistical methods, confidence intervals, and effect sizes. Results of post-hoc analyses and additional analyses that emerged from the primary results are then reported. The tables and figures that exemplify and illustrate the results of the research are presented throughout this section. A brief Summary section reiterates the results of the research and introduces the material included in Chapter 5.

Data Collection

The Walden University Institutional Review Board gave approval for this study in February of 2014 (IRB Approval # 02-27-14-0058690). The proposal was then presented to the San Diego School District for approval. The pertinent documents for data collection permission and memorandum of agreement are located in Appendix A. The data were obtained and compiled from the school district database using a query for physical fitness variables, standardized academic achievement variables, gender, and ethnicity. The data were entered into an Excel spreadsheet, and then imported into the IBM SPSS Statistics program for Macintosh Version 21.0.0.0. Scaled scores in ELA were converted to *z* scores, then to *t* scores using the data transformation option. The math data were first divided into categories by math test taken, transformed to *z* scores within each test category, then to *t* scores with a mean of 50 and standard deviation of 10 so that each math test was equally standardized. Analyses utilized the standardized *t* scores as the dependent variables in all cases.

The study sample consisted of 5,416 students, of which 2,555, or 47.2%, were female and 2,881, or 52.8%, were male. Students with physical or moderate to severe cognitive disabilities were not tested, and therefore not included in the sample. The frequency distribution data are in presented in Table 1. This differs slightly from the district data due to the differences in demographic distribution throughout the county. According to the latest Census statistics, San Diego County population demographics include 32.7% Hispanic or Latino, 47.6% White, 5.6% Black or African American, 11.6% Asian (U.S. Census Bureau, 2014). The other ethnic groups were similar to those in the school district for this study. No population statistics were shown in the Census data for Filipino or Indochinese ethnic groups. Such differences are likely the norm from school district to school district in a large, culturally diverse metropolitan area such as San Diego. The district frequencies and percentages of ethnicities are summarized in Table 1.

Table 1

Ethnicity: Frequency Distribution of Ethnicities in San Diego School District 2012-2013

Ethnicity	Frequency	Percent
Hispanic or Latino	2081	38.4
White	1517	28.0
Black or African American	464	8.6
Filipino	441	8.1
Indochinese	363	6.7
Two or More Races	295	5.4
Asian	203	3.7
Pacific Islander	34	.6
Native American	18	.3
Total	5414	100.0

Within the sample, 3,533 students successfully passed all six fitness tests, and 1,883 passed five tests. Further breakdown of the students who passed five of the six tests revealed that 123 students did not pass the aerobic capacity test, 255 did not pass the abdominal curl-up test, 895 did not pass the body mass index (BMI) test, 113 did not pass the flexibility test, 127 did not pass the trunk lift, and 370 did not pass the upper body strength test. The descriptive statistics for each weakness are shown in Table 2.

The data were analyzed using ELA *t* scores and the collective standardized *t* scores for geometry, algebra I, and algebra II for math *t* scores as the dependent variable, and fitness level, either optimal or minimal, as the independent variables. The minimal fitness level group was further divided into categories labeled by weakness as, "Abdominal Curls", "Aerobic Capacity", "BMI", "Flexibility", "Trunk Lift", and "Upper Body Strength". "No Weakness" was the category given to the optimally fit group for ease of interpretation in tables and graphs that illustrate all of the explored variables.

Table 2

Frequency Distribution of FITNESSGRAM Weaknesses

Weakness		Frequency	Percent
No Weakness		3533	65.2
Abdominal Curls		123	2.3
Aerobic Capacity		255	4.7
BMI		895	16.5
Flexibility		113	2.1
Trunk Lift		127	5.4
Upper Body Strength		370	6.8
	Total	5414	100.0

An independent sample *t* test was performed in order to ascertain if there were differences in math and ELA academic achievement scores between the optimally and minimally fit students. The *t*-test results indicated that optimally fit students who passed all six fitness tests had significantly higher scores in math achievement (*M* = 50.71; *SD* = 10.12) than minimally fit students who passed five of the six fitness tests (*M* = 48.52; *SD* = 9.56), *t* (3584) = 7.68, *p* = .000. Similar results were observed in ELA scores. Optimally fit students (50.83, ±10.01) scored significantly better in the ELA achievement test than minimally fit students (*M* = 48.25; *SD* = 9.76), *t*(3485) = 8.98, *p* = .000. The frequency and central tendencies for both optimal and minimal fitness groups are shown in Table 3a for math and Table 4a for ELA, and the results for the *t* test analysis are shown in Table 3b for math and Table 4b for ELA.

Table 3a

Means of Groups: Descriptive Statistics for Specific FITNESSGRAM Weaknesses

				95% Confidence Interval for Mean	
Weakness	N	Mean	Std. Deviation	Lower Bound	Upper Bound
No Weakness	3506	50.7868	10.12420	50.4516	51.1220
Abdominal Curl	122	49.0522	9.54673	47.3410	50.7633
Aerobic Capacity	250	48.1821	9.42075	47.0086	49.3556
BMI	887	49.3871	9.77400	48.7430	50.0312
Flexibility	111	46.8476	8.87113	45.1790	48.5163
Trunk Lift	127	46.5265	9.33826	44.8867	48.1664
Upper Body Strength	364	47.6545	9.29330	46.6966	48.6124
Total	5367	50.0000	9.99534	49.7325	50.2675

Note. Dependent variable: *t*-score Math

Table 3b

Group Statistics: Group Comparisons between Optimal and Minimal Physical Fitness Independent Samples t-Test

Fitness Level			Std. Error	95% Confidence Interval Lower	Upper
Optimal Fitness	N	3644			
	Mean	50.8316	.1640	50.5017	51.1529
	Std. Deviation	10.00649	.11598	9.77611	10.23350
	Std. Error Mean	.16576			
Minimal Fitness	N	1734			
	Mean	48.2524	.2364	47.7980	48.7160
	Std. Deviation	9.76088	.15692	9.45009	10.06873
	Std. Error Mean	.23440			

Note. Dependent Variable: *t* Scores Math

A one-way ANOVA was conducted to evaluate the relationships among the *t*-scores in math and ELA and specific weaknesses in the minimally fit group. The test showed significance for math, $F(5, 1860) = 4.00$, $p = .001$. The strength of the relationship between math and weakness, as assessed by η^2, was small, accounting for 1.1% of the variance in math *t*-scores. The test was significant for ELA, $F(5,1858) = 3.50$, $p = .000$. The strength of the relationship between ELA and weakness, as assessed by η^2 was also small, accounting for 0.9% of the variance of the ELA *t* scores. These results are shown in Table 3c and Table 4c, respectively. Graphical illustrations for math *t* scores versus all weakness groups and ELA *t* scores versus all weakness groups are shown in *Figure 1* and *Figure 2*, respectively.

Table 3c

Multiple Comparisons within and between Optimal and Minimal Physical Fitness ANOVA Math t Scores and Weaknesses

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1817.87	5	363.57	4.00	.001
Within Groups	168762.27	1855	96.74		
Total	170580.14	1860			

Note. Dependent Variable: *t* Score Math

The variance among means was quite large (87 to 100) so, alternative post-hoc tests were performed to evaluate pairwise differences among the means. The Dunnet's *C* was used as the post hoc test, as it does not assume equal variances throughout the seven groups. The results of the Dunnets' *C* indicated that there were significant differences in means within the minimally fit group. These multiple comparisons among the various weakness categories within minimal fitness are shown in Table 3d for math and 4d for ELA. The group with no weakness showed higher mean ELA *t* scores and math *t* scores in comparison to any group with a specific weakness, as shown in Table 3a and Table 4a, and illustrated in *Figure 1* and *Figure 2*. The descriptive statistics for optimal and minimal fitness levels, including the minimal fitness subgroups, are shown in Table 2. The 95% confidence intervals for the pairwise differences among groups, as well as the means and standard deviations for the six weakness groups, are reported in Table 3a for math and Table 4a for ELA. The t test calculations are also summarized in Table 3b for math and Table 4b for ELA. *Figure 1* graphically illustrates these relationships for math *t* scores vs. all weakness, and *Figure 2* graphically illustrates these relationships for ELA *t* scores vs. all weakness.

Table 3d

Multiple Comparisons of Specific Weaknesses between and within Minimal Fitness Groups

Dunnett *C*

(I) Weakness	(J) Weakness	Mean Difference (I-J)	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Abdominal Curl	Aerobic Capacity	.87011	1.04979	-2.1619	3.9021
	BMI	-.33496	.92453	-3.0077	2.3377
	Flexibility	2.20453	1.20666	-1.2926	5.7017
	Trunk Lift	2.52567	1.19737	-.9407	5.9921
	Upper Body Strength	1.39769	.99213	-1.4680	4.2634
Aerobic Capacity	Abdominal Curl	-.87011	1.04979	-3.9021	2.1619
	BMI	-1.20507	.68022	-3.1562	.7460
	Flexibility	1.33442	1.03150	-1.6477	4.3165
	Trunk Lift	1.65556	1.02061	-1.2905	4.6016
	Upper Body Strength	.52758	.76959	-1.6805	2.7357
BMI	Abdominal Curl	.33496	.92453	-2.3377	3.0077
	Aerobic Capacity	1.20507	.68022	-.7460	3.1562
	Flexibility	2.53949	.90371	-.0765	5.1554
	Trunk Lift	**2.86063***	.89126	.2859	5.4354
	Upper Body Strength	**1.73265***	.58734	.0516	3.4137
Flexibility	Abdominal Curl	-2.20453	1.20666	-5.7017	1.2926
	Aerobic Capacity	-1.33442	1.03150	-4.3165	1.6477
	BMI	-2.53949	.90371	-5.1554	.0765
	Trunk Lift	.32114	1.18136	-3.1017	3.7440
	Upper Body Strength	-.80683	.97275	-3.6197	2.0060
Trunk Lift	Abdominal Curl	-2.52567	1.19737	-5.9921	.9407
	Aerobic Capacity	-1.65556	1.02061	-4.6016	1.2905
	BMI	**-2.86063***	.89126	-5.4354	-.2859
	Flexibility	-.32114	1.18136	-3.7440	3.1017
	Upper Body Strength	-1.12798	.96120	-3.9026	1.6466
Upper Body Strength	Abdominal Curl	-1.39769	.99213	-4.2634	1.4680
	Aerobic Capacity	-.52758	.76959	-2.7357	1.6805
	BMI	**-1.73265***	.58734	-3.4137	-.0516
	Flexibility	.80683	.97275	-2.0060	3.6197
	Trunk Lift	1.12798	.96120	-1.6466	3.9026

Note. Dependent Variable: *t* Score Math

***.** The difference between weakness group means is significant at the 0.05 level.

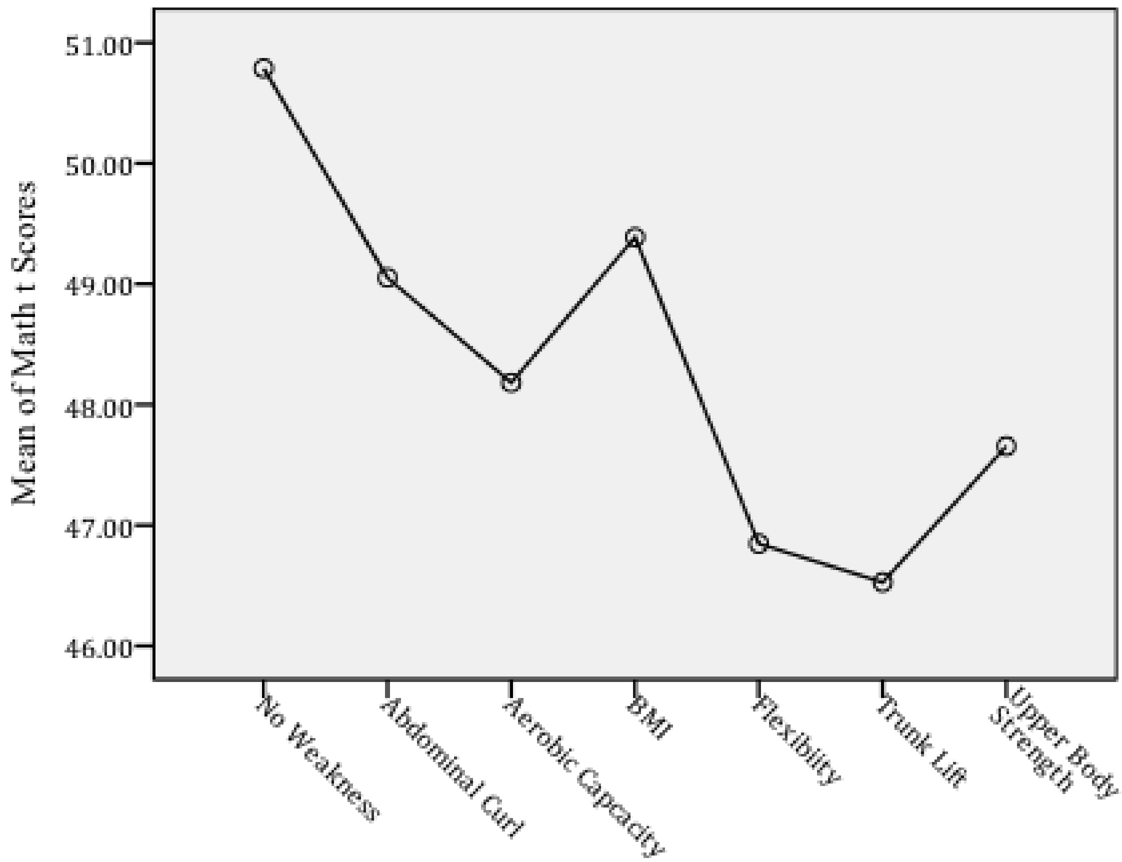

Figure 1. Math *t* Scores by Weakness

Basic univariate analysis indicated that there were significant differences among the groups within the minimal fitness level. A one-way analysis of variance was conducted to evaluate the relationships among the six subgroups of minimally fit students groups based upon which specific fitness test of the six was not successfully completed. There was a significant difference between groups regarding specific weaknesses, $F(5, 1860) = 3.40$, $p < .05$ for math, and a significant difference between groups within the minimal fitness level regarding specific weaknesses, $F(5, 1863) = 3.50$, $p < .05$ for ELA.

These results demonstrated that there were differences among groups within the minimally fit group of students based upon various weakness categories.

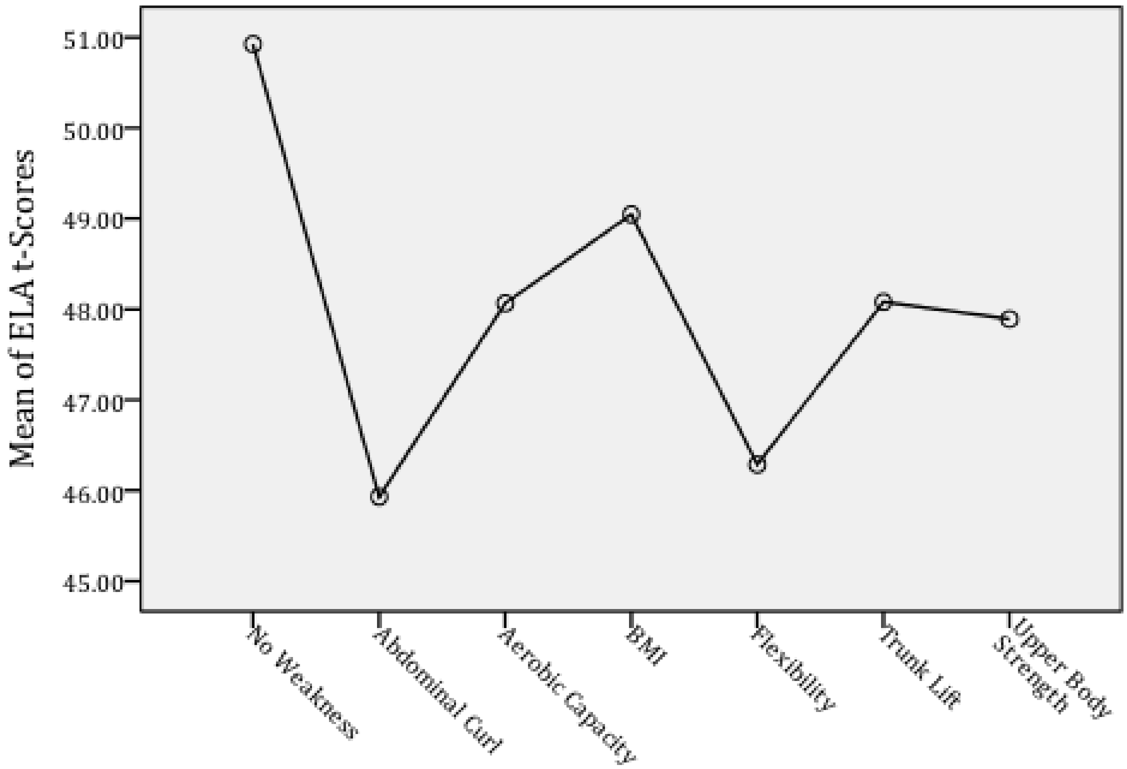

Figure 2. Mean ELA *t* Scores by Weakness

Table 4a

Means of Groups: Descriptive Statistics for Specific FITNESSGRAM Weaknesses

Weakness	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound
No Weakness	3514	50.9246	9.94709	50.5956	51.2536
Abdominal Curl	119	45.9307	10.78252	43.9733	47.8881
Aerobic Capacity	252	48.0653	9.37066	46.9027	49.2278
BMI	890	49.0454	9.79980	48.4007	49.6901
Flexibility	112	46.2863	10.15000	44.3858	48.1868
Trunk Lift	127	48.0795	9.59192	46.3952	49.7639
Upper Body Strength	364	47.8906	9.90073	46.8701	48.9111
Total	5378	50.0000	10.00000	49.7327	50.2673

Note. Dependent Variable: *t*-scores ELA

Table 4b*: Group Comparisons between Optimal and Minimal Physical Fitness Group Statistics: Independent Samples t-Test*

Fitness Level			Std. Error	95% Confidence Interval Lower	Upper
Optimal Fitness	N	3636			
	Mean	50.7045	.1667	50.3801	51.0243
	Std. Deviation	10.12251	.13105	9.85271	10.37314
	Std. Error Mean	.16787			
Minimal Fitness	N	1731			
	Mean	48.5201	.2294	48.0790	48.9772
	Std. Deviation	9.55795	.21310	9.14414	9.98010
	Std. Error Mean	.22973			

Note. Dependent Variable: *t*-Scores ELA

Table 4c

Multiple Comparisons within and between Optimal and Minimal Physical Fitness ANOVA ELA t-Scores and Weaknesses

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1694.31	5	338.86	3.50	.000
Within Groups	179746.15	1858	96.74		
Total	181440.46	1863			

Note. Dependent Variable: *t* Score ELA

Table 4d

Multiple Comparisons of Specific Weaknesses between and within Minimal Fitness Groups

Dunnett C

(I) Weakness	(J) Weakness	Mean Difference (I-J)	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Abdominal Curl	Aerobic Capacity	-2.13458	1.15128	-5.4623	1.1932
	BMI	**-3.11472***	1.04159	-6.1280	-.1014
	Flexibility	-.35564	1.37726	-4.3477	3.6364
	Upper Body Strength	-2.14885	1.30439	-5.9261	1.6284
	Trunk Lift	-1.95986	1.11638	-5.1864	1.2666
Aerobic Capacity	Abdominal Curl	2.13458	1.15128	-1.1932	5.4623
	BMI	-.98015	.67554	-2.9177	.9574
	Flexibility	1.77893	1.12618	-1.4784	5.0363
	Upper Body Strength	-.01427	1.03581	-3.0045	2.9760
	Trunk Lift	.17471	.78597	-2.0801	2.4296
BMI	Abdominal Curl	**3.11472***	1.04159	.1014	6.1280
	Aerobic Capacity	.98015	.67554	-.9574	2.9177
	Flexibility	2.75908	1.01378	-.1763	5.6945
	Upper Body Strength	.96587	.91233	-1.6700	3.6017
	Trunk Lift	1.15486	.61417	-.6031	2.9129
Flexibility	Abdominal Curl	.35564	1.37726	-3.6364	4.3477
	Aerobic Capacity	-1.77893	1.12618	-5.0363	1.4784
	BMI	-2.75908	1.01378	-5.6945	.1763
	Upper Body Strength	-1.79321	1.28230	-5.5086	1.9222
	Trunk Lift	-1.60422	1.09048	-4.7581	1.5496
Upper Body Strength	Abdominal Curl	2.14885	1.30439	-1.6284	5.9261
	Aerobic Capacity	.01427	1.03581	-2.9760	3.0045
	BMI	-.96587	.91233	-3.6017	1.6700
	Flexibility	1.79321	1.28230	-1.9222	5.5086
	Trunk Lift	.18899	.99687	-2.6882	3.0661
Trunk Lift	Abdominal Curl	1.95986	1.11638	-1.2666	5.1864
	Aerobic Capacity	-.17471	.78597	-2.4296	2.0801
	BMI	-1.15486	.61417	-2.9129	.6031
	Flexibility	1.60422	1.09048	-1.5496	4.7581
	Upper Body Strength	-.18899	.99687	-3.0661	2.6882

Note. Dependent Variable: *t* Score ELA
* The difference between weakness group means is significant at the 0.05 level.

The next layer of analysis separated the minimally fit students by sex. Male students were labeled, “M”, and female students were labeled, “F”. An ANOVA was then conducted in order to evaluate the relationships among weakness, math *t* scores, and ELA *t* scores, with the independent variables of weakness separated by sex. The ANOVA was significant for ELA, $F(11, 1852) = 2.28$, $p = .009$, but not for math, $F(11, 1814) = 1.11$, $p = .304$, at the standard *p* value of .05. *Figure 3* and *Figure 4* illustrate differences in the *t* score means between sexes within each group. Females had higher average ELA *t* scores than males, regardless of weakness. Females also scored higher average math *t* scores in all weakness groups except “Trunk Lift” and “Upper Body Strength”. Females in the “Trunk Lift” weakness group scored considerably lower in math *t* scores, and males in the “Flexibility” weakness group scored markedly lower in math *t* scores relative to their counterparts.

The 95% confidence intervals for the pairwise differences for weakness and gender, the means, and standard deviations for the seven weakness groups are reported in Table 5a for math *t* scores**.** The critical *F* statistic and significance value for this analysis are shown in Table 5b. The math *t* scores versus weakness group separated by sex are graphically illustrated in *Figure 3.*

Table 5a

Means of Groups: All Weakness by Sex

Weakness	Sex	Mean	95% Confidence Interval Lower Bound	Upper Bound
No Weakness	F	50.924	50.449	51.400
	M	50.661	50.207	51.116
Abdominal Curl	F	49.185	46.809	51.561
	M	48.890	46.268	51.513
Aerobic Capacity	F	48.348	46.951	49.744
	M	47.609	45.010	50.208
BMI	F	49.699	48.611	50.786
	M	49.211	48.394	50.028
Flexibility	F	47.320	44.541	50.098
	M	46.475	44.004	48.945
Trunk Lift	F	44.641	41.565	47.716
	M	47.394	45.308	49.479
Upper Body Strength	F	46.278	44.875	47.682
	M	49.191	47.708	50.674

Note. Dependent Variable: *t* score Math

Table 5b

Critical F and Significance: Weakness by Sex

F	df1	df2	Sig.
1.17	11	1814	.304

Note. Dependent Variable: *t* score Math

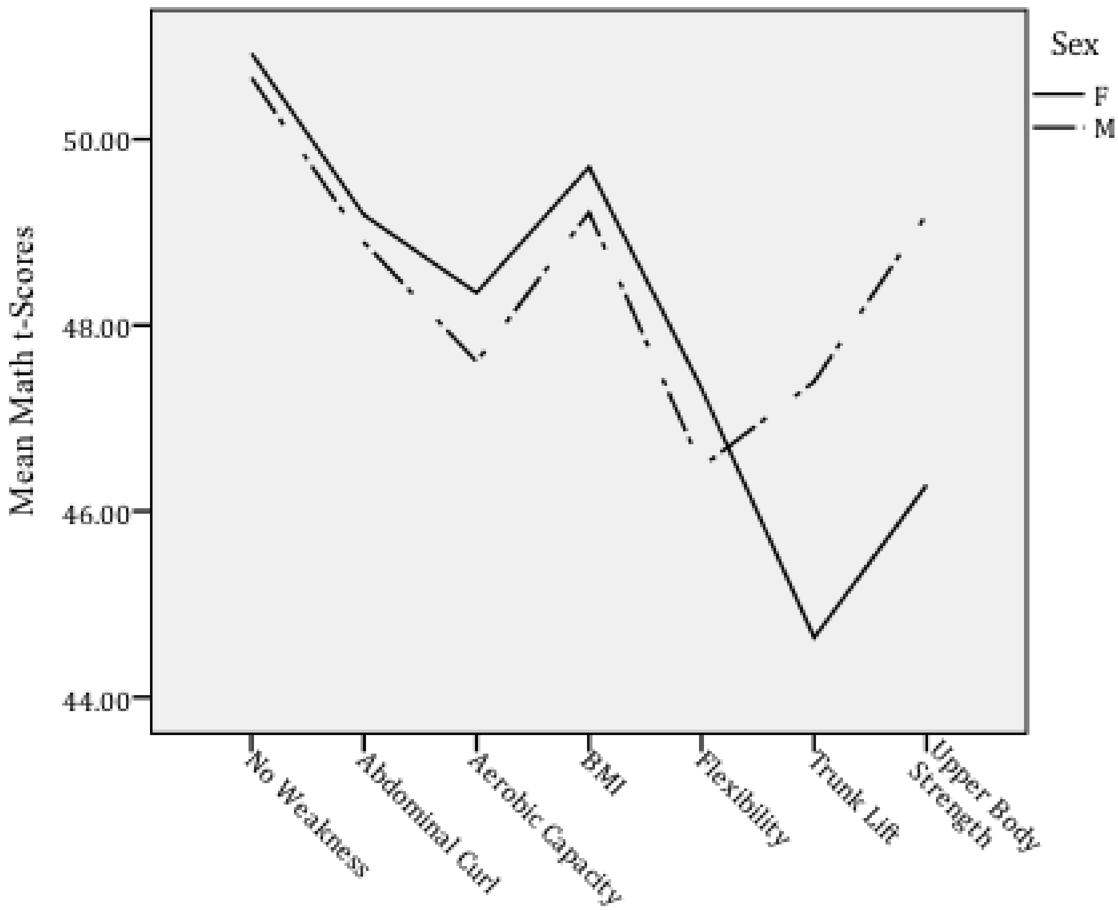

Figure 3. Math *t* Scores by All Weakness and Sex

The 95% confidence intervals for the pairwise differences by weakness and gender, as well as the means and standard deviations for all weakness groups, are reported in Table 6a for ELA *t* scores, and the critical *F* statistic and significance value for this analysis are shown in Table 6b. The ELA *t* scores vs. weakness group separated by sex are graphically illustrated in *Figure 4.*

Table 6a

Means of Groups: All Weakness by Sex

Weakness	Sex	Mean	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
No Weakness	F	52.101	51.630	52.572
	M	49.848	49.398	50.299
Abdominal Curl	F	47.872	45.496	50.247
	M	43.514	40.863	46.165
Aerobic Capacity	F	48.660	47.285	50.035
	M	45.934	43.332	48.536
BMI	F	50.533	49.454	51.612
	M	48.210	47.402	49.019
Flexibility	F	48.823	46.066	51.581
	M	44.313	41.882	46.745
Trunk Lift	F	48.671	45.620	51.723
	M	47.807	45.738	49.877
Upper Body Strength	F	48.940	47.561	50.318
	M	46.667	45.178	48.156

Note. Dependent Variable: *t*-score ELA

Table 6b

Critical F and Significance: Weakness by Sex

F	df1	df2	Sig.
2.28	11	1852	.009

Note. Dependent Variable: *t* score ELA

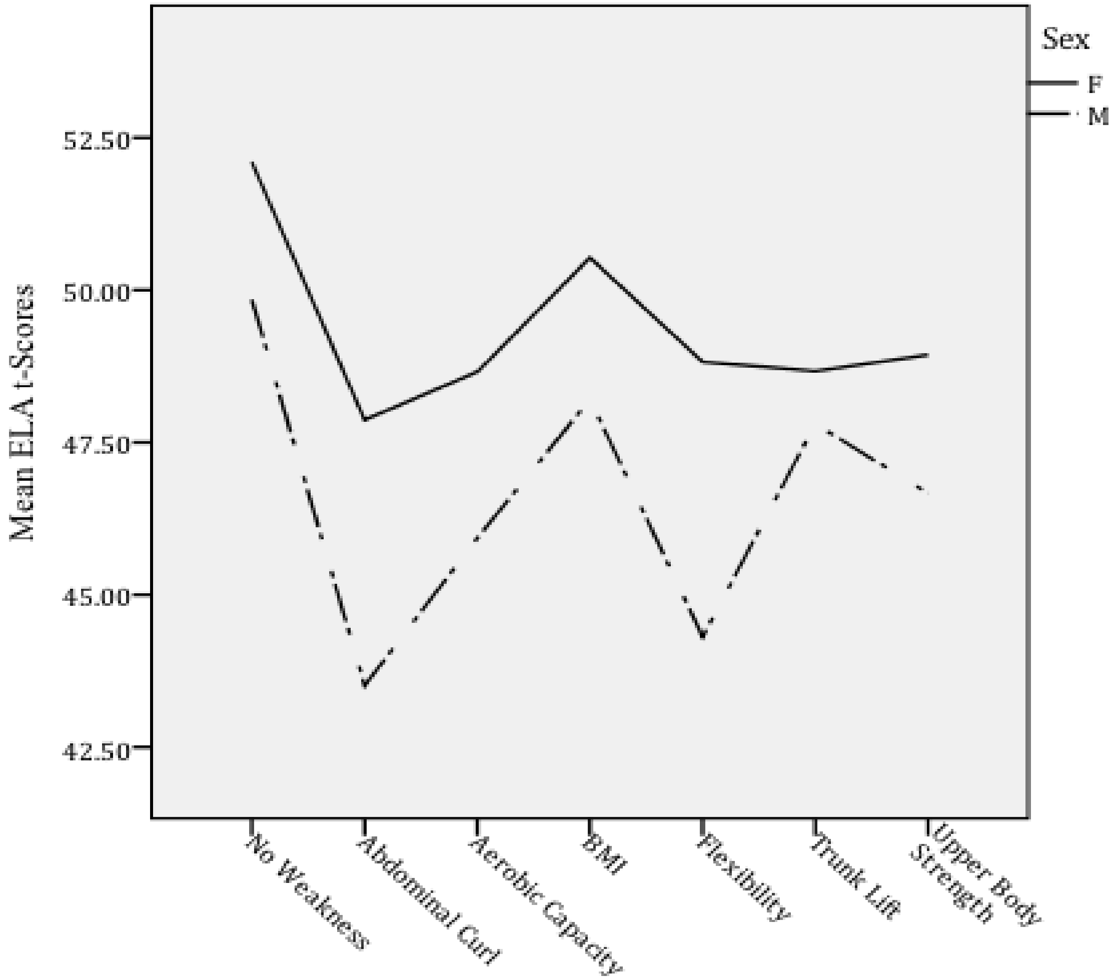

Figure 4. ELA *t* Scores by All Weakness and Sex

The next layer of analysis separated students by ethnicity; however, complete statistical analyses using this group were not possible due to a large amount of insufficient data within ethnicity groups. The ANOVA was conducted to evaluate the interrelationships between ethnicity and math *t* scores within the minimally fit group. The same ANOVA was conducted examining the interrelationships between ethnicity and ELA *t* scores within the minimally fit group. The ANOVA was found to be non-significant for both math, $F(46, 1814) = 1.11$, $p = .286$, and for ELA, $F(46, 1817) = 1.01$, $p = .451$. These results are shown in Table 7b and Table 8b respectively. Dunnet's *C* was again performed in order to test the means with unequal variance. *Figure 5* and *Figure 6* illustrated differences among weakness and ethnicity groups. There was a peak in ELA *t* scores and in math *t* scores for Pacific Islander students and Asian students in the "Flexibility" weakness group. Lower *t* scores were achieved in ELA for Asian students in both the "Abdominal Curl" weakness group and the "Trunk Lift" weakness group relative to other ethnic groups. Hispanic students in the "Flexibility" weakness group also had a decrease in ELA *t* scores relative to other ethnic groups. Pacific Islander students in the "BMI" weakness group showed lower math *t* scores relative to other ethnic groups. The covariates of ethnicity by sex were not utilized due to the loss of several data points as a result of further division of groups. The 95% confidence intervals for the pairwise differences by weakness and ethnicity, as well as the means and standard deviations for the six weakness groups, are reported in Table 7a, and are illustrated in *Figure 5* for math *t* scores. The 95% confidence intervals for the pairwise differences by weakness and ethnicity, as well as the means and standard deviations for the six weakness groups, are reported in Table 8a, and are illustrated in *Figure 6* for ELA *t* scores.

Table 7a

Means of Groups: All Weakness by Ethnicity

Weakness	Ethnicity	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
No Weakness	Hispanic	47.499	.237	47.035	47.964
	White	53.032	.258	52.527	53.537
	Black/Af-American	47.510	.454	46.620	48.401
	Asian	56.333	.670	55.020	57.647
	Native American	47.268	2.233	42.890	51.646
	Pacific Islander	48.799	1.626	45.611	51.987
	Filipino	52.173	.462	51.267	53.080
	Indochinese	54.666	.507	53.673	55.659
	Two+ races	52.878	.557	51.786	53.970
Abdominal Curl	Hispanic	46.493	.868	44.790	48.195
	White	52.025	.893	50.275	53.776
	Black/Af-American	46.504	.962	44.618	48.389
	Asian	55.327	1.072	53.225	57.428
	Native American	46.261	2.396	41.564	50.959
	Pacific Islander	47.793	1.842	44.181	51.405
	Filipino	51.167	.953	49.298	53.036
	Indochinese	53.659	.985	51.729	55.589
	Two+ races	51.871	1.022	49.868	53.875
Aerobic Capacity	Hispanic	45.561	.617	44.352	46.770
	White	51.093	.637	49.845	52.342
	Black/Af-American	45.572	.732	44.136	47.007
	Asian	54.395	.894	52.641	56.148
	Native American	45.329	2.316	40.789	49.870
	Pacific Islander	46.861	1.731	43.468	50.253
	Filipino	50.235	.744	48.776	51.694
	Indochinese	52.727	.773	51.212	54.243
	Two+ races	50.940	.806	49.360	52.519
BMI	Hispanic	46.806	.351	46.117	47.494
	White	52.338	.387	51.579	53.097
	Black/Af-American	46.817	.530	45.778	47.855
	Asian	55.640	.735	54.198	57.081
	Native American	46.574	2.252	42.159	50.989
	Pacific Islander	48.106	1.650	44.871	51.340
	Filipino	51.480	.528	50.445	52.514
	Indochinese	53.972	.593	52.810	55.134
	Two+ races	52.184	.628	50.952	53.417

Table 7a *continued*

Means of Groups: Weakness by Ethnicity

Weakness	Ethnicity	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Flexibility	Hispanic	44.210	.914	42.418	46.001
	White	49.742	.924	47.931	51.554
	Black/Af-American	44.221	.985	42.290	46.151
	Asian	53.044	1.124	50.840	55.247
	Native American	43.978	2.411	39.251	48.705
	Pacific Islander	45.510	1.849	41.885	49.134
	Filipino	48.884	1.006	46.911	50.856
	Indochinese	51.376	1.016	49.384	53.368
	Two+ races	49.588	1.053	47.524	51.653
Trunk Lift	Hispanic	43.618	.858	41.936	45.300
	White	49.151	.870	47.446	50.856
	Black/Af-American	43.629	.932	41.801	45.457
	Asian	52.452	1.076	50.344	54.561
	Native American	43.387	2.390	38.701	48.073
	Pacific Islander	44.918	1.835	41.322	48.515
	Filipino	48.292	.958	46.415	50.170
	Indochinese	50.785	.952	48.919	52.651
	Two+ races	48.997	1.001	47.035	50.959
Upper Body Strength	Hispanic	45.080	.516	44.067	46.092
	White	50.612	.540	49.553	51.672
	Black/Af-American	45.091	.654	43.809	46.373
	Asian	53.914	.826	52.294	55.533
	Native American	44.848	2.292	40.356	49.341
	Pacific Islander	46.380	1.700	43.047	49.712
	Filipino	49.754	.666	48.448	51.059
	Indochinese	52.246	.703	50.867	53.625
	Two+ races	50.458	.735	49.018	51.899

Note. Dependent Variable: *t* score Math

Table 7b

Critical F and Significance: Weakness by Ethnicity

F	df1	df2	Sig.
1.11	46	1814	.286

Note. Dependent Variable: *t* score Math

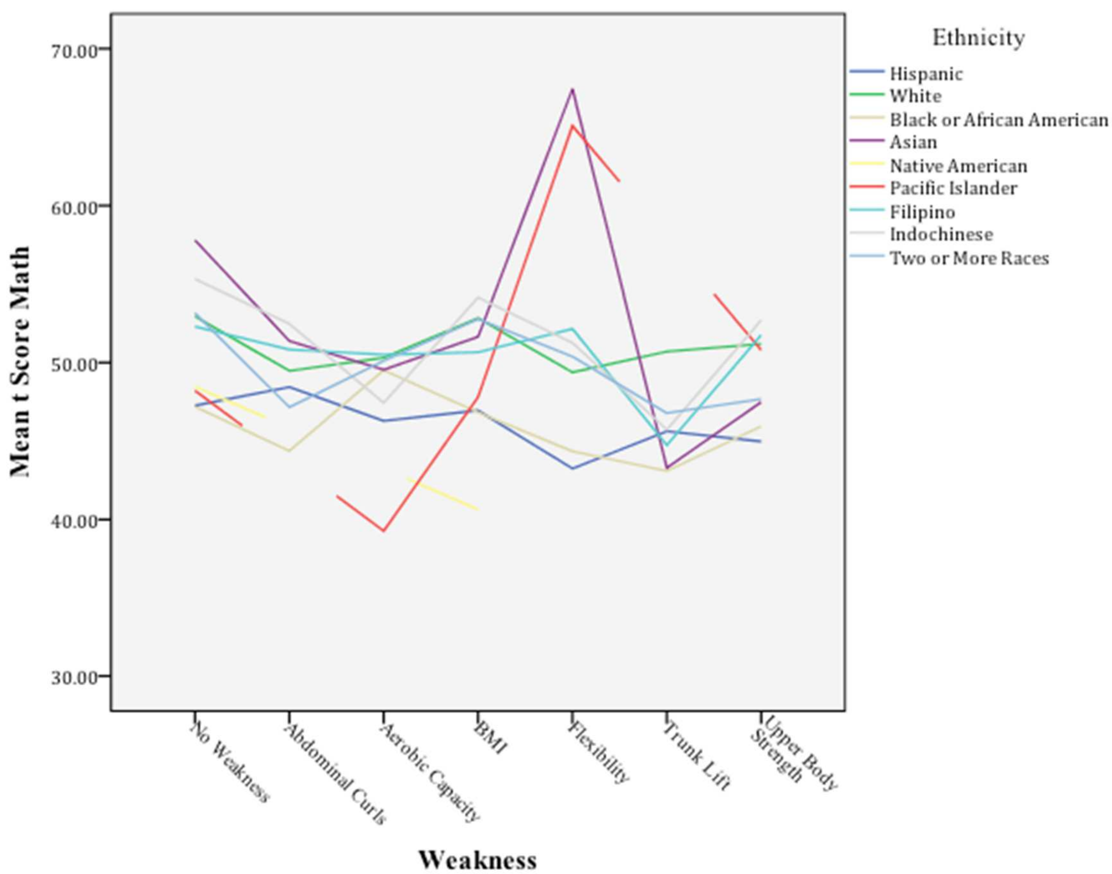

Figure 5. Math *t* Scores by All Weakness and Ethnicity

Table 8a

Means of Groups: All Weakness by Ethnicity

Weakness	Ethnicity	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
No Weakness	Hispanic	46.648	.259	46.140	47.157
	White	55.507	.279	54.960	56.055
	Black/Af-American	46.432	.534	45.386	47.479
	Asian	55.157	.736	53.714	56.600
	Native American	51.301	2.344	46.707	55.896
	Pacific Islander	47.223	1.815	43.664	50.781
	Filipino	51.856	.541	50.794	52.917
	Indochinese	51.480	.562	50.379	52.582
	Two+ races	54.423	.626	53.195	55.650
Abdominal Curl	Hispanic	44.082	1.182	41.765	46.398
	White	54.573	2.139	50.379	58.767
	Black/Af-American	40.574	3.431	33.848	47.299
	Asian	35.210	3.209	28.919	41.501
	Native American	.[a]	.	.	.
	Pacific Islander	.[a]	.	.	.
	Filipino	52.462	2.344	47.867	57.056
	Indochinese	44.196	3.025	38.265	50.127
	Two+ races	44.077	5.240	33.804	54.350
Aerobic Capacity	Hispanic	45.178	.850	43.512	46.845
	White	53.481	1.144	51.239	55.723
	Black/Af-American	44.347	1.893	40.637	48.057
	Asian	47.934	3.705	40.670	55.198
	Native American	.[a]	.	.	.
	Pacific Islander	48.981	9.076	31.187	66.775
	Filipino	52.625	2.269	48.177	57.074
	Indochinese	45.819	2.269	41.370	50.267
	Two+ races	50.858	2.517	45.923	55.793
BMI	Hispanic	45.707	.456	44.813	46.600
	White	55.102	.623	53.880	56.325
	Black/Af-American	46.732	1.021	44.730	48.734
	Asian	54.769	1.893	51.059	58.480
	Native American	42.462	5.240	32.189	52.735
	Pacific Islander	44.735	3.705	37.470	51.999
	Filipino	48.828	.926	47.012	50.644
	Indochinese	50.079	1.580	46.982	53.177
	Two+ races	52.092	1.418	49.313	54.871

Table 8a *continued*

Means of Groups: Weakness by Ethnicity
Dependent Variable: *t* score ELA

Weakness	Ethnicity	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Flexibility	Hispanic	41.804	1.353	39.151	44.456
	White	52.719	1.657	49.470	55.968
	Black/Af-American	41.971	2.344	37.377	46.566
	Asian	60.643	9.076	42.850	78.437
	Native American	.[a]	.	.	.
	Pacific Islander	63.694	9.076	45.900	81.487
	Filipino	47.546	4.059	39.588	55.503
	Indochinese	48.459	2.737	43.094	53.824
	Two+ races	49.160	4.538	40.264	58.057
Trunk Lift	Hispanic	44.514	1.297	41.972	47.056
	White	55.782	1.630	52.586	58.977
	Black/Af-American	44.907	2.201	40.591	49.223
	Asian	35.614	6.418	23.032	48.196
	Native American	.[a]	.	.	.
	Pacific Islander	.[a]	.	.	.
	Filipino	50.865	4.538	41.968	59.762
	Indochinese	47.974	2.139	43.780	52.168
	Two+ races	49.011	3.705	41.747	56.275
Upper Body Strength	Hispanic	45.148	.692	43.792	46.505
	White	52.626	.917	50.829	54.424
	Black/Af-American	42.435	1.685	39.131	45.739
	Asian	43.468	2.737	38.103	48.833
	Native American	.[a]	.	.	.
	Pacific Islander	60.643	9.076	42.850	78.437
	Filipino	51.371	1.935	47.577	55.164
	Indochinese	52.127	2.344	47.533	56.721
	Two+ races	51.740	2.269	47.291	56.188

Note. Dependent Variable: *t* Score ELA
a. This level combination of factors is not observed, thus the corresponding population marginal mean is not estimable.

Table 8b

Critical F and Significance: Weakness by Ethnicity

F	df1	df2	Sig.
1.01	46	1817	.451

Note. Dependent Variable: *t* score ELA

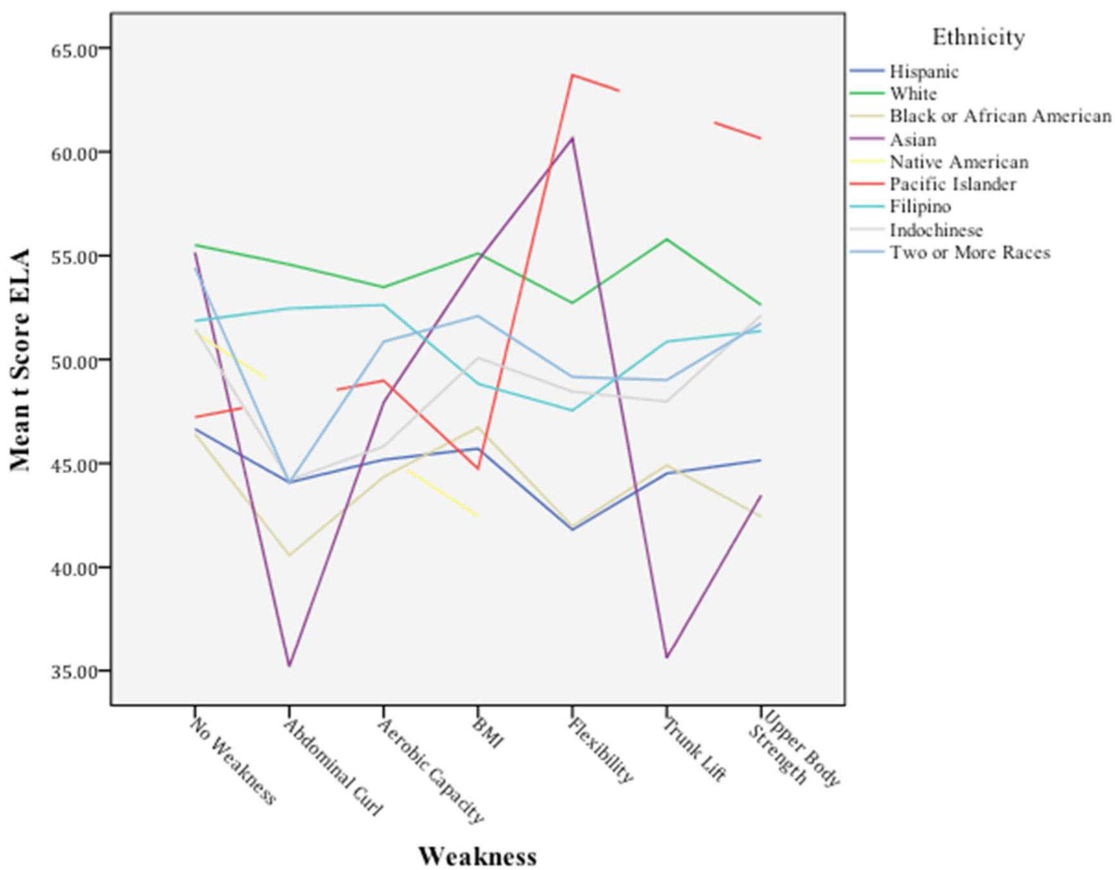

Figure 6. ELA *t* Scores by All Weakness and Ethnicity

Summary

The purpose of this study was to quantitatively investigate how optimal and minimal physical fitness relate to the CST academic achievement test scores in math and ELA in ninth grade students. Optimal physical fitness is described as passing all six FITNESSGRAM tests with no weakness. Minimal physical fitness is described as passing any five of the six FITNESSGRAM tests. The null hypotheses stated that there were no differences among groups, whereas the alternative stated that there was at least one difference. There was a significant difference in academic achievement *t* scores between optimal and minimal fitness groups in both ELA and math. Females scored significantly higher than males ELA but not math. Within the minimal fitness group, there were also differences in academic achievement with regards to specific weaknesses. The following chapter consists of an interpretation of these findings, analysis of the theoretical framework, implications for positive social change, and recommendations for further study and practice.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to quantitatively investigate how optimal and minimal physical fitness relate to the CST academic achievement test scores in math and ELA in ninth grade students. The methodology conducted in comparing specific physical fitness levels in this study has not been utilized and provided further explanation regarding the relationship between student physical fitness and academic achievement. Researchers continually point to the need for further and more elaborate studies regarding this relationship. Optimal physical fitness is described as passing all six FITNESSGRAM tests with no weakness. Minimal physical fitness is described as passing any five of the six FITNESSGRAM tests. The dependent variables included the academic raw scores of the math and ELA tests converted to *t* scores for standardized comparison. The independent variable was physical fitness level, as being optimal or minimal. Minimal physical fitness was subcategorized by the specific weakness in the FITNESSGRAM. The covariates were sex and ethnicity. The study was conducted to determine if certain weaknesses of physical fitness might negatively influence student scores in math and ELA on the CST academic achievement test.

There were significant differences in academic achievement scores in math and ELA between optimally and minimally fit students. These results are illustrated in *Figure 1* for math and *Figure 2* for ELA. There were also significant differences within the minimal fitness group based upon weakness category. Further analysis by sex illustrated that females trended toward higher scores than males in ELA in minimally fit groups as well as the optimally fit group. Females also trended toward higher scores than males in math, except in "Trunk Lift" and "Upper Body Strength" weakness groups. These findings are demonstrated in *Figure* 3 for math and *Figure* 4 for ELA. Sporadic differences in both math and ELA were observed regarding ethnicity as the covariate; significance was incalculable due to missing values in certain weakness groups based upon ethnicity. These differences are shown in *Figure 5* for math and *Figure 6* for ELA.

Interpretation of the Findings

The results of this study corroborate the studies conducted by Grissom and the CDC (2003), as well as Grissom (2005). The author showed in both studies that the more physical fitness tests a student passed, the higher the student performed on academic achievement tests in math and ELA. Grissom also indicated in both studies that the trend towards higher academic performance was greater for females than males. In both studies, the author reported a more pronounced positive relationship between the number of fitness tests females passed and their academic achievement scores relative to males. In his studies, the trend was more evident in math than in ELA. The present study also illustrated significant differences in CST scores between the optimally fit group and each of the minimally fit subgroups with one weakness, with better academic achievement attained in females who passed all six tests. These mutual findings suggest that there is a principle that can be employed when developing physical education curriculum designed to increase student physical fitness, to in turn help to maximize academic performance.

Chomitz et al. (2009) used logistic regression analysis to predict the odds of passing academic achievement tests based upon the number of physical fitness tests successfully passed. The author found that the odds of passing English achievement tests increased by 20% with each fitness test passed, while the odds of passing math achievement tests increased by 24% for each fitness test passed. The present study results also corroborate the findings of Chomitz (2009); students who passed each of the six fitness test components performed significantly better in both math and ELA than those who passed any combination of five components. With a physical education curriculum that can be geared toward the achievement of optimal physical fitness, student academic achievement may significantly improve as well.

The present study also substantiates historical findings regarding physical fitness and academic achievement. Ismail and Gruber (1967) attempted to develop a fitness test that would predict IQ. The authors found that there was no correlation between the physical fitness improvement program and IQ; however, a large improvement was seen in certain subject areas of academic achievement scores. The present study also found that students who are more physically fit also score higher in academic achievement tests in math and ELA. This further supports the notion that physical education curriculum is valuable in increasing student academic achievement.

The theoretical basis chosen for this study was Bandura's (1977) self-efficacy theory. The SET was selected to further elucidate the relationship between academic achievement and physical fitness, with the premise that past mastery, vicarious experiences, verbal persuasion, and emotional arousal may contribute to both physical and academic aspects of achievement in the form of task-carryover (Tollefson, 2000), and improved self-image (Van Der Roest et al., 2011). The tenets of SET and task-carryover may have contributed to the observed increase in academic achievement in students who successfully passed all six physical fitness test components. For example, it may have been that students who performed well physically in the FITNESSGRAM were able to carry the self-efficacy from these difficult tasks into the classroom when attempting to learn new and difficult tasks. When the sample was separated by sex, the same relation was apparent; however, when the sample was separated by ethnicity, the disparate outcomes were difficult to explain using the SET. It is apparent from the graphical illustrations of weakness vs. academic scores separated by ethnicity that there was no observable trend or relationship between academic achievement and physical fitness. A biopsychosocial theoretical model might have better explained these relationships had I had access to the types of data required for such analyses. Although the biopsychosocial model was originally proposed for analyzing differences in susceptibility, treatment outcomes, and attitudes towards diseases by various ethnic groups, it has been utilized in analyses concerned with similar ethnic differences in learning style, cognition, and attitude towards academic pursuits (Krawanski, 2009). The ethnic variations in achievement and physical fitness necessitate an approach that serves to explain, as well as integrate, cultural and ethnic diversities into attitudes toward healthful behaviors and physical fitness, when developing pedagogy and curriculum in physical education.

The uniqueness of this study design gives some insight regarding the differences within variable groups, especially when separated by sex and ethnicity. By looking deeper within the minimally fit subgroups, it may be possible to discern which aspects of physical fitness may be most influential, especially within the lower levels of FITNESSGRAM tests results by students who passed four fitness tests, three tests, two tests, or only one. There may have been a statistical difference within the groups of students who did not pass the FITNESSGRAM, but passed certain fitness tests within it. Further study regarding the remaining groups of students based on weaknesses may add another level of interpretation in the investigation regarding which areas of physical fitness are most influential to student academic achievement. London and Castrechini (2011) followed students' physical fitness levels from fifth, through seventh and ninth grade as well as their academic achievement test scores. The authors found that the average academic improvement by students moving from the "not passing" to the "passing" level in FITNESSGRAM was 2.5 percentage points in math and five percentage points in ELA. Further study should include investigation of other variables such as improvement factors and test variable subcategories within the non-passing levels of the FITNESSGRAM in order to ascertain which aspects of physical fitness within these categories might have an improving effect upon academic achievement.

Limitations of the Study

The sample size of 5,416 in this study was small relative to the total student population in the city limits, county, or beyond, which limited the possible generalizability of the results. Although a selected proportion of students in the district were used in the study, it may not have been completely representative of other school districts, counties, or states. Nonetheless, the results corroborate other authors' published results, thus giving plausible evidence of the relationship between student physical fitness and academic achievement. Bias or variability among evaluators of the state of physical fitness may have occurred due to the subjectivity of some aspects of performance in various components of the FITNESSGRAM test. It was assumed that test administrators oversaw proper testing procedures and that students applied their best efforts in all testing situations. Another limitation was that only physically fit students (i.e., those who passed either five or six of the six FITNESSGRAM test components) were included in the sample. Further study should include lower levels of physical fitness as they relate to academic achievement. As covariates were partitioned, some weakness-based groups that had passed five tests became too small for statistical analyses, thereby making comparisons among some covariate groups impossible. In this study, as with similar studies, due to the correlative nature, a concrete cause:effect relationship between physical fitness and academic achievement cannot be postulated.

Qualitative aspects of student motivation were not measured, nor were other quantitative measures such as socioeconomic status, student nutritional status, or individual school physical education and academic program rigor. Further investigation into these aspects might have provided better credence regarding the relationship between student physical fitness and academic achievement. By utilizing the same tests mandated by the school district, face validity and reliability were supported in that students were all tested in the same manner in the same district without the addition of outside testing procedures.

Recommendations

The results of this study corroborate contemporary as well as historical investigations regarding physical fitness and academic achievement. Authors of the former studies, as well as the present study, have shown that the more fit a student is physically, the better he or she will perform academically. Not only do the schools of today encounter an achievement gap in spite of NCLB but schoolchildren also face a serious health crisis as a result of their lack of physical fitness. As policymakers and administrators reduce opportunities for physical fitness improvement in order to increase time for core classes, they are conceivably contributing to the problems of reduced academic performance and diminished student health status (Sallis, 2010; Smith & Lounsberry, 2009; NASPE, 2013; Viadero, 2008). The results of previous studies and the present study should stimulate administrators, policymakers, and educators to reassess the importance of physical fitness of schoolchildren in their curricular programs so that better physical health as well as greater academic achievement might be achieved. The positive effects of physical fitness upon academic achievement may be negated if districts continue to authorize non-physical education related classes being considered as physical education credit. The district-mandated minutes for physical education in elementary schools should be increased from 200 minutes every ten days to the recommended 400 minutes for middle and high school students. Quality physical education classes should be taught on a daily basis to all grades by highly qualified and certificated physical education teachers. An investment in student physical fitness might yield better academic success in schools. Directing more attention towards student physical fitness and the biological, psychological and sociological aspects thereto will address two major issues regarding schoolchildren, namely obesity with its related health issues, and academic underachievement.

Implications for Positive Social Change

The benefits of student physical fitness upon both health status and improved academic performance have been well documented in a wide range of study designs. As more research and applied data explaining the strength and direction of this relationship are established, the validity and importance of this relationship will be substantiated. In order to produce higher student academic achievement, administrative and statewide reassessment should be made relative to the role and importance of student physical fitness in that achievement.

The results of this study carry implications for health and education policy, as well as pedagogy and curricular design. Using an interactional model that incorporates the SET as well as the biopsychosocial model, new physical education curricula can be restructured to include the effects of biological, psychological and sociological aspects of sex, culture, and self-efficacy upon student physical and academic achievements. These aspects should be taught in the teacher preparation programs in college and university pedagogy and methodology coursework, teacher credential programs, and other physical education certification programs. Continuing education programs for current educators and administrators should incorporate these aspects into staff development and best practice activities.

Conclusions

The purpose of this investigation was to examine the relationships between academic achievement and optimal versus minimal physical fitness, as well as to examine the influences of the individual weaknesses of minimal physical fitness. It was found that optimally fit students performed better than minimally fit students in the CST, and that there were differences within the minimally fit group with regards to academic achievement. Optimal physical fitness showed the greatest influence concerning academic achievement. Further analysis by sex illustrated that females trended towards higher scores than males in ELA in minimally fit groups as well as the optimally fit group. As groups were differentiated by ethnicity, it became unviable to illustrate differences among groups due to limited group sizes.

The results of this study substantiate other studies of similar methodology, yet no definite conclusions can be made regarding which aspects of physical fitness are better suited than others in influencing student academic achievement. Further study should expound upon this methodology to include students who passed four, three, two, one, and no fitness tests, using the same analysis within weakness groups, by sex, and by ethnicity. This approach may help to better explain the relationships among the various aspects of physical fitness and the influence each may have upon student academic achievement.

Further study might also include utilizing more than one school district in order to provide ubiquitous demographical representation and using data from each of all three grade levels that require the FITNESSGRAM test. Further study might also explore the biopsychosocial aspects within groups of optimal fitness, minimal fitness, and the different levels of fitness below minimal fitness.

Given that test scores will continue to be a significant evaluative criterion for school effectiveness, policy makers and administrators should utilize all avenues that will enhance academic excellence. In this respect, they should review recent publications and study findings that demonstrate the positive effects student physical fitness has upon achievement test scores. School programs and curricula must shift the paradigm toward producing better, more well-rounded, and adaptive learners, rather than demand that students learn more by emphasizing more core content at the expense of reduced physical education and opportunities for physical fitness improvement. An investment in student physical fitness, in addition to better academic performance and student health, might carry over into a healthy and productive adult life. If higher obesity rates and fewer opportunities for the improvement of student physical fitness give students less of a chance of academic success and a greater risk of poor adolescent health, their adult outcomes will be even further jeopardized. Enhanced physical fitness has been shown previously, as well as in this study, positive benefits upon health behavior and academic achievement outcomes. This, as well as the biological, psychological, and sociological aspects associated with student physical fitness may synergistically amend two major issues afflicting schoolchildren today: namely, childhood obesity and inactivity and the related health issues, and academic underachievement. The carrying forward of these outcomes may contribute to positive social change in that healthy and successful students become more productive and health-conscious citizens of society as they become adults.

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APPENDIX A: Approval, Signatures and Forms- SDUSD

San Diego Unified
SCHOOL DISTRICT

Peter D. Bell
Director
Research and Reporting Department
P - 619 725.7193
F - 619 725.7187
pdbell@sandi.net

May 12, 2014

Ms. Tona Wilson
4568 Georgia St. #6
San Diego, CA 92116

Dear Ms. Wilson:

San Diego Unified School District's Research Proposal Review Panel was happy to review your application to conduct research in San Diego Unified School District on "Relationships Among Specific Health-Related Fitness Components and Standardized Academic Achievement Tests." The committee has decided to approve your request.

Your district sponsor, Bruce Ward, stands ready to support your efforts in the district. You and he will need to submit a completed Memorandum of Agreement prior to your starting work in the district.

At completion of the study, our office and Bruce's would greatly appreciate an electronic copy of the final report on your findings, which will be posted on the district web site (or linked via a provided URL).

If you have any questions or if I can be helpful to you in any way, please contact me at (619) 725-7193.

Sincerely,

Peter D. Bell

Peter D. Bell, Ph.D.
Director

c Bruce Ward

San Diego Unified
SCHOOL DISTRICT

Bruce Ward
Director
Physical Education, Health and Interscholastic Athletics
P - 619 725.7126
F - 619 725.7127
bward1@sandi.net

March 19, 2014

Walden University School of Behavioral Sciences
4568 Georgia Street, #6
San Diego, CA 92116

To Whom It May Concern:

The San Diego Unified School District Physical Education, Health and Athletics Department endorses Tona Wilson Doctoral project.

Studying the relationship and collecting data on how physical fitness contributes to improved test scores that fits within the data we are collecting in our elementary and our secondary schools California Endowment Grant.

We are looking forward to overseeing and assisting Tona Wilson's doctoral endeavors.

Bruce Ward

Bruce Ward
San Diego Unified School District
Director of Physical Education, Health and Athletics
City Conference Coordinator
4100 Normal Street Room 2140
San Diego, CA 92103
619 725-7126
bward1@sandi.net

San Diego Unified
SCHOOL DISTRICT

OFFICE OF ACCOUNTABILITY
Research and Reporting Department

Memorandum of Agreement
By and Between
Tona DeAune Wilson
and
the San Diego Unified School District
May 20, 2014

This agreement is entered into by the San Diego Unified School District (SDUSD) and Tona De Aune Wilson located at 4568 Georgia St. #6 San Diego, California for the purpose of researching and sharing information between the parties in a manner consistent with the Family Educational Rights and Privacy Act of 1974 (FERPA) and SDUSD Administrative Procedure Nos. 6525, 6527, and 4930.

BACKGROUND

My name is Tona Wilson; I am proposing the current project for my dissertation at Walden University. I am a PhD candidate in the field of Psychology specializing in Health Psychology. I am currently a physical education teacher in this district at Lincoln High School. My Master's Degree Thesis examined the correlation between academic achievement and physical fitness. My findings suggested that there is a positive relationship between physical fitness and academic achievement. This topic is of interest to me because I have worked 16 years in the district at low-performing schools and believe that focusing on physical fitness can ultimately affect student academic achievement. As resources diminish and student-teacher ratios increase, it is important to create the minimal level of physical fitness that contributes the most to student academic achievement. The results of this study may help to create optimal physical education curriculum focus for programs in SDUSD.

PURPOSE OF THE STUDY

The purpose of this study is to determine if there are significant differences among the five combinations of the six fitness test result groups on the FITNESSGRAM relative to the four content areas of the CST. Further, if there are differences, the secondary purpose is to ascertain which components of physical fitness are most related to academic achievement? The answers to these questions may help to create physical fitness curricula that optimize both physical fitness as well as academic achievement.

SCOPE OF WORK

The main focus of this study is to determine the relationships among various components of physical fitness and academic achievement. Data will be collected anonymously by using matriculation numbers as the identifying variable. Data collected will be collected only from 500 freshman students who successfully completed 5/6 FITNESSGRAM tests. The data will include which FITNESSGRAM components were passed, percentile scores in the math, science, social science and English language arts CST's. Covariates will include gender, ethnicity, school API and English proficiency level. There is no direct contact with students, teachers, administrators, or others. It is a query from data that is available to teachers and parents. This should cost nothing monetarily. It may take 3-4 days to query and compile the data and up to three weeks to register and analyze the data statistically. It may take up to two weeks to understand the results. Findings will be shared with the district and the board of education when completed.

I. PARTIES

The SDUSD REPRESENTATIVE is Peter Bell, Director of the Research and Reporting Department, Office of Accountability, SDUSD, who is authorized by the SDUSD to maintain and release student records subject to FERPA and SDUSD policies and procedures.

The APPLICANT is Tona De Aune Wilson who is affiliated with Walden University and Lincoln High School

The APPLICANT'S single authorized REPRESENTATIVE to request data under this agreement is Peter Bell

The APPLICANT may also be represented by other persons associated with the APPLICANT to assist in any phase of the research effort. If applicable, REPRESENTATIVES of the APPLICANT include Kwan Wong, PhD, Walden University- Dissertation Chairperson

The SDUSD SPONSOR is Bruce Ward, Director of Physical Education, Health, and Interscholastic Athletics.

The SDUSD SPONSOR will monitor the research ensuring that research is being conducted as proposed and meets the obligations of this agreement. If necessary, the SDUSD SPONSOR may provide logistical assistance to the APPLICANT.

II. COMPLIANCE WITH FERPA

A. The APPLICANT will comply with the provisions of FERPA in all respects. For purposes of this agreement, the APPLICANT will use data collected and shared under this agreement for no purpose other than research authorized under §99.31 (6)(iii) of Title 34, Code of Federal Regulations. Nothing in this agreement may be construed to allow either party to maintain, use, disclose, or share student information in a manner not allowed by federal law or regulation. In particular, the APPLICANT will not disclose any data contained under this agreement in a manner that could identify any individual student or the student's parent(s)/guardian(s), per 34 CFR §99.31 (6)(ii)(A), except as authorized by FERPA.

B. The APPLICANT will abide by information redisclosure limitations per 34 CFR §99.33 (a)(1); §99.33 (a)(2). Data that contain personal information from students' education records are protected by the FERPA (20 U.S.C. §1232g) and may not be re-released without consent of the parents or eligible students.

C. The APPLICANT will destroy all data obtained under this agreement when they are no longer needed for the purpose for which they were obtained in compliance with 34 CFR §99.31(6)(ii)(B); §99.35 (b)(2), or returned to the SDUSD REPRESENTATIVE.

III. COST OF RESEARCH

A. The SDUSD REPRESENTATIVE agrees to provide requested data under this agreement, to be billed at district cost.

B. The APPLICANT agrees to pay all other costs associated with the implementation of research activities.

IV. RESEARCH METHODOLOGY

A. The APPLICANT will adhere to a "small numbers" policy of suppressing findings for any group of students numbering fewer than ten, and to require all employees, contractors, and agents of any kind to also abide by such policy. Where "small numbers" reporting becomes necessary, the APPLICANT will request formal consent from the SDUSD REPRESENTATIVE unless prior approval from SDUSD has been obtained.

V. DATA REQUEST AND USE

A. The APPLICANT agrees that the single authorized REPRESENTATIVE to request data under this agreement will transmit all data requests and maintain a log or other record of all data requested and received pursuant to this agreement, including confirmation of the completion of any projects and the return or destruction of data as required by this agreement.

B. The ability to access or maintain data under this agreement shall not under any circumstances transfer from the APPLICANT to any other institution or entity. The APPLICANT may not disclose SDUSD data to parties not identified in Part I without the written consent of the SDUSD REPRESENTATIVE.

C. No other entity is authorized to continue using SDUSD data obtained under this agreement upon cessation of studies conducted under the direct supervision of the APPLICANT.

D. The APPLICANT will require all employees, contractors, and agents of any kind to comply with all applicable provisions of FERPA and other federal laws with respect to the data shared under this agreement. The APPLICANT agrees to require and maintain an appropriate confidentiality agreement from each employee, contractor, or agent with access to data pursuant to this agreement.

E. The APPLICANT will maintain an original data set of SDUSD data obtained pursuant to this agreement separate from all other data files.

F. Nothing in this agreement authorizes the APPLICANT to maintain data beyond the time period reasonably needed to complete the purpose of the request. Unless authorized in writing by the SDUSD REPRESENTATIVE, all data relating to an individual student must be returned or destroyed when no longer needed for the purposes for which the study was conducted.

G. The APPLICANT agrees that the SDUSD REPRESENTATIVE may, upon request, review the records required to be kept under this agreement.

H. The APPLICANT agrees that the SDUSD REPRESENTATIVE may decline to comply with a request if, in her/his discretion, s/he determines that providing the requested data would not be in the best interest of current or former students in the SDUSD.

I. The APPLICANT agrees that all requests will include a statement of purpose, if not included in the original proposal, for which data are requested and an estimation of the time needed to complete the project for which the data are requested. The parties may agree to accept data requests by electronic mail, telephone, or facsimile.

VI. RESEARCH INSTRUMENTS

A. The APPLICANT agrees to submit to the SDUSD REPRESENTATIVE for review and approval, **at least two weeks prior** to administration, all surveys, interviews, assessments, or focus group activities that impact SDUSD staff or students.

VII. RESEARCH PRODUCTS

The APPLICANT intends to present research findings in X written and/or X oral format. *(If initialed, continue.)*

A. The APPLICANT will present a **first** draft of either preliminary or endmost research findings generated under this agreement and related methodology to the SDUSD REPRESENTATIVE **at least six weeks prior** to any written or oral presentation thereof. The draft must identify the intended audience and cite specific forums (e.g., journals, conferences, dissertation) in which the findings will be presented.

PB B. The SDUSD REPRESENTATIVE agrees to take no longer than **two weeks** from receipt to review the **first** draft of either preliminary or endmost findings, cite inaccuracies, and/or offer revisions that comport with rigorous research methodology.

C. The APPLICANT agrees to submit the **final research product** to the district prior to any written or oral presentation of endmost findings and after presentation or dissemination an electronic copy of the final version for posting on the district website.

VIII. TERM OF AGREEMENT

A. The APPLICANT agrees to terminate all research activities (including presentation of the final report) on or before May 19, 2015.

IX. AMENDMENT TO, OR CANCELLATION OF, MEMORANDUM OF AGREEMENT

This agreement expresses the entire agreement of the parties. Any modification or amendment to the agreement must be executed in writing and signed by both the SDUSD REPRESENTATIVE and the APPLICANT.

A. Both the APPLICANT and the SDUSD REPRESENTATIVE agree that the Memorandum of Agreement takes effect upon signature by the authorized representative of each party and shall remain in effect until the termination date identified above, or until canceled or amended by either party upon thirty days written notice.

B. The APPLICANT agrees that the SDUSD REPRESENTATIVE may cancel the Memorandum of Agreement immediately upon violation of any element agreed to herein.

Entered into this 20th day of May, 2014.

APPLICANT

SDUSD REPRESENTATIVE

Bruce Ward

SDUSD SPONSOR

Curriculum Vitae

Tôna De Aune Wilson
Curriculum Vitae

Mission Statement

To empower people through psychological well-being by way of nutritional and physical fitness, while empowering them through nutritional and physical fitness by way of psychological well-being.

Education

- Doctorate: Walden University, Minneapolis, MN,
  - Ph.D. Psychology, Health Psychology Specialization
  - Predicted graduation date December 2014
- National Board of Professional Teaching Standards
  - Certificate: Early Adolescence through Young Adulthood Physical Education, December 2006
- Masters of Arts in Education
  - San Diego State University, August of 2003
  - Major: Curriculum and Instruction. Cumulative GPA 4.0
  - Thesis: The Correlations Between Student's Physical Fitness Levels and Standardized Academic Achievement: Implications Regarding the Demographics of Monroe Clark Middle School
- Single-Subject Clear Credential State of California
  - Physical Education, Pre-K through Grade 12
- Post-Baccalaureate Teaching Certificate, Physical Education.
  - University of Arizona, August 1997
    - Degree: Bachelor of Science in Health Sciences, Physical Education Major
    - Certificate: Secondary Physical Education
- Bachelor of Health Science in Exercise Sciences
  - University of Arizona, August 1995
  - Major: Exercise Science,
  - Minor: Nutritional Sciences
  - Emphasis: Sport Psychology

Employment

- 2007 to Present:
    - Abraham Lincoln High School, San Diego City Schools
        - Teaching: Standards-based physical education instruction grades 9th through 12th. Sports Medicine and Athletic Training instructor for 11th and 12th grade elective.
        - Leadership: Department Chairperson, 2007-2008 Physical Education. Race Team Coordinator, SD Union Tribune Race for Literacy, 2007-present
        - Service: Athletic Trainer, Injury Rehabilitation Specialist for all sport teams and staff. Staff and community fitness director; fitness diagnostician MicroFit testing laboratory.
- 2008 July-Aug:
    - Healing Arts Centre, Mammoth Lakes CA
        - Service: Massage Therapy Technician- Therapeutic massage, sport massage for general population. Front desk assistant.
        - Leadership: Volunteer Coordinator: Organized a large scale volunteer effort utilizing all massage therapists in the Mammoth Lakes area for free massage service to the Sherwin Firefighters.
- 2002 to 2007:
    - Monroe Clark Middle School, San Diego City Schools
        - Teaching: Standards-based physical education instruction grades 6th through 8th. Botvin Life Skills curriculum instruction.
        - Leadership: Department Head- 2003-2004 school year through 2004-2005 school year.
        - Master teacher for student teacher 2003-2004 and 2006-2007. Jordan Fundamentals Grant Recipient 2002.
        - Charger's Champions Grant runner up, 2004.
        - Committee member for 2006 Clark reconstitution committee.
        - Service: Coach, 14 and under flag football team 2002.
        - XDC Weight training instructor 2002-2006.
        - Mentor, "Best Friends" program for girls.
- 2003 to Present
        - Self-employed: "Fit to a 'T' Lifestyle and Health Enhancement Coaching"-
        - Service: Personal fitness training for all populations, lifestyle coaching, personal fitness cooking and nutrition education, therapeutic bodywork.
- 1998 – July 2000
    - Woodrow Wilson Academy Middle School, San Diego City Schools
        - Teaching: Physical Education instruction 6th through 8th grade; 7th and 8th grade Life Skills "Dragonslayers"; 8th grade Sexual Education.

- 1999 –2002
    - Head Coach- Girl’s Gymnastics, El Cajon Valley High School
        - Coaching: United States Gymnastics Federation- Junior Olympic Level 5- Junior Varsity, Junior Olympic Level 6 and 7- Varsity.
- 1990 - present
    - Personal Training and Aerobics Instruction:
    - Sporting Club at Avantine, 24 Hour Fitness, Sorrento Valley Athletic Club, Club La Jolla, Her Fitness and Day Spa La Jolla, Peninsula Athletic Club San Diego, and self-employed. Metro Fitness, Gym’s Fitness, World Gym Tucson, Desert Sports and Fitness and self-employed.
    - Teaching: Group Fitness Instruction including indoor cycling, step aerobics, water aerobics, special populations, boot camp, kickboxing and aerobic kickboxing.
    - Personal Chef/Cooking Instruction: Workshop and program development monthly (Gym’s Fitness) for healthy cooking, fitness and wellness education. Personal cooking instruction, cooking and menu preparation for personal training clients.
    - Specific Populations: Personal fitness/nutrition programming for people with diabetes, Chron’s disease, Celiac’s disease, fibromyalgia, burn victims, Guillian-Barrés syndrome, stroke victims, pre/post- surgery or injury rehabilitation, cardiac rehabilitation, bulimia-nervosa, morbid obesity, and/or depression. Specific nutrition and training program design for marathon runners, bodybuilders, fitness/bodybuilding competitors, prenatal/postnatal fitness, and/or general fitness/wellness.
- 1997 - 1998
    - Grossmont Union, Lemon Grove, and San Diego Unified School Districts
        - Teaching: Substitute Teacher: Physical Education, Special Education, all classrooms and content areas K-12.
- 1990 - 1992
    - Santa Catalina Villas Retirement Community
        - Consulting: Nutritional consultation for seniors and special diet populations
        - Service: Front desk security attendant, emergency first-responder
- 1989 - 1991
    - Student Recreation Center, University of Arizona
        - Teaching: Water aerobics, swimming lessons
        - Service: Pool attendant, lifeguard on duty
- 1986-1990: Summer Employment
    - Pima County Parks and Recreation Arizona Lifeguard, Water Safety Instructor, Assistant Pool Manager,
        - Teaching: Swimming lessons and lifeguard training for students aged pre-school to adult. Water aerobics instruction for adults.
        - Leadership: Assistant manager, program director for swimming lesson program

- 1987 - 1988
    - El Conquistador Fitness Center, Sheraton El Conquistador Tucson
        - Instruction: Floor training, weight room help and supervision
    - Service: Fitness desk attendant

Intramural Service

- 2007- present
    - Lincoln High School
        - Service: Staff and student after school fitness director, athletic trainer for all sport teams, team coordinator and coach, San Diego Union Tribune Race for Literacy.
        - Coaching: Coach, cheerleader tumbling for Lincoln High School competitive cheer squad. Coach, girl's wrestling .
- 2005 - 2007
    - Monroe Clark Middle School
        - Service: Mentor, Best Friends Program for girls.
- 2003 - 2005
    - Monroe Clark Middle School
        - Leadership: Department head-elect, Physical Education Department. One two-year tenure.
- 2002 - 2003
    - Monroe Clark Middle School
        - Coaching: City Heights Parks and Recreation League- 14 and under, 8-man flag football. Third place in City-Wide Tournament December 2002.
- 2004 - present
    - Monroe Clark Middle School
        - Teaching: Extended Day Program (XDC) weight training class instructor.
- 1997 - 2003
    - El Cajon Valley High School
        - Coaching: Coach, after school tumbling club and team coach for ECV school gymnastics team, Olympic levels 4-10.

- 2008—Summer
    - Mammoth Lakes Healing Arts Centre
        - Program Development/Volunteer: Organized a large scale volunteer effort to give massage therapy free of charge to firefighters assisting in the Sherwin Fire which threatened the town of Mammoth Lakes.

- 2002-present
    - San Diego State University
        - Teaching: Guest professor in credential program- Teaching incoming credential candidates the theory and practice of standards-based physical education curriculum, as well as the theory and practice of contemporary teaching techniques such as writing to learn, shared and guided reading, read-aloud, project-based learning and cross-curricular learning as it applies to current physical education classes.
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- 2003-2004 and 2006--2007
    - San Diego State University
        - Teaching: Master teacher for physical education credential candidates.
- 1990-1992
    - NovaCare Rehab Institute of Tucson
        - Volunteer: Help in group and single-patient physical therapy including sports medicine, pediatrics, geriatrics, cardiovascular and cerebrovascular patients.

Publications

- 2005
    - Featured teacher in a chapter on research-based best practices. Also featured in 2007 edition.
        - Vacca, RT; Vacca, JL. (2005). *Linking Physical Education with Literacy Learning. Content Area Reading- Literacy and Learning Across the Curriculum, 7th ed.* Boston, MA: Allyn and Bacon p.183

Research

- 2003
    - Master's Thesis, San Diego State University
        - *"The Correlations Between Student's Physical Fitness Levels and Standardized Academic Achievement: Implications Regarding the Demographics of Monroe Clark Middle School"*
- 2013-2015
    - Doctoral Dissertation, Walden University
        - *Relationships Between Specific Health-Related Fitness Components and Standardized Academic Achievement Tests*

Grants

- 2002
    - Nike Jordan Foundation grant recipient- $1500.00
        - Project: Traversing rock wall to be placed inside the activity room in the physical education department. Curriculum and project-based unit including self-esteem and team-building activities and projects.
- 2005
    - San Diego Charger's Champions runner-up recipient $50,000.00
        - Project: Community-based fitness program incorporating our existing weight room, activity room and paid resources as staff. Would educate students as well as their parents about fitness, wellness, weight loss, nutrition and physical activity. Facility would be open to only family members of Clark students after school.
        - Members would be required to complete fitness testing and one week of classes consisting of safety, nutrition, activity and family-focused fitness before using facilities.

Leadership/Programs Developed

- 2007—present
    - Lincoln High School Physical Education Department
        - Program Development Member
        - Physical education department and the school principal is creating a distinguished standards—based physical education curriculum. The aim is to earn the "California Distinguished" award for our excellence in physical education curriculum and student performance.
        -
- 2008—Summer
    - Mammoth Lakes Healing Arts Centre
        - Program Developer/Volunteer
            - Organized a large scale volunteer effort to give massage therapy free of charge to firefighters assisting in the Sherwin Fire which threatened the town of Mammoth Lakes. A "Firefighter Appreciation" tent was set up in the parking lot with posters, balloons and other community members showing their appreciation to the firefighters as they saved the town. Firefighters were given 30 minutes of massage by a therapist volunteer. The town was saved within three days, thanks to the efforts of the men and women who fought the blaze around the clock.

- 2006--present
    - Lincoln High School
        - Program Development: Community, Staff and Student after school fitness program.
            - An after school program utilizing our MicroFit fitness diagnostic testing lab, spinning room and weight room in a group instruction/group personal training setting. Program participants receive personal fitness training, healthy coaching/ nutritional advice, cooking and shopping advice on a budget or food stamps/EBT program. "Social exercise" is emphasized in that being a part of a group is more engaging with more accountability. Individual goals are established, progress is monitored and goal attainment is celebrated as a group.
- 2004--2005
    - Monroe Clark Middle School
        - Program Development Committee Member: Clark curriculum reconstitution committee.
        - As elected committee members, we are in the process of reconstituting our school. Our API and AYP were such that we feel the need for complete school reconstitution. I oversee the development of the physical education program as well as give feedback for other programs in development. The new constitution is due to launch September of 2006.
- 2006
    - Monroe Clark Middle School
        - Program Development:: "The Best Loser"
        - Created as a play off the popular television show "The Biggest Loser", included staff members as well as students.
- 2006
    - Monroe Clark Middle School
        - Program Development: "SD Union Tribune Race for Literacy"
        - In-class and after school training program for the May 2007 5K Race for Literacy. Students who want to train for the race are given a training regimen and log to be completed step by step in PE class or after school. The students meet with me once a week with their logs. Several weekend long runs are planned around the neighborhood at specific stages of training. Teambuilding activities are also incorporated.

- 2007 - Present
  - Abraham Lincoln High School
    - Leadership: Department head-elect, Physical Education Department. One year tenure.
    - Program Development: Community fitness project. Before and after school workout and health education program for students, staff and surrounding community.
    - Program Development: Student Athletic Trainer program. Developed and taught a sports medicine curriculum to students and trained each to become student athletic trainers assigned to specific sport teams during games for varsity and junior varsity boys and girls sports.

- 2003 - 2005
  - Monroe Clark Middle School
  - Leadership: Department head-elect, Physical Education Department. One two-year tenure.
    - Designed and initiated a department-wide fitness regimen to be administered by all PE teachers to all classes each day. Every two weeks, a new workout was created and implemented as students' fitness levels increased. The goal was to increase the number of students passing all six State-mandated Fitnessgram standards. The results showed more students passing physical fitness tests both years the program was in place.
    - Developed a department-wide regulation routine for meeting classes, teaching cues and disciplinary action. All cues and routines were standardized in order for teacher accountability and student responsibility to be maintained in any class.
    - Created a "Weight Room Safety and Instruction" video with a colleague in the department. This video instructs students on proper equipment use, spotting techniques and safety considerations for the Cybex machines, barbells and dumbbells in the weight room. This video is shown to every class before they enter the weight room and is a part of the curriculum. Students are tested on content viewed in the video.
- 2000
  - Monroe Clark Middle School
    - Program Development: Family Fitness Night
    - Developed a monthly fitness night when students could bring their parents and work out in the weight room, or take one of two aerobics classes offered that night. Aerobics classes included either a step aerobics or a salsa aerobics class. Students were allowed to participate if they had a parent with them.

- 1992 - 1996
    - Gym's Fitness, Metro Fitness and World Gym- Tucson, Arizona
        - Program Development: Nutrition, fitness and wellness, personal fitness training
        - Designed monthly seminars based on members' requests, contemporary wellness issues, fad diet analysis, proper free weight training form and cooking/nutrition. Seminars were also directed toward special populations including people with diabetes, COPD, obesity, and the elderly.

Memberships and Certifications

- Certified Personal Trainer and Aerobics Instructor, American Council on Exercise
- Certified Spinning Instructor, Mad Dogg Athletics, Inc.
- Certified Personal Fitness Chef, National Exercise and Sport Training Association
- Certified Food Psychology Coach, National Exercise and Sport Training Association
- Certified Sports Psychology Coach, National Exercise and Sport Training Association
- Certified Sports Nutrition Specialist, National Exercise and Sport Training Association
- Certification in process- Personal Lifestyle Strategies Coach, National Exercise and Sport Training Association
- Certified First Aid and CPR-AED, American Heart Association
- Certified Interscholastic Coach, National Federation Interscholastic Coaches Education Program
- Member- Psi Chi, International Honor Society in Psychology
- Member- American and California Association for Health, Physical Education, Recreation and Dance (AAHPERD & CaAHPERD)
- Member- International Dance and Exercise Association (IDEA)
- Member- American Psychological Association (APA) Division 38 Health Psychology, Divieion 47 Sport and Exercise Psychology
- Member- Association for Applied Sport Psychology (AASP)

Tôna DeAune Wilson
Curriculum Vitae

Empowering people through psychological well-being by way of nutritional and physical fitness, while empowering them through nutritional and physical fitness by way of psychological well-being.