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The Relationship Between Body Mass Index, Fitness, Socioeconomics, and Academic Accountability School Rating: A Texas Study

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THE RELATIONSHIP BETWEEN BODY MASS INDEX, FITNESS, SOCIOECONOMICS, AND ACADEMIC ACCOUNTABILITY SCHOOL RATING: A TEXAS STUDY

by

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Earning a PhD is a huge endeavor–a marathon, and mine included several difficult courses, learning a new language, a seven-month study abroad, and a dissertation. Throughout this program, I was exposed to new ideas, experiences, and events that challenged my thoughts, feelings, beliefs, and morals and made me question almost everything I'd ever known to be true. It profoundly changed me in many unimaginable and unforeseeable ways.

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DEDICATION

To my family–

Christopher K. Bahe
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&
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They earned and deserve this degree as much as me.
Their sacrifice, support and unconditional love throughout this process
and our lives together will always be remembered.
I love you all very, ***very*** much–today, tomorrow and *always*.

THE RELATIONSHIP BETWEEN BODY MASS INDEX, FITNESS, SOCIOECONOMICS, AND ACADEMIC ACCOUNTABILITY SCHOOL RATING: A TEXAS STUDY

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Between 1980 and 2000, obesity rates in the United States have doubled for adults and tripled for children (Centers for Disease Control [CDC], 2015). In addition, Texas, the second largest state, ranks 10th for the highest percentage of obesity among youth age 10-17 (CDC, 2015). Nationally, the United States falls behind other countries in high school and college completion rates (Greenstone, Harris, Li, Looney, & Patashnik, 2012), and since 2001 when the No Child Left Behind Act (NCLB) began, school administrators have reduced physical education, art, music, and recess by 44% to increase the time students spent in reading and math courses preparing for standardize tests (Kohl & Cook, 2013). While standardized testing helps measure student learning, it may be that it also contributes to the growing obesity epidemic among youth in America. This study examined the school-level relationship between body mass index (BMI), fitness, socioeconomics, and academic accountability school rating in Texas for 3 separate school years (2010-2011, 2012-2013, and 2013-2014). A significant relationship between BMI, fitness, and academic achievement was found. However, the relationship was inconsistent. This study adds to existing research and uses the most recent data to date.

TABLE OF CONTENTS

Table of Contents—Continued

LIST OF TABLES

List of Tables—Continued

LIST OF FIGURES

Chapter One: Study Overview

Presidential candidate Mike Huckabee said, "We don't have a healthcare crisis…we have a *health* crisis" (Huckabee, 2015). The 2015 State of Obesity Report confirms his statement by calling the obesity epidemic one of America's most serious health crises (Trust for America's Health, 2015). Between 1980 and 2000, obesity rates in the United States have doubled for adults and tripled for children, and currently 81% of U.S. adults fail to meet the suggested federal guidelines for physical activity and muscle strengthening (Centers for Disease Control and Prevention [CDC], 2015). At the state level, Texas, the second largest state in the United States, ranked 10th for the highest percentage of obesity among youth age 10-17 (CDC, 2015). When compared to other countries, the United States leads in the total number of overweight people (McKay, 2014; The Organisation for Economic Co-operation and Development [OECD], 2014), and at the same time falls behind other countries in high school and college completion rates (Greenstone, Harris, Li, Looney, & Patashnik, 2012).

Sabia (2007) found a significant negative relationship between body weight and academic grade point average (GPA), as body weight increased, GPA decreased. Obesity may not be the only factor contributing to a person's increase or decrease in academic achievement, as Crosnoe and Muller (2004) found lower achievement in adolescents who were at risk for obesity and whose parents also earned less income when compared to other students. Therefore, this study examined the relationship between Texas public schools' (grades 3 -12) percent of students with at-risk body mass index (BMI), percent of students who passed all six state mandated physical fitness tests, percent of students classified as socioeconomically disadvantaged and the schools' academic accountability school rating.

Background

According to Porter (2014), American K-12 education is improving but not enough to remain globally competitive. In the United States today, students spend more class time practicing standardized test questions and taking benchmark tests for core courses (reading, math, and science) than other forms of learning, such as from books, group work, experiments, purposeful homework, career related activities, teacher-student discussions, fine arts participation, and physical education (Cox, et al, 2011; Kohl & Cook, 2013; Risku & Harding, 2013; Winter, 2009). While standardized testing helps measure student learning, it may be that it also contributes to the growing obesity epidemic in America since only about half of youth today meet the current guidelines of 60 minutes per day of vigorous- or moderate-intensity physical activity (Kohl & Cook, 2013; Winter, 2009).

Because of testing pressures, many districts have removed physical education (along with arts and career courses) to increase the time students spend in their seats practicing test questions and learning valuable skills to raise state mandated standardized test scores (Baker, 2012; Cooper, et al., 2010; Cox, et al., 2011; Kohl & Cook, 2013; Patterson, 2013; Risku & Harding, 2013; Winter, 2009; Zhu, Boiarskaia, Welk, & Meredith, 2010). For some students, this means the only time they set foot outside is to travel to and from school, since there is less or no recess and/or free play for many students (Kohl & Cook, 2013; Risku & Harding, 2013; Winter, 2009). Little, if any, time is left in a child's day for physical movement, i.e. exercise. Despite the No Child Left Behind Act (NCLB) and more per pupil spending, American students' test scores for reading and math remain virtually unchanged (Greenstone et al., 2012).

Problem Statement

The United States continues to remain behind other countries academically as illustrated by the Programme for International Student Assessment (PISA) test scores for math, science, and reading (OECD, 2013). At the same time, the United States remains in the first place for the total number of overweight people when compared to other countries (McKay, 2014; OECD, 2014). While countries such as China look to integrate and encourage innovation, creativity, and a more liberal education to prepare students for global leadership, the United States is moving toward a more nationalized common core curriculum (Common Core State Standards Initiative, 2015; Özturgut, 2011). This standardization has encouraged U.S. schools to focus more on testing skills and less on physical education, the arts, and other liberal arts education geared toward educating the whole child (Baker, 2012; Cox, et al., 2011; Kohl & Cook, 2013; Patterson, 2013; Risku & Harding, 2013; Winter, 2009). According to Kohl and Cook (2013), since 2001 when the No Child Left Behind Act began, school administrators reduced physical education, art, music, and recess by 44% to increase the time students spent in reading and math courses.

The problem is that standardization has not helped increase academic achievement in comparison with other countries as shown by PISA scores (OECD, 2013), but instead has caused many schools to reduce or eliminate physical education and recess to keep students in their seats practicing for these tests (Cox, et al., 2011; Kohl & Cook, 2013; Risku & Harding, 2013; Winter, 2009). This may in effect be a factor in the childhood obesity epidemic, which research suggests may itself contribute to academic decline in overweight and obese students (Cournot, et al., 2006; Cserjesi, Molnar, Luminet, & Lenard, 2007; Dahl, et al, 2009; Gunstad, et al., 2007; Li, Dai, Jackson, & Zhang, 2008). Cooper et al. (2010) Texas Statewide Assessment of Youth Fitness study found that despite rising trends of childhood obesity and Type 2 diabetes along the

Rio Grande Valley in Southern Texas, school administrators still did not support full implementation of the Texas Senate Bill 530 that mandates students participate in 30 minutes per day of physical fitness and annual fitness testing. These researchers assert that administrators feared state-mandated test scores would decrease if required to set aside time for physical fitness during the school day. In addition, the researchers point to other factors that also contribute to the problem, including reduction in physical education courses and recess during the school day as well as the decline in the number of children who walk to school regularly. It may be that the removal of fitness from schools and from children's lives produces the decline in academic achievement as several researchers suggest (Castelli, Hillman, Buck, & Erwin, 2007; Chomitz, et al., 2009; Grissom, 2005; Risku & Harding, 2013; Welk, et al., 2010; Winter, 2009). This study examined the impact of Texas public schools' BMI rates, physical fitness levels, and socioeconomic percentages on schools' state academic accountability school rating using the most recent, comprehensive public data available, which differentiates this study from past research.

Purpose of the Study

When examining BMI, physical fitness, socioeconomics, and academic achievement, there are mixed results. Some researchers found no relationship between BMI and/or physical fitness and academic achievement (Abdelalim, et al., 2010; Agarwal, Bhalla, Kaur, & Babbar, 2013; Hill-Jones, 2008; Kaestner & Grossman, 2008; Thompson, 2013; Tremblay, Inman, & Willms, 2000), while others found a relationship (Campos, Sigulem, Moraes, Registrar, & Fisberg, 1996; Christodoulou, 2010; Coe, Pivarnik, Womack, Reeves, & Malina, 2006; Cottrell, Northrup & Wittberg, 2007; Datar & Sturm, 2006; Davis & Cooper, 2011; Eveland-Sayers, Farley, Fuller, Morgan, Caputo, 2009; Han, 2012; Johnson, 2007; Krukowski, et al., 2009; Li, 1995; Mo-Suwan, Lebel, Puetpaiboon, & Junjana, 1999; Stevens, To, Stevenson, & Lochbaum, 2008). Most of these studies examined data collected before 2000, and few are longitudinal. Of the longitudinal studies, none examine a relationship beyond eight years.

Even though some researchers have found a relationship between students' physical fitness levels (and BMI) and academic achievement, school administrators continue to reduce or remove physical education and recess from the school day (Castelli, et al., 2007; Chomitz, et al., 2009; Grissom, 2005; Welk, et al., 2010). The purpose of this study was to examine three years of school data using the Texas Education Agency's released public aggregate Fitnessgram fitness testing data and aggregate academic accountability school performance data for the relationship between BMI, physical fitness, socioeconomics, and academic achievement in Texas public schools.

Definition of Terms

For the purpose of this study, the definition of the academic accountability school rating was the same definition used by the Texas Education Agency (TEA) for each year. Due to changes in the state standardized academic accountability test, the definition of a school's pass rate (met standard or did not meet standard) depended on the year in which the test was taken. During the 2010-2011 school year when the Texas Assessment of Knowledge and Skills (TAKS) test was taken, there were four academic accountability ratings: exemplary (at least 90% of students tested passed the test), recognized (at least 80% of students tested passed the test), academically acceptable (varied by subject: for reading/English language arts, writing, and social studies at least 70% of students tested passed the test; for mathematics at least 65% of students tested passed the test; and for science at least 60% of students tested passed the test), and the last rating, academically unacceptable (students tested below the minimum percentages listed in the latter). Schools that were not rated were not included in this study. The following school year, 2011-2012, was the first implementation of the State of Texas Assessments of Academic Readiness (STAAR) test and no public academic data was released. Therefore, this school year was not included in the study.

According to the TEA (2013, 2014 & 2015) the academic accountability school rating for 2012-2015 school years were based on four indexes that had a score of 0 to 100. Those indexes were student achievement, student progress, closing performance gaps, and postsecondary readiness. For the 2012-2013 school year, schools that received a “met standard” or “met alternative standard” rating must have reached their campus’ performance index target on *all* indexes. For the purpose of this study, all schools that received a rating of “improvement required” were classified as “did not meet standard.” The 2013-2014 school year was slightly different than the latter year. The rating was a calculated percent of the maximum number of points possible for all the indexes together whether a school fell short on some indexes or not (i.e. the school did not have to meet their required points for all the indexes but instead reach a certain combined total point level for their campus).

The definition of BMI, physical fitness level, and socioeconomic percentage derived from the Fitnessgram fitness measurement instrument, and all data came from the Fitnessgram report itself, as published on the TEA website. All of these indicators were a calculated percent from the original data representing the population of a particular school.

The definition of overweight and obese in this study was the Fitnessgram definition, which was adapted using standards obtained from the Center for Disease Control and Prevention (CDC) growth charts (Going, Lohman, & Eisenmann, 2013). According to the CDC (2015) an adult BMI of 25 – 29 is overweight and 30 and over is obese. The CDC (2015) measures the

BMI of children using the same scale, but takes into account age and sex differences due to growth. The charts use percentiles showing the distribution of BMI at a given age for a specific gender, which can help determine whether a child is normal, overweight, or obese (CDC, 2015). The Fitnessgram definition of overweight is a BMI greater than the 85th percentile, and obese is BMI greater than the 95th percentile for a student's age and gender.

The Fitnessgram test consisted of six fitness activity tests that measure five health-related fitness components: aerobic capacity, muscular strength, muscular endurance, flexibility, and body composition. Each component had a fitness activity or activities that measured the fitness level for that component. Physical education teachers or other expert testers selected activities that were best for measuring a particular component based on the students' gender and grade (age level). Welk et al. (2010) used the percentage of students achieving healthy fitness zone (HFZ) for the cardiovascular fitness component as their primary indicator for fitness. Those activities included the progressive aerobic cardiovascular endurance run (PACER), the 1-mile run, and walk test. For the purpose of examining physical fitness level, this study used the percentage of students achieving HFZ for all six fitness activity tests, because Texas' goal is to have all students achieve HFZ for all six fitness activity tests (Texas Department of State Health Services, 2015, p. 9)

The Fitnessgram data sets also reported the aggregate socioeconomic levels of the students tested. The data stated the total number of students who took the Fitnessgram test and were classified as either one of three economically disadvantaged categories within a particular school. This was calculated into a total percent of economically disadvantaged students within each school for the purpose of this study. According to the TEA's Section 4: Description of Codes (2009-2010), there are three classifications for students classified as socioeconomically disadvantaged. Socioeconomically disadvantaged 01 refers to the number of students who were eligible for free meals under the government sponsored program: The National School Lunch and Child Nutrition Program. Economically disadvantaged 02 refers to the number of students who were eligible for reduced-priced meals under the government sponsored program: The National School Lunch and Child Nutrition Program. Economically disadvantaged 99 refers to other economic disadvantages, including coming from a family with an annual income at or below the official poverty line as defined by the federal government, being eligible for Temporary Assistance to Needy Families (TANF) or other public assistance, receiving a Pell Grant or other comparable state program based on financial need, being eligible for Title II programs under the Job Training Partnership Act (JTPA), or being eligible for benefits under the Food Stamp Act of 1977.

Theoretical Framework

James Sallis and Thomas McKenzie, two renowned researchers and proponents for K-12 physical education, first published the article “Physical Education’s Role in Public Health” (1991) with the intention of helping to build a relationship between physical education and public health. Sallis and McKenzie advocate for physical education courses that are designed to engage students physically but also teach fitness as a lifetime activity because of its associated long-term health benefits. While there is no official academic theory which states that being fit or becoming fit improves academic success, Sallis and McKenzie’s (1991) research along with others support positive associations between physical education and/or fitness and academic achievement (London & Castrechini, 2011; Sallis, et al., 2012; Welk, et al., 2010; Wittberg, Northrup, & Cottrel, 2009). Other research suggests positive associations between BMI and academic achievement (Campos, et al., 1996; Cho, Lambert, Kim, & Kim, 2009; Christodoulou, 2010; Crosnoe & Muller, 2004; Cserjesi, et al., 2007; Datar & Sturm, 2006; Davis & Cooper, 2011; Gurley-Cavez & Higginbotham, 2010; Han, 2012; Johnson, 2007; Krukowski, et al., 2009; Li, 1995; Li, et al., 2008; Mo-Suwan, et al., 1999; Shore, et al., 2008; Sigfusdottir, Kristjansson, & Allegrante, 2007) and between socioeconomic level and academic achievement (Cho, et al., 2009; Crosnoe & Muller, 2004; Gurley-Calvez & Higginbotham, 2010; London & Castrechini, 2011). These studies provide the theoretical framework for this study.

Research Questions

This study answered the following questions: (1) Does the percentage of students with BMI at-risk (BMI%) predict the academic accountability school rating (AASR)? (2) Does the percentage of students who achieve Health Fitness Zone (HFZ) six times (FIT%) predict the academic accountability school rating (AASR)? (3) Does the percentage of students classified as low socioeconomic level (SES%) predict the academic accountability school rating (AASR)? (4) When controlling for school type, %Female, and school size are the percentage of students with BMI at-risk (BMI%), percentage of students who pass all six Fitnessgram activity tests (FIT%), and percentage of students who are categorized as having low socioeconomic level (SES%) associated with the academic accountability school rating (AASR)?

Overview of the Research Design

This quantitative correlational study was designed to duplicate some aspects of the Texas Youth Study conducted by Welk et al. (2010) that explored student academic achievement, fitness levels, body mass index, socioeconomic levels, ethnicity, race, and other factors. The difference between this study and the latter is that this study examined only the school level relationship between academic accountability school rating, BMI, physical fitness, and socioeconomic levels for three years during the period of 2010 to 2014 (with the exclusion of

2011-2012, which was the first implementation of the new state academic assessment test and no public academic data was released). Additionally, this study looked solely at data from Texas public schools and only third through twelfth grades (the testing grade levels).

Study Significance

A unique aspect of this study was the availability of recent aggregate data from the state of Texas. Before now, the Texas Youth Study was the most recent comprehensive study of student physical fitness and academic achievement. This study added to the existing research by filling the gap that once existed in studying recent BMI, physical fitness, socioeconomics, and academic achievement data.

There are many stakeholders in education, including national and state legislators, local school districts, teachers, business owners, and community leaders. The future of many students may be in a vulnerable position, but those most concerned with the future success of today's children are the children's own parents. Parents want their children to live successful and productive lives. This study may help today and tomorrow's parents and children. Identification of a relationship between these factors may guide educational policy in the United States of America and elsewhere. Policy makers and educational stakeholders may be able to use the information found in this study to significantly help future generations who ultimately would benefit most from this research.

Limitations of the Study

There were four initial limitations to the study. First, because of the federal law Family Educational Rights and Privacy Act (FERPA) individual student scores from state standardized academic tests could not be linked to individual fitness test scores (Morrow, Martin, Welk, Zhu, & Meredith, 2010). This made examining individual student BMI, physical fitness, and socioeconomic results with their academic assessment test results impossible, and therefore, this study only allowed for analysis of data at the aggregate level. Second, there are many factors that contribute to a student's academic success, weight, physical fitness and socioeconomic level. Therefore, causality is not suggested, which limits the interpretation of the relationship or correlation between the variables, if found. Third, the study was limited to students attending public schools in the state of Texas, the second largest state in the United States. Therefore, the information acquired from this study may not be applicable or generalizable to other areas which have different cultural populations and experience different environmental conditions. The fourth limitation pertains to the fitness testing of high school students. Texas law requires that students take one credit of physical education during their high school experience. Students who were not enrolled in physical education courses during the Fitnessgram testing period may have been ill prepared for the testing, and therefore not performed as well as they could have with adequate preparation (Corbin, 2010). Also, as pertains to the Fitnessgram physical fitness tests and the state standardized academic accountability tests, some students may not have performed their best on the test for a variety of different individual, personal and/or physical reasons.

An additional limitation should also be noted: the study used data for which there was no means to validate. (It is unknown whether the data provided by the schools to TEA was validated.) During the data cleaning process, it was found that some of the cases listed more students tested than were enrolled at a school. Those cases were removed from the study.

Chapter Two: Literature Review

Research has shown that the brains of healthy weight people perform better than those who are obese (Cserjesi, et al., 2007; Gunstad, et al., 2007; Li, et al., 2008). However, the United States has a greater percentage of overweight adults and children than any other country in the world (McKay, 2014; OECD, 2014). With increased academic pressures for students, it has become imperative to study the relationship between BMI, physical fitness, socioeconomic levels, and academic achievement.

Researchers examined the impact of exercise on academic achievement and found an association between fitness and academic success (Carlson, et al., 2008; Castelli, et al., 2007; Chomitz, et al., 2009; Coe, et al., 2006; Cottrell, et al., 2007; Eveland-Sayers, et al., 2009; Grissom, 2005; Stevens, et al., 2008; Welk, et al., 2010; Wittberg, et al., 2009). Researchers who studied the association with other factors (most relating to physical fitness), found that overweight and/or obese students scored consistently poorer on academic indicators than normal weight students (Campos, et al., 1996; Datar & Sturm, 2006; Krukowski, et al., 2009; Li, 1995; Shore, et al., 2008; Tershakovee, Weller, & Gallagher, 1994). The following review of the literature is organized first to address BMI and its relationship to academic achievement, followed by physical fitness and socioeconomic level.

BMI and Academic Achievement

An *International Journal of Health Science* review suggested that the cognitive skills of the obese have become limited as evidenced when compared to normal weight people. According to Christodoulou's (2010) review of the literature from 2008-2010, there was a significant decline in the IQ scores for the severely obese (those with BMI greater than 30). Christodoulou proposes that obesity makes people less capable of combating their challenges and becoming successful in life, because there is a gradual decline in will power and intelligence with increased weight.

Datar and Sturm (2006) analyzed data from the Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K), which is a cohort of kindergarten students during the 1998-1999 school year from about 1,000 U.S. kindergarten programs who were followed through eighth grade (sponsored by the National Center for Education Statistics). From a sample of 7,000 first-time kindergarteners, they studied the association of BMI/overweight/obesity and student achievement. They found that overweight students had lower test scores, but also that children who *became* overweight by third grade had similar scores to those who had always been overweight. They also found that students who had always been overweight had more absences than healthy weight students. Further, overweight students had a higher grade repetition than healthy weight students.

Two dissertations that also used data from the ECLS-K study found an association between obesity and student achievement. Han's (2012) dissertation investigated the effect of obesity on standardized test scores. The sample included 4,460 children from fifth to eighth grade. Han found that obese eighth grade students scored lower than normal weight students on math and reading tests. Math scores of obese students were significantly lower than for normal weight students. Obesity also affected the female academic performance more than the male. Obese students also tended to have poorer academic study habits than normal weight students.

Johnson's (2007) dissertation found that higher BMI was significantly associated with lower scores on a longitudinal basis for both reading and math. Math was even more significantly affected over time. However, Johnson included only 1,538 cases for her study. It is unclear if Datar and Sturm (2006), Johnson (2007), and Hann (2012) used the same cases, and therefore are finding the same evidence for the same study.

Mo-Suwan, Lebel, Puetpaiboon, and Junjana (1999) studied first through sixth grade Thai students in Thailand. They found that the higher the student's BMI, the lower his or her GPA. In addition, an upward trend in BMI status was associated with a greater risk of having a lower GPA.

Campos, Sigulem, Moraes, Registrar, and Fisberg (1996) compared the intelligence of 65 obese and 35 normal weight children age 8 to 13 years old. They found that obese children had lower IQs than the healthy weight children. The obese children fell within the "lower to middle range" of the Wechsler Intelligence Scale for Children (WISC), whereas the normal weight children scores were located in the middle range (normal). Within the obese group, 4.6% of the obese children scored below 70 on the WISC test, which indicates mental weakness despite no observance of such in these children. The researchers also found that obese children had a narrow and low field of interest when compared to the healthy weight children.

Davis and Cooper (2011) studied 170 overweight (according to their BMI for their age) and sedentary but healthy 7- to 11-year-old children. They found that math achievement was more affected by overweight/ obesity than reading. However, reading was more affected by physical fitness.

Gurley-Cavez and Higginbotham (2010) examined fifth grade students using a panel of data from 55 West Virginia school districts from 2003-2007 that included health information from the Coronary Artery Risk Detection in Appalachian Communities (CARDIAC) Project. Due to data availability and the need to avoid reverse causation problems that other older children and adults may experience, they chose to focus on the fifth grade students. Health screenings that measured height, weight, and BMI were compared to proficiency levels in reading and math. They found the effect of obesity on student achievement was zero for districts that had an average poverty rate. However, in districts with a high poverty rate they found an association where for each one percent decrease in obesity there was a .15% increase in reading proficiency. They also found that students scored higher when surrounded by high performing peers, and students in urban areas also scored higher.

Li (1995) investigated the differences between the measures of intelligence and personality of both normal weight and obese weight children. One-hundred and two children age 6 to 13 (65 males and 37 females) participated in the study. Li found that obese children scored significantly lower on performance IQ tests, but there was no difference between the scores of obese children and their controls for verbal IQ.

Li, Dai, Jackson, and Zhang (2008) examined data from 2,519 children who were part of the Third National Health and Nutrition Examination Survey study conducted from 1988 to 1994 which consisted of U.S. noninstitutionalized citizen households. They found an association between BMI and cognitive function in school-age children and adolescents. Their sample was large and the association with BMI was specifically for cognitive impairment in visuospatial organization and general mental ability. When adjusting for family socioeconomic levels, television watching, psychosocial development, physical activities, and other possible confounders, the association remained.

Using data obtained from a random selection telephone survey of 2,358 parents, Krukowski et al. (2009) found that it was more likely for overweight students to perform poorer at school (grades) than their non-overweight peers even when accounting for all other factors. Students who experienced weight-based teasing were more than 50% less likely to perform well in school when compared to others who experienced no weight-based teasing. Females experienced more consequences associated with weight based teasing than males.

Cserjesi et al. (2007) studied the cognitive profiles of overweight male students to normal weight male student peers (control). They found that the obese male students performed worse on mental flexibility tests (measuring the ability to restructure knowledge to fit a situation). However, their study was small and consisted of only 24 male students (mean age 12.1), 12 healthy weight and 12 obese weight.

Shore et al. (2008) found normal weight students had higher grades, higher reading test scores, better attendance rates, and fewer disciplinary problems than overweight students. Their study included 566 sixth and seventh grade students from a Philadelphia suburb.

Sigfusdottir, Kristjansson, and Allegrante's (2007) analyzed data from the 2000 Icelandic Study (a survey which included questions about academic and health behaviors) from 6,346 14- and 15-year old students (51.4% females and 48.6% males). Sigfusdottir et al. said that BMI was strongly correlated to school achievement (student self-reported grades). However, in their study parent education, absenteeism, and self-esteem significantly influenced academic success more than BMI. In addition, reliability of the self-reported grades is a limitation.

Cserjesi et al. (2007) found obese students had shorter attention spans than other normal weight students. However, their study was small. The cognitive profiles of only 24 male students were examined (mean age 12.1), 12 healthy weight and 12 obese weight. Tershakovee, Weller, and Gallagher's (1994) study found similar results. They compared 104 healthy-weight and obese-weight black students between the ages of 8 and 12 years old. They found that obese students exhibited more behavior problems. In addition, these students were more often placed in special education classes.

Cho, Lambert, Kim, and Kim (2009) examined a subgroup containing 2,000 high school seniors. The seniors were part of the Korean Education and Employment Panel Survey conducted by the Korea Research Institute for Vocational Education and Training. The researchers found that poor school performance (test scores) increased students' risk of becoming overweight which also significantly lowered test scores.

Students at risk of becoming overweight who attended schools with higher BMI averages did better in those schools than if they attended schools where obesity was considered a liability by classmates (Crosnoe & Muller, 2004). They also found that students at risk of obesity who participated in school athletic programs did better in the school environment. This is similar to the study mentioned previously that found students involved in school clubs and/or activities had higher College Scholastic Ability Test (CSAT) scores (Cho, et al., 2009).

Gunstad et al. (2007) studied 486 normal, overweight, and obese participants (ages ranging from 21 to 82). They too found a relationship between memory deficits and otherwise healthy overweight and obese participants. In their study, overweight and obese participants scored lower in verbal memory tests than normal weight participants who had a similar age, estimated IQ, education level, and other demographic factors.

Similarly, Cournot et al. (2006) found higher BMI was associated with reduced memory. They analyzed the data of 2,223 healthy participants (ages 32 to 62) and found that higher BMI was associated with lower psychometric cognitive test scores (after adjusting for demographics and other health-related variables).

The Dahl et al. (2009) study analyzed data from 781 participants (age 25 to 63 with a mean age of 41.6). The participants were part of the Swedish Twin Registry. They found a significantly lower average performance in cognitive ability for study participants with high BMI, which declined more rapidly as time passed.

Researchers said females were most affected academically by overweight/obesity (Gable, Krull, Chang, 2012; Judge & Jahns, 2007; Krukowski, et al., 2009). Sabia's (2007) research suggested that females may be affected more by the weight gain itself, which affected their self-esteem and radiated to other areas of their life, including academics. Sabia (2007) also suggested that possible teacher weight discrimination against females may be more likely to affect their academic performance. His study examined whether body weight adversely affected academic achievement. He analyzed data from the 1994-1995 academic year that was part of the National Longitudinal Study of Adolescent Health, which collected information from students in grades 7 to 12, parents, and school administrators.

Cluskey and Grobe's (2009) study examining college transition weight gain found that more male students gained weight and at a higher magnitude than female students. Unlike Sabia's (2007) study, Datar, Sturm, and Magnabosco's (2004) found that males were most affected by overweight/obesity. Their study analyzed the association of overweight status and academic performance in 11,192 kindergarteners from the Early Childhood Longitudinal Study.

Greenstone, Harris, Li, Looney, and Patashnik's (2012) Hamilton Project examining America K-12 schools found that the more education parents had the more they were able to invest in the education of their children. Lamerz et al. (2005) found that a parent's educational attainment was significantly associated with student obesity. When examining the data of 2,020 Aachen, Germany students born during a specific period, the more education the parents had (especially the mother) the less likely the child was to be obese. The researchers hypothesized that mothers typically spend more time with their children than fathers, which may be the reason their educational attainment affected the obesity rate of their children more. Parents with lower educational attainment tended to bottle feed their babies compared to parents of higher education attainment who were more likely to breast feed. Well educated parents may be more informed about the advantages of breast feeding (Lamerz, et al., 2005).

According to Lamerz et al. (2005), parents with higher educational attainment are better informed and practice that knowledge in their daily habits. Zoellner et al. (2011) found that health literacy improves the diet patterns, overall health, and obesity rates in an area, but found that areas with the greatest need also have the lowest availability of health information and literacy. They found that more health literacy equated to less sugary beverage consumption.

Physical Fitness and Academic Achievement

A few studies explored the relationship between physical fitness and student academic achievement. Welk et al. (2010) examined Texas TAKS test scores and the Texas student fitness standard test (FITNESSGRAM program). They found positive associations between fitness and academic achievement; when fitness levels decreased, test scores also decreased. The effects of high stake test pressures prevent the effective implementation of physical education courses, and thus many school districts have reduced or eliminated physical education programs and recess (Baker, 2012; Cox, et al., 2011; Kohl & Cook, 2013; Patterson, 2013; Risku & Harding, 2013; Winter, 2009).

Wittberg, Northrup, and Cottrel (2009) found an association between physical fitness and academic performance. Children considered in the “healthy zone” for their fitness test measuring aerobic capacity and abdominal strength were more likely to master language arts, math, sciences, and social studies skills than children who scored in the “needs improvement” zone.

The researchers said that a “fitter child is more likely to succeed in the academic environment” (p. 33).

London and Castrechini’s (2011) study examined fourth through seventh and sixth through ninth grade students using administrative and individual growth modeling data. When comparing students in their study who were consistently fit to students who were consistently unfit, there were differences in math and English language arts scores, particularly for females and those classified as Latino. Fitness predicted academic achievement, and gaps in achievement with regards to fitness were seen as early as fourth grade.

While these researchers suggested that all students need physical fitness to improve academic achievement test scores or raise academic achievement overall (i.e. grades), Carlson et al. (2008) found that physical education classes only helped increase the test scores of some females but not for males. Their study used data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998 to 1999 (ECLS-K) where kindergarten participants were followed through eighth grade. The researchers analyzed the time spent in physical fitness education with reading and math tests. One of the limitations for the study, though, was using a large data base with a large amount of missing data. Although the data was nationally representative, the researchers’ said their statistical weights did not adjust for the large amount of missing data in the main variable, which was the length of time in a physical education course. That may have biased their data.

Donnelly et. al (2009) studied children in second and third grades from 26 elementary schools for three years (random cluster study). They found that academic achievement was significantly improved with the use of a fitness curriculum in the classroom program (Physical Activity Across the Curriculum or PAAC). In addition, researchers stated that teachers who participated in the classroom fitness activities had students who were also more active in the fitness classroom program.

Shilts, Lamp, Horowitz, and Townsend (2009) conducted a quasi-experimental design research study with 84 sixth grade students that included an EatFit program (intervention). They found that behavior focused nutrition programs impact school performance. Furthermore, Schibsted (2006) found that school implemented fitness and nutrition programs raised the overall school standardized test scores and reduced the number of student behavior issues (office referrals).

While many researchers point to the association of physical activity and academic test scores, El Nokali (2011) and Moses (2011) found no significant association. Moses's (2011) dissertation examined the relationship between physical activity and reading, writing, and math test performance in fifth grade elementary students. He found that no matter how much physical activity a student participated in, there was no significant difference in their reading, writing, and math scores. However, El Nokali's (2011) dissertation found that structured physical activity in the school setting (i.e. games or other activities with a direct end) positively predicted a child's self-regulatory skills and achievement. El Nokali (2011) investigated 104 4- and 5-year old children in a preschool setting and 993 ethnically and economic diverse third and fifth grade students in a school setting (as well as a 297 low income subsample).

Socioeconomic Level and Academic Achievement

Research finds that many obese are also economically disadvantaged. Crosnoe and Muller (2004) examined a sample of 132 middle and high schools (20,475 students) from the National Longitudinal Study of Adolescent Health database. They found lower achievement in adolescents who were at risk for obesity and whose parents also earned less when compared to other students. They suggested that risk of overweight and living in a lower socioeconomic environment may set the stage for a life of obesity and low income before a student enters secondary education. If the research is accurate for all populations, they also suggest that the pattern would be repeated in students' offspring. They found that students at risk of obesity were more influenced by the school structure.

Cho et al.'s (2009) study analyzed data of 6,000 students in the KEEP Survey database, a survey conducted by the Korea Researched Institute for Vocational Education and Training. They found that the mother's income and education significantly related to their child's academic achievement. Datar et al. (2004) found similar results. They analyzed the association of overweight status and academic performance in 11,192 kindergarteners from the Early Childhood Longitudinal Study (ECLS-K) that followed students through eighth grade. They also found that students from lower socioeconomic homes had higher obesity rates (noting particularly students of Hispanic ethnicity). They concluded that the mother's education level was a strong predictor of academic success. When the researchers controlled for socioeconomic differences, the association was weaker.

London and Castrechini (2011) discovered that students as young as fourth grade (or about age 9-10 years old) who were persistently fit or persistently unfit continued on that path. The researchers found the gap to be particularly profound for elementary school females and Latinos. They also found that the outliers in their study came from higher socioeconomic backgrounds. Those most affected were from lower socioeconomic backgrounds.

Obesity is not necessarily a permanent condition. In situations where income and obesity are present, increasing socioeconomic income level and reducing weight could raise scores according to Gurley-Calvez and Higginbotham (2010). For their study, they used data from the

Coronary Artery Risk Detection in Appalachian Communities (CARDIAC) Project, which is comprised of health data from participating fifth grade students in 55 districts within West Virginia. The data represents 40 to 43 percent of fifth grade students but has been found to be representative of all students in the area with regards to weight.

Sometimes it is perceived that having a lower income would affect personal eating habits. However, income is not necessarily associated with purchasing more unhealthy food according to Inglis, Ball, and Crawford (2009) who studied 74 women (ages 18-65) selected from the Socioeconomic Status and Activity in Women (SESAW) study. The participants completed an itemized weekly food shopping list that reflected their grocery purchases for their entire household. Then they were asked about items they would add to their list if they had 25% more money to spend, and what items they would remove from their original list if they had 25% less money to spend. Even with a lower income, food purchasing power is not directed only by food budget. When budgets were increased, women with lower incomes bought more healthy food (than when buying with their lower budgets) but women with higher incomes added more unhealthy foods. The researchers concluded that the core of the women’s food from the food budget was not affected by additional income. Their core purchases still remained the same, and therefore income had no effect on purchasing more healthful food.

Research Supporting No Association Between BMI and Academic Achievement

Research specifically reporting for BMI, overweight or obesity, and student achievement suggest that high BMI affects academic performance. However, some researchers found otherwise. The following studies support no association between BMI and academic achievement.

Abdelalim et al. (2010) investigated the association between obesity and academic performance in the classroom. By random selection, they recruited and analyzed data from 999 male fifth grade students living and attending sex-segregated schools in Kuwait who were both present the day of the study and had been at their schools long enough to have grades. The researchers found no difference between obesity and academic achievement among male students, but instead said overweight students did better than both the normal and obese students. The researchers hypothesized the reason was due to the education level of their parents, since study participant students already had high grades.

Kaestner and Grossman's (2008) working paper series studied weight and children's educational achievement. They examined fourth through seventh and sixth through ninth grade students using administrative and individual growth modeling data. They found no association between obesity and student achievement, however they used older data from the 1979 cohort in the National Longitudinal Survey of Youth (NLSY). London and Castrechini (2011) found an increased soda consumption of youth during a 20-year period, which may explain why Kaestner and Grossman (2008) found no association between fat and academic achievement, since eating and drinking patterns of society and its youth changed.

Hill-Jones (2008) doctoral dissertation explored the prevalence of obesity and high school student performance in a low socioeconomic school district. The researcher did not find a significant association between obesity and student performance, however, there were only 13 male and 22 female participants. One larger, mixed method dissertation study, Thompson (2013), investigated 680 students from one suburban North Carolina intermediate school (grades 4 through 6). She found no correlation between math grades or language arts benchmark scores and BMI. However, she did find that in underweight students absenteeism affected student achievement. Thompson also said there was no correlation between physical activity and BMI. In addition, detentions and out-of-school suspensions did not differ between students with normal weight and students with overweight or obese weights.

Agarwal, Bhalla, Kaur, and Babbar (2013) studied 30 first year medical students of both sexes in New Delhi. They found no association between BMI and cognition or BMI and physical self-concept. In her literature review examining current research, Daniels (2008) espoused that current literature indicates there is an association between academic performance and obese adolescents when socioeconomic factors were considered. However, there was no link between obesity and academic performance.

Chapter Three: Methodology

Standardized testing in the United States is prevalent, and all indicators suggest it will continue to remain a part of public school education (Common Core State Standards Initiative, 2015; Özturgut, 2011). While testing does provide a tool for measuring student academic achievement, pressures for all students to pass and surpass minimum requirements encourages school administrators to keep students in their seats by reducing or eliminating physical education and recess (Baker, 2012; Cox, et al., 2011; Kohl, & Cook, 2013; Patterson, 2013; Risku & Harding, 2013; Winter, 2009). With rising obesity rates among children and research suggesting overweight and obese children perform below normal weight children (Campos, et al., 1996), it is important to study the relationship between BMI, fitness, socioeconomics, and academic achievement.

Research Questions and Hypothesis

This was a quantitative correlational study that examined the school-level relationship between percent of students with BMI risk (BMI%), percent of students who pass all six Fitnessgram activity tests (FIT%), percent of students classified as socioeconomically disadvantaged (SES%), and academic accountability school rating (AASR) during the 2010-2011, 2012-2013, and 2013-2014 school years in the state of Texas. A conceptual framework is depicted in Figure 1.

This study examined the following research questions:

(1) Does BMI% predict AASR?

Null Hypothesis 1.

There is no association between BMI% and AASR in Texas K-12 schools for each school year.

Alternative Hypothesis 1.

There is an association between BMI% and AASR in Texas K-12 schools for each school year.

(2) Does FIT% predict AASR?

Null Hypothesis 2.

There is no association between FIT% and AASR in Texas K-12 schools for each school year.

Alternative Hypothesis 2.

There is an association between FIT% and AASR in Texas K-12 schools for each school year.

(3) Does SES% predict AASR?

Null Hypothesis 3.

There is no association between SES% and AASR in Texas K-12 schools for each school year.

Alternative Hypothesis 3.

There is an association between SES% and AASR in Texas K-12 schools for each school year.

(4) When controlling for school type, %Female, and school size are BMI%, FIT%, and SES% associated with AASR?

Null Hypothesis 4.

There is no association between AASR, BMI%, FIT%, and SES% when controlling for school type (elementary, middle and junior high, elementary and secondary combined, and secondary), %Female, and school size (number of students) in Texas K-12 schools for each school year.

Alternative Hypothesis 4.

There is an association between AASR, BMI%, FIT%, and SES% when controlling for school type (elementary, middle and junior high, elementary and secondary combined, and secondary), %Female, and school size (number of students) in Texas K-12 schools for each school year.

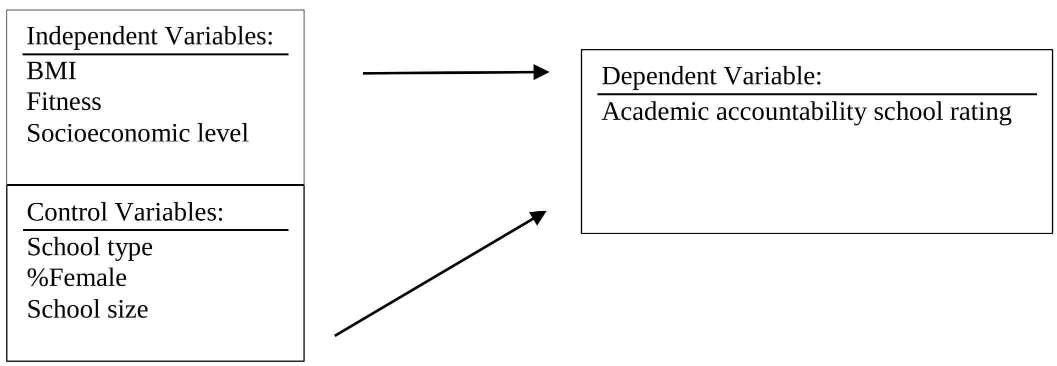

Figure 1. Conceptual framework of the study.

Study Sample

There were no human participants in this study. Public aggregated data acquired from the TEA website was analyzed. The data included TAKS and STAAR academic accountability school ratings and Fitnessgram fitness test results. Each school year's data were examined and compared.

The Fitnessgram database listed cases by school, grade, and gender followed by their fitness test results and socioeconomic information (i.e. Johnson High School, grade 10, females, fitness results, and socioeconomic information). Academic achievement was determined using the TEA's academic accountability school rating, which was based on the school students' standardized test score results.

The standardized test scores data base reported the cases by school (and school type) and whether the school met standards, met alternative standards, improvement required, or not rated. Schools that had a “not rated” rating were removed from the study sample. The data was merged with school Fitnessgram data for each year. All Texas public schools that had all data with regards to BMI%, FIT%, SES%, and AASR were included in the study. Schools lacking any of this information were removed from the study. The 2012-2013 and 2013-2014 school years had significantly more lacking data than the 2010-2011 school year. Table 1 shows the sample description by year and type of school for the schools included in the study.

Table 1

Sample Description Showing the Number of Schools Each Year Based on the School Type

Sample	Total Schools	Elementary	Middle/Junior High	Both (K-12)	High School
2010-2011	5,266	2,916	1,099	220	1,031
2012-2013	3,787	2,138	760	171	718
2013-2014	1,839	1,080	362	69	328

Setting

The settings for the participants in the study were Texas public schools: elementary, middle and junior high, elementary and secondary combined, and secondary. Students completed state mandated tests in assigned classrooms and seating with a trained teacher test proctor. The Fitnessgram tests were also conducted in a school classified as an elementary, middle and junior high, elementary and secondary combined, and secondary, but the tests were held outside or inside in a fitness (i.e. gym class) setting with a trained teacher or test administrator.

Research Variables

The seven primary variables in the study were BMI%, FIT%, SES%, school type (elementary, middle and junior high school, elementary and secondary combined, and secondary), %Female (gender), school size (number of students enrolled), and AASR (did not meet standard or met standard). The dependent variable was AASR (did not meet standard or met standard), which was the academic accountability school rating (met standard or did not meet standard) for a particular school year listed in the data obtained from the TEA website.

The independent variables were BMI%, FIT%, and SES%. BMI% was the calculated percentage of the total number of students at a school who participated in the Fitnessgram test that were classified as having some-risk (overweight, BMI > 85th percentile) and high risk (obese, BMI > 95th percentile) for their age and gender based on the Fitnessgram definition, which was adapted using standards obtained from the Center for Disease Control growth charts (Going, et al., 2013). The FIT% was the total number of students at a school who achieved HFZ (rating) for six fitness activity tests administered during the Fitnessgram test, which is the maximum number a student can achieve that was reported in the data, divided by the total number of students who took the Fitnessgram test. SES% was calculated as the total number of students who were classified as economically disadvantaged 01, economically disadvantaged 02, or economically disadvantaged 99 who participated in the Fitnessgram test divided by the total number of students who took the Fitnessgram test. School type (elementary, middle and junior high school, elementary and secondary combined, and secondary), was obtained from the TAKS and STAAR school academic ratings data.

The control variables were school type, gender, and school size. TEA lists the school type as elementary, middle and junior high school, elementary and secondary combined, and secondary. Gender (%Female) was the number of females who took the Fitnessgram test divided by the total number of students who took the test. School size was the total number of students who participated in the Fitnessgram at a particular school, which was chosen as a representation of the school size (enrollment total) due to Texas Senate Bill 530 that mandates all students in Texas public schools participate in 30 minutes per day of physical fitness and annual fitness testing. For elementary students, this bill mandates that students participate in a physical education class. However, students in high school may substitute physical education class with participation in band, sports team, or similar equivalent activity.

Data classification. The dependent variable and academic achievement indicator (academic accountability school rating) was whether or not a school met the academic standard during a particular school year based on the enrolled students' TAKS or STAAR test results. This was a numeric and nominal variable. BMI%, FIT%, SES%, and %Female are all numeric and scale variables. School type was categorical and nominal but was coded numerically in SPSS for analysis. School size was the total number of students who participated in the Fitnessgram test. See Table 2.

Research Design

Background. During the 2007-2008 school year, the Texas legislature voted to mandate physical fitness testing in Texas public schools and chose to use the Fitnessgram measurement instrument. The data collected from the Fitnessgram along with student standardized state test results (as well as other demographic factors) were examined by researchers. This study became known as the Texas Youth Fitness Study (Morrow, et al., 2010). Due to the Family Educational Rights and Privacy Act (FERPA) researchers were not allowed to examine and compare

Table 2

Variable Type by Code Name Explaining How the Data Is Coded, Its Measure, and Definition

Variable Code Name	Data Code	Measure	Definition
AASR	Numeric	Nominal	Academic accountability school rating; 0 = did not meet standard and 1= met standard
BMI%	Numeric	Scale	Percentage of students at a school classified as overweight and obese
FIT%	Numeric	Scale	Fitness indicator; the total percentage of students at a school who achieved HFZ six times
SES%	Numeric	Scale	Total percentage of students at a school who are classified as economically disadvantaged 01, 02, and 99
School type (elementary, middle and junior high school, elementary and secondary combined, and secondary)	Numeric	Nominal	Elementary school = 0, middle school = 1, elementary/middle combined = 2, high school = 3
%Female	Numeric	Scale	Total percentage of females who took the Fitnessgram test
School size (number of students)	Numeric	Scale	Total number of students

individual data but instead an aggregate of school data that would not identify or be linked to the identity of individual students. The framework for this study was to examine public data in a similar process as the researchers of the Texas Youth Fitness Study (Welk, et al., 2010). This study examined the Texas public schools' Fitnessgram data with those same schools' academic accountability school rating for the 2010-2011, 2012-2013, and 2013-2014 school years using the aggregate public data available from the TEA website. Due to changes in the standardized test, data for the 2011-2012 school year was not made public, and therefore was not included in this study.

Study design. This study was a quantitative correlational study using secondary, public aggregated data based on the framework from the Texas Youth Study (Welk, et. al., 2010). Three school years of data was obtained from the TEA website (2010-2011, 2012-2013, and 2013-2014).

Data Analysis

Two types of data sets were collected from the TEA website and analyzed. The first was the aggregate Texas state assessment scores for individual schools. Currently, TEA lists schools' academic accountability school rating as met standard, met alternative standard, improvement required, or not rated. However, past years used other rating systems. For the purpose of this study, schools' ratings were determined based on that year's rating system and recoded as either met standard or did not meet standard. Data sets from 2010-11, 2012-13, and 2013-14 were collected and analyzed.

The second aggregate data set examined in this study was collected from the Fitnessgram database obtained from the TEA website. The Fitnessgram was given by trained physical education teachers. A study was conducted to ensure test validity and consistency of teacher examiners according to the Fitnessgram guidelines. Morrow, Martin and Jackson (2010) found the teacher collected data to be reliable and approximately the same results as the expert testers.

The state reports aggregate student fitness scores by school, gender, grade, body mass index (as the number of students at some risk and number of students at high risk), total students achieving healthy fitness zone (HFZ) once, twice, three times, four times, five times, and six times, and total students achieving HFZ for six to 10 different fitness activities. Because TEA's goal is to have all students meet the minimum standard to achieve HFZ on all six activities required in the Fitnessgram test (Texas Department of State Health Services, 2015, p. 9), the fitness indicator for this study was the percentage of students who took the Fitnessgram test and achieved HFZ six times. A second indicator of fitness for this study was the aggregate percentage of students who participated in the Fitnessgram test who were classified as some-risk and high-risk for BMI. Welk et al. (2010) also used these indicators.

Procedures. The statistical program SPSS 22 was used to examine and identify associations. First, the data were cleaned to remove all cases with missing data. A second cleaning was performed to remove all cases with discrepancies in the data, such as the total number of students tested exceeding the total number of students enrolled at a school. Then descriptive statistics were used to characterize the sample. For each school year, three point-biserial correlation tests were run for research questions one through three. For the fourth question, a multivariate logistic regression analysis test was run for each school year. Assumptions were verified for each test. The significance level used for the study was $p < .05$. Table 3 shows the analytical tests performed. Table 4 shows the variable classifications.

Protection of human subjects and ethical considerations. Institutional Review Board (IRB) approval was obtained prior to beginning the study. Ethical considerations for the study included the sensitive nature of obesity, fitness, socioeconomic indicators, and student test scores. It is not possible to link test scores, BMI and physical fitness test results, or socioeconomic indicators to individual students because the data is aggregated due to the public schools' adherence to the FERPA law which protects the privacy of its students. However, due to the sensitive nature of the subject being studied, appropriate attention was given with the presentation of the findings in order respect the dignity of humans whom may be affected by obesity, physical fitness, socioeconomics, and academic achievement.

Table 3

Analysis Tests for the Research Questions Showing the Type of Statistical Analysis and the Appropriate Independent Variable(s) and Dependent Variable

Research Question	Statistical Analysis	Independent variable(s)	Dependent Variable
1. Does BMI% predict AASR?	Point-biserial correlation	BMI%	AASR
2. Does FIT% predict AASR?	Point-biserial correlation	FIT%	AASR
3. Does SES% predict AASR?	Point-biserial correlation	SES%	AASR
4. When controlling for school type, %Female, and school size are BMI%, FIT%, and SES% associated with AASR?	Logistic regression	BMI%, FIT%, SES% School type, control; %Female, control; school size, control.	AASR

Table 4

Variable Categories Describing the Variable Classification, Variable Name, Type of Measure for the Variable, and the Statistical Category of the Variable

Classification	Variable	Measurement	Category
IV*	BMI%	Numeric	Continuous
IV	FIT%	Numeric	Continuous
IV	SES%	Numeric	Continuous
CV**	%Female	Numeric	Continuous
CV	School type (elementary, middle and junior high school, elementary and secondary combined, and secondary)	Nominal	Categorical
CV	School size (number of students)	Numeric	Continuous
DV***	AASR (Met standard and did not meet standard)	Nominal	Dichotomous

**IV is an independent variable. **CV is the control variable. ***DV is a dependent variable.*

Chapter Four: Results

The purpose of this study was to examine the relationship between BMI, physical fitness, socioeconomics, and academic accountability school rating in Texas public schools. A quantitative analysis was used to examine three years of school data using the TEA's released public aggregate Fitnessgram fitness testing data and aggregate academic accountability school rating performance data for the relationship between BMI, physical fitness, socioeconomics, and academic achievement in Texas public schools.

Data Cleaning Procedure

To conduct the analysis, fitness and academic accountability school rating data were collected from the TEA website for the 2010-2011, 2012-2013, and 2013-2014 school years via downloaded Excel spreadsheet. The fitness data base contained multiple records per school. It listed the records by school identification number, grade level, and gender, and their respective aggregate fitness results (i.e. school number, grade 3, males, fitness results). This meant that before analysis could begin the school data had to be aggregated into one record per school. To do this, first a new variable was created to list only the total number of females, which would later be used to create the %Female variable. Then the grade and gender (males or females) variables were removed. The final step was aggregating the data into one school case. The fitness data was then merged with the academic accountability school rating database.

The academic accountability school rating database contained only one record per school. Each record included the school identification number, the campus name, and the accountability school rating code. The school rating code was re-coded for analysis into met standard or did not meet standard for the respective year, and the school name variable removed. Both the fitness and academic accountability school rating files were merged together using their school identification number. The resulting file included one school record for each school in Texas that had complete data which listed the school's academic accountability school rating and their aggregate fitness results.

Before merging the fitness data with the academic accountability school rating data, the fitness database was cleaned to remove any schools with missing data. Once the data was merged, it was cleaned a second time after testing and verifying for incorrect data. School records with incorrect data were removed. For example, the total number of students tested for the fitness test was tested to verify that the number didn't exceed the total number of students enrolled at the school (school enrollment number from the Fitnessgram data). One final cleaning was performed when the enrollment numbers listed in the Fitnessgram data was found to be inconsistent. New enrollment information was obtained for each year from the TEA website. A third cleaning was performed to remove all cases where the number of students tested exceeded the TEA enrollment number, as well as removing all cases where the number of students classified as socioeconomically disadvantaged exceeded the TEA enrollment number. This was to be sure all cases with incorrect data were removed.

For the 2010-2011 school year, 5,691 schools were removed for missing or incomplete data, and 7,054 removed from the 2012-2013 school year and 7,858 removed from the 2013-2014 school year. (See Table 5.) In addition, frequencies tests revealed the remaining cleaned data contained similar distribution profiles as all data together. Elementary school percentages remained between 52-54%, middle/junior high schools between 19-20%, both (K-12) between 5-7%, and high school between 20-21% for each school year. (See Table 6.) This indicates the cleaned data was similar in profile as the total data before cleaning.

Table 5

Total Schools Included and Not Included in the Study by Year

	Total number of schools in the original data set	Total number of schools removed from the study due to data missing or inconsistencies	Total number of schools included in the study
2010-2011	8,526	5,691	2,835
2012-2013	8,555	7,054	1,501
2013-2014	8,574	7,858	716

Table 6

Data Distribution by School Type for Each School Year

		% Elementary	% Middle/Junior High	% Both (K-12)	% High School
2010-2011	All Data	53.5	20.0	5.6	20.9
	Removed	52.8	20.0	5.8	21.4
	Cleaned	54.9	19.9	5.2	20.1
2012-2013	All Data	53.9	19.9	5.7	20.4
	Removed	54.2	20.0	5.6	20.3
	Cleaned	52.6	19.7	6.5	21.1
2013-2014	All Data	53.9	19.9	5.6	20.6
	Removed	54.1	19.9	5.4	20.6
	Cleaned	52.5	19.7	7.5	20.3

Assessing for Normality and Outliers

Descriptive statistics were run for each school year for each of the three variables, BMI%, FIT% and SES%. The data showed a normal distribution for BMI% for the 2010-2011 school year. The 2012-2013 school year is nearly a normal distribution for BMI with a slightly negative skew. The 2013-2014 school year distribution shows there are about 20 outliers (or about 2% of the total cases). The outliers in BMI% represent schools that reported having no students who were classified as being at risk for overweight or obesity. Because the outliers were a small percentage of the total data, they were retained. (See Figures 2-4.)

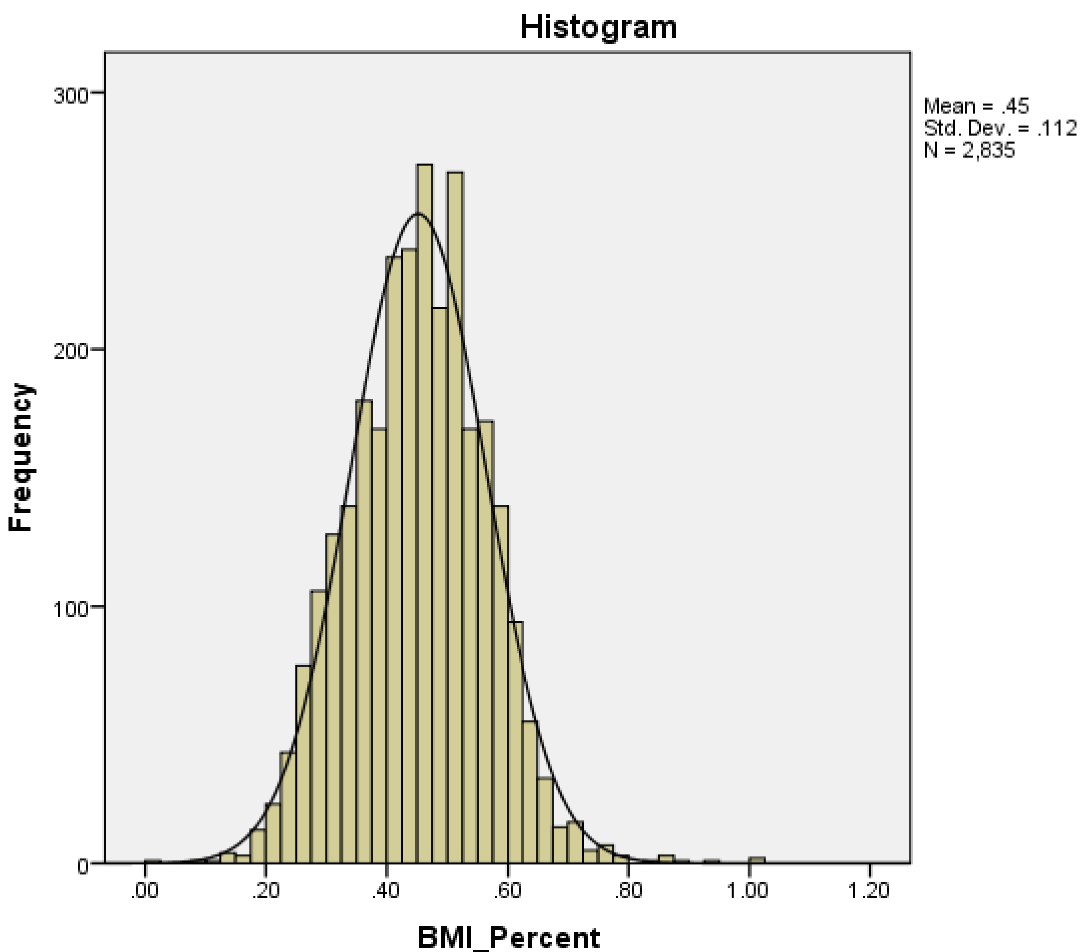

Figure 2. Histogram of the variable BMI% for the 2010-2011 school year.

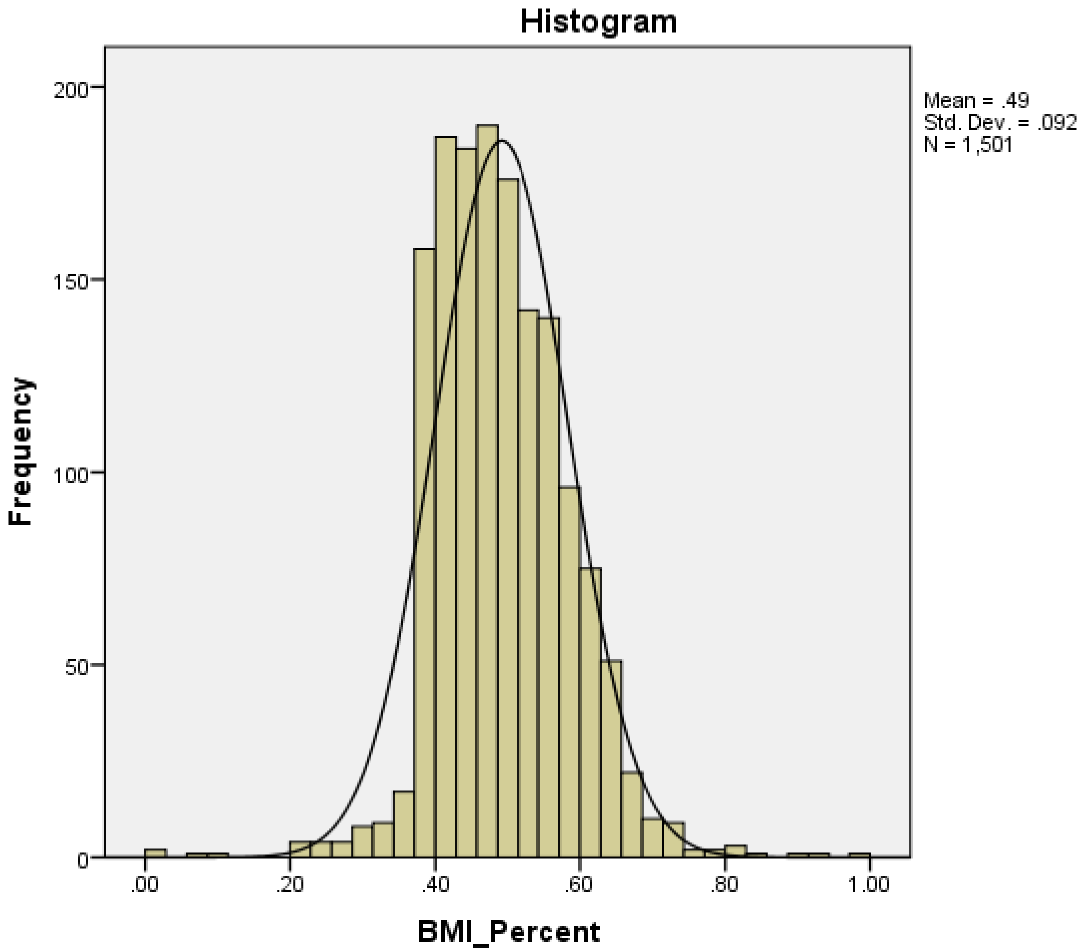

Figure 3. Histogram of the variable BMI% for the 2012-2013 school year.

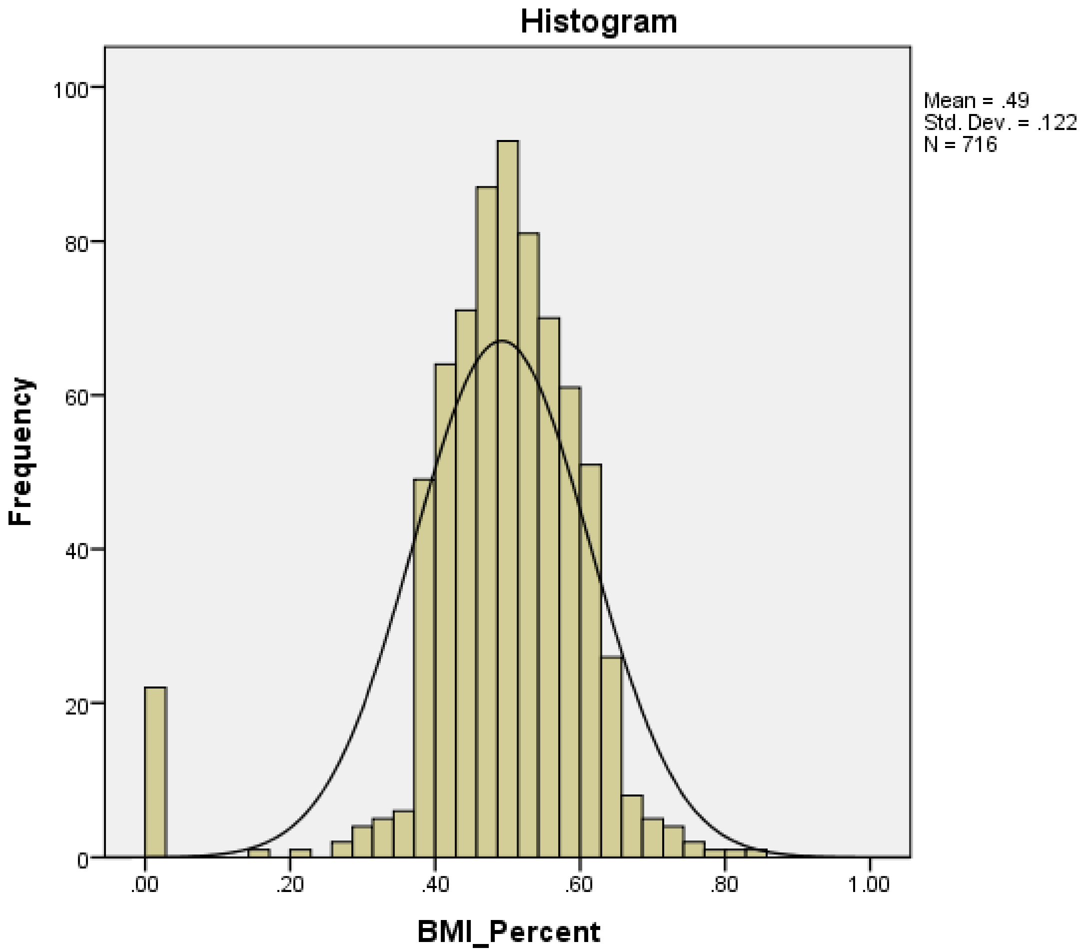

Figure 4. Histogram of the variable BMI% for the 2013-2014 school year.

Data for the second variable, FIT%, also contained outliers, but in every year. Like BMI%, the outliers represent schools that reported no students who were physically fit as defined as having passed all six physical fitness activities in the Fitnessgram fitness test. The data is normally distributed for all three years with the exception of those outliers. For the 2010-2011 school year, there were about 200 outliers (or about 7%). For the 2012-2013 school year, there were about 150 outliers (or nearly 10%). For the 2013-2014 school year, there were about 80 outliers (or about 11%). There was no way to check the validity of the data, since it was public data posted on the TEA's website. Because of the latter and the fact that the values are plausible, the outliers were retained. See Figures 5-7.

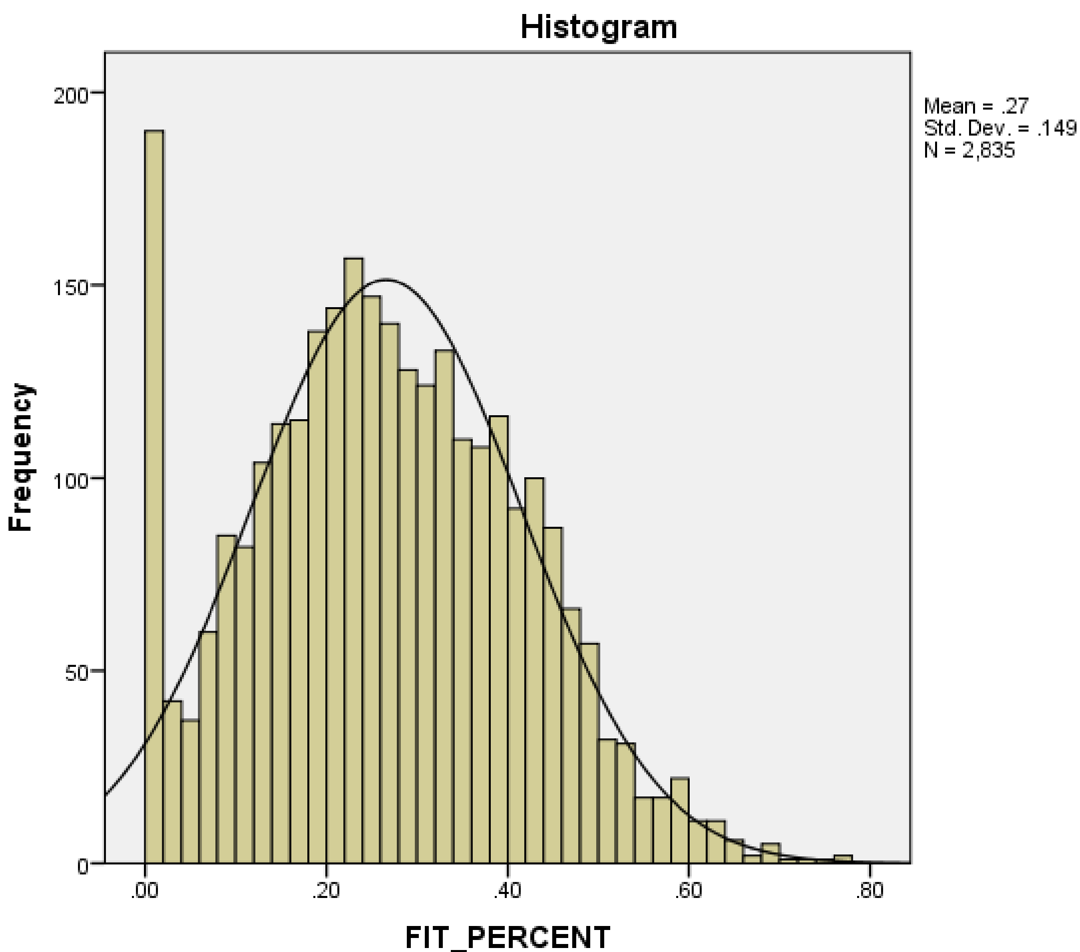

Figure 5. Histogram of the variable FIT% for the 2010-2011 school year.

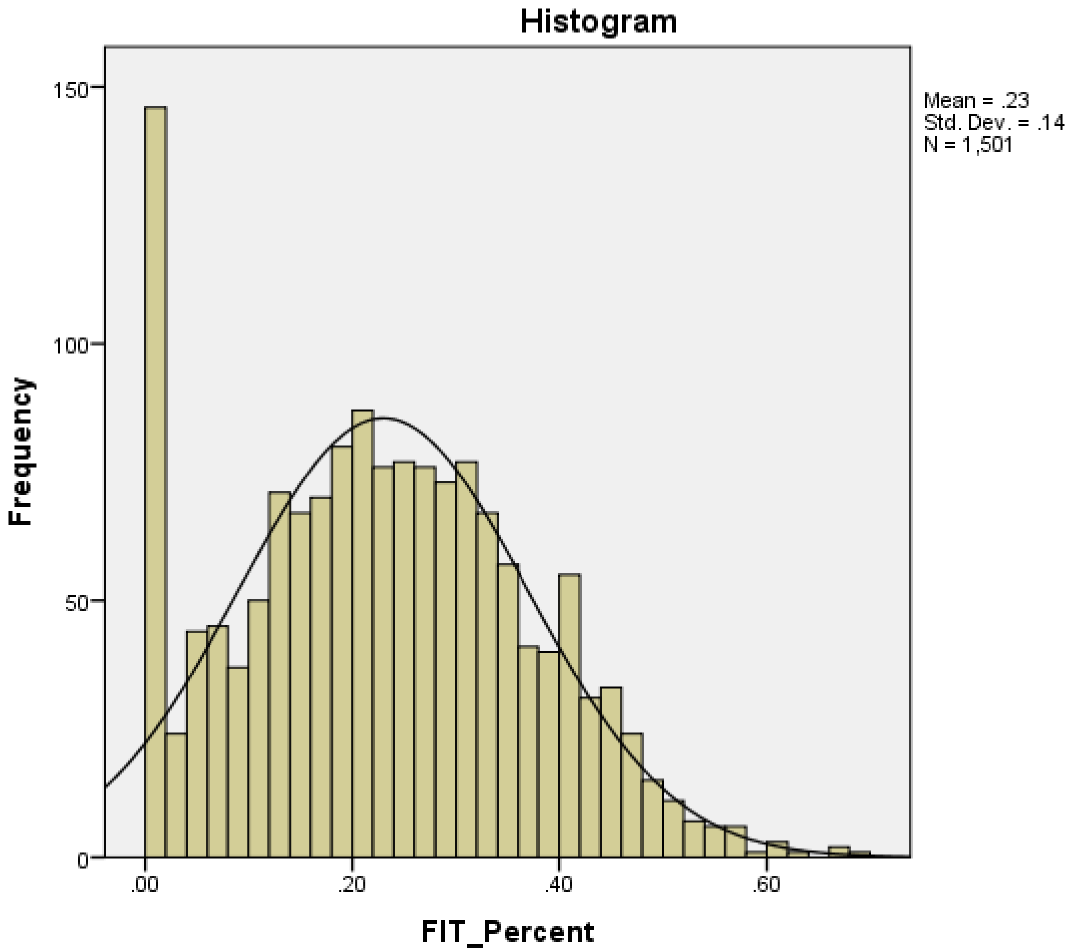

Figure 6. Histogram of the variable FIT% for the 2012-2013 school year.

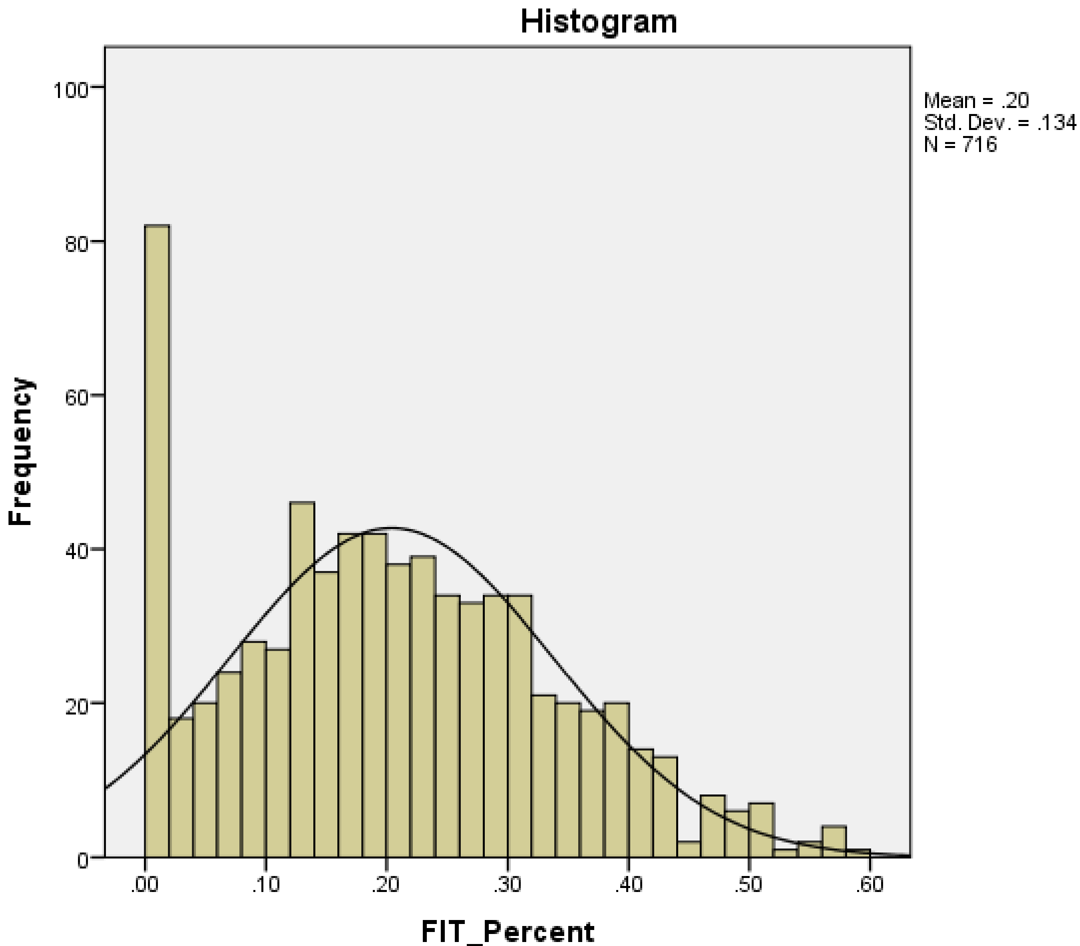

Figure 7. Histogram of the variable FIT% for the 2013-2014 school year.

Data for the third variable, SES%, was not normally distributed for all three years. There also were no outliers for any year. See Figures 8-10.

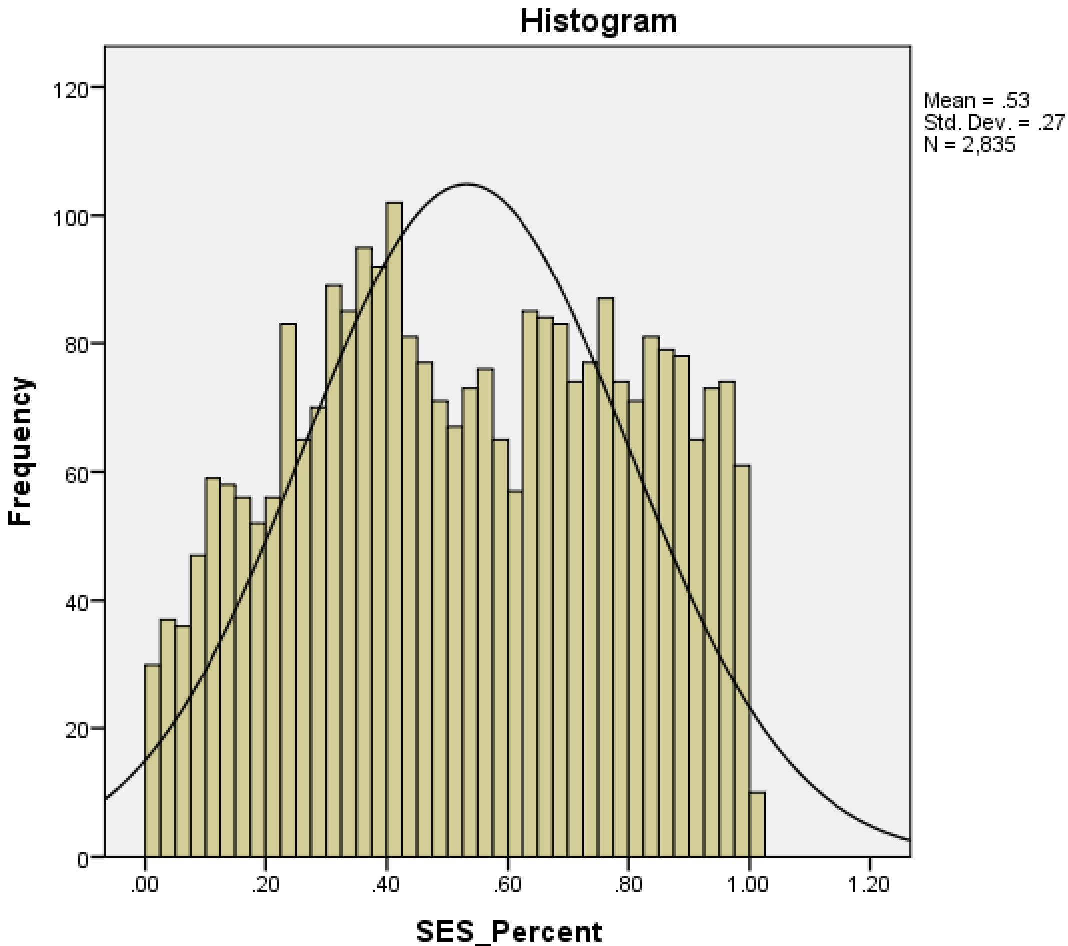

Figure 8. Histogram of the variable SES% for the 2010-2011 school year.

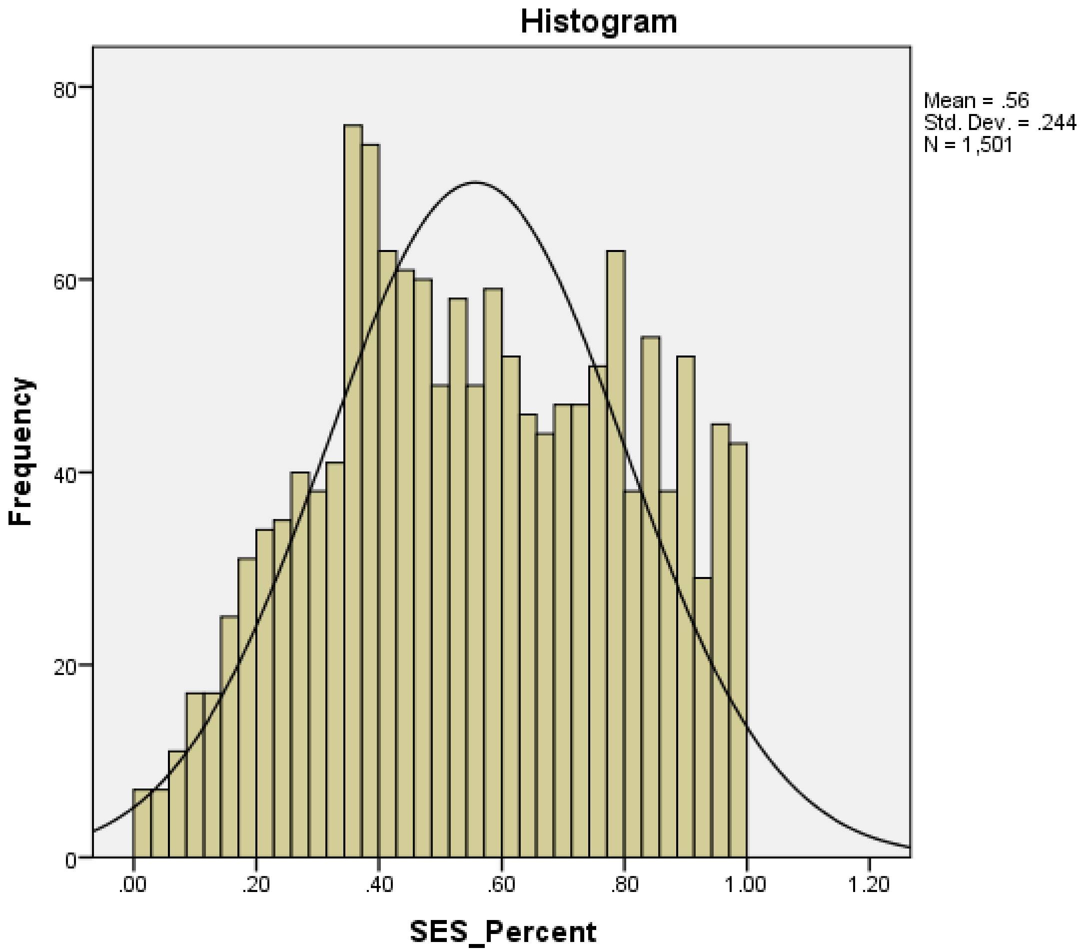

Figure 9. Histogram of the variable SES% for the 2012-2013 school year.

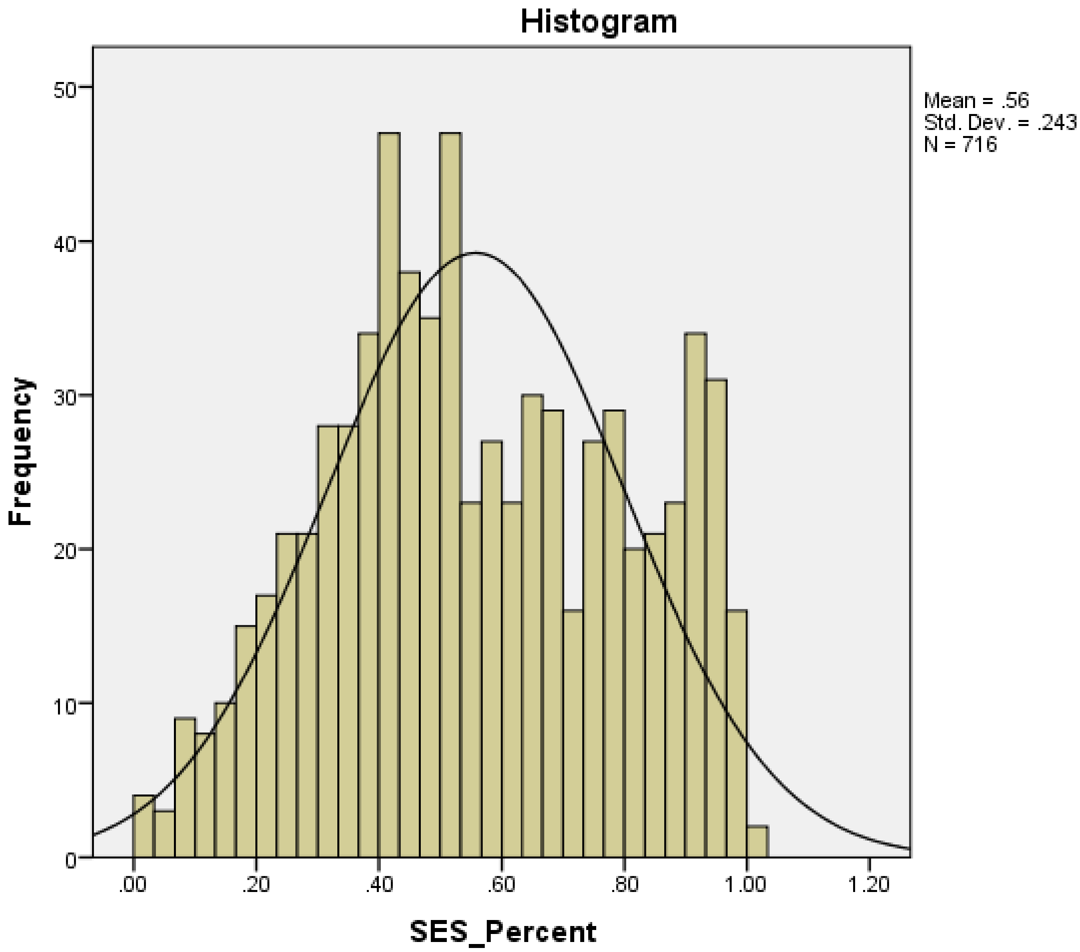

Figure 10. Histogram of the variable SES% for the 2013-2014 school year.

Data for the control variable %Female was normally distributed for all three years. For the 2010-2011 school year the distribution shows a kurtosis of 22.404. The 2012-2013 school year distribution shows a kurtosis of 10.052. The 2013-2014 school year shows a kurtosis of 10.633. See figures 11-13.

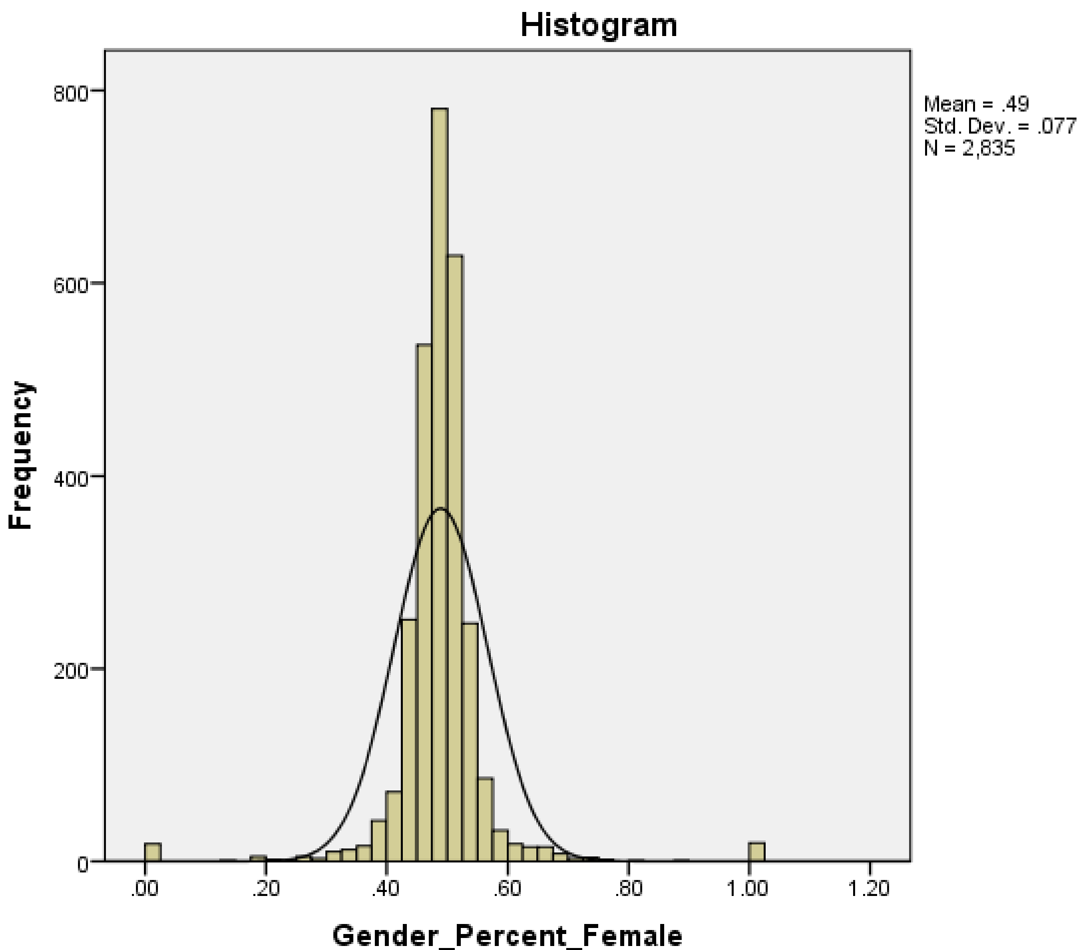

Figure 11. Histogram of the variable %Female for the 2010-2011 school year.

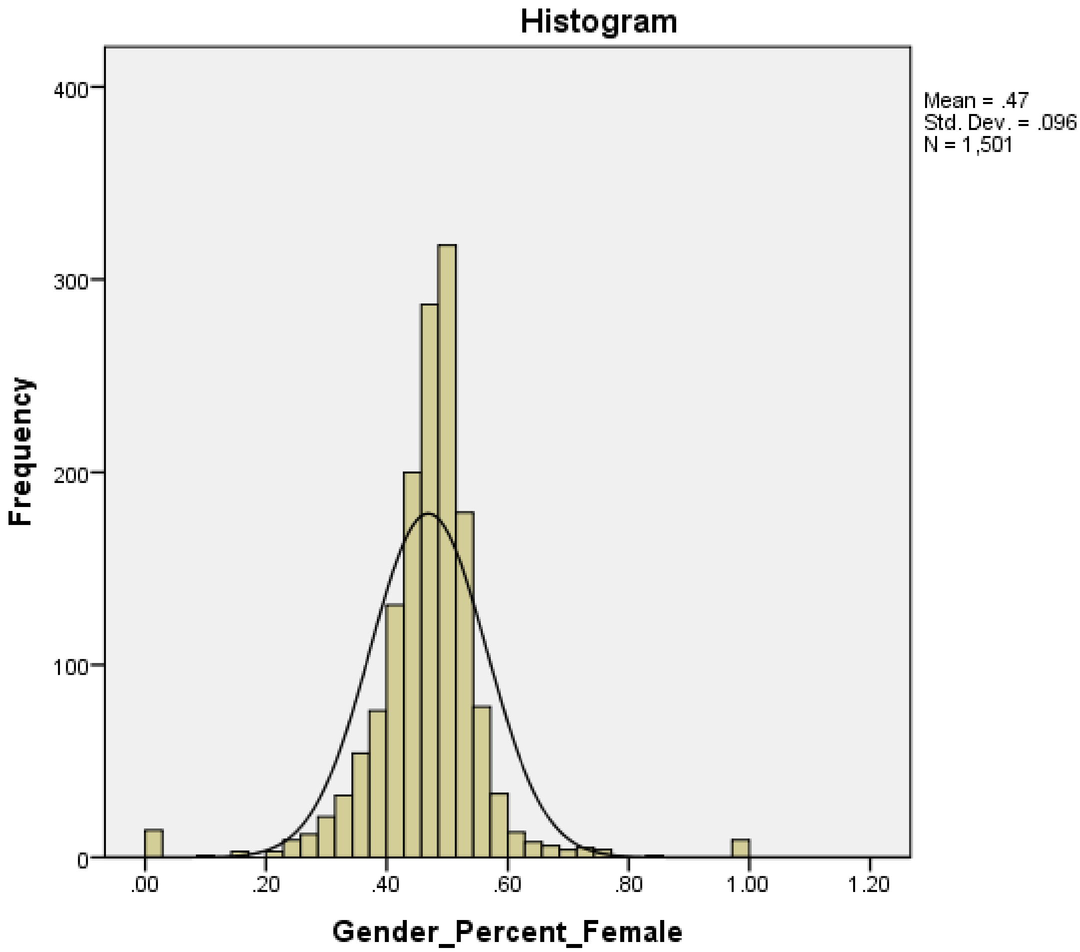

Figure 12. Histogram of the variable %Female for the 2012-2013 school year.

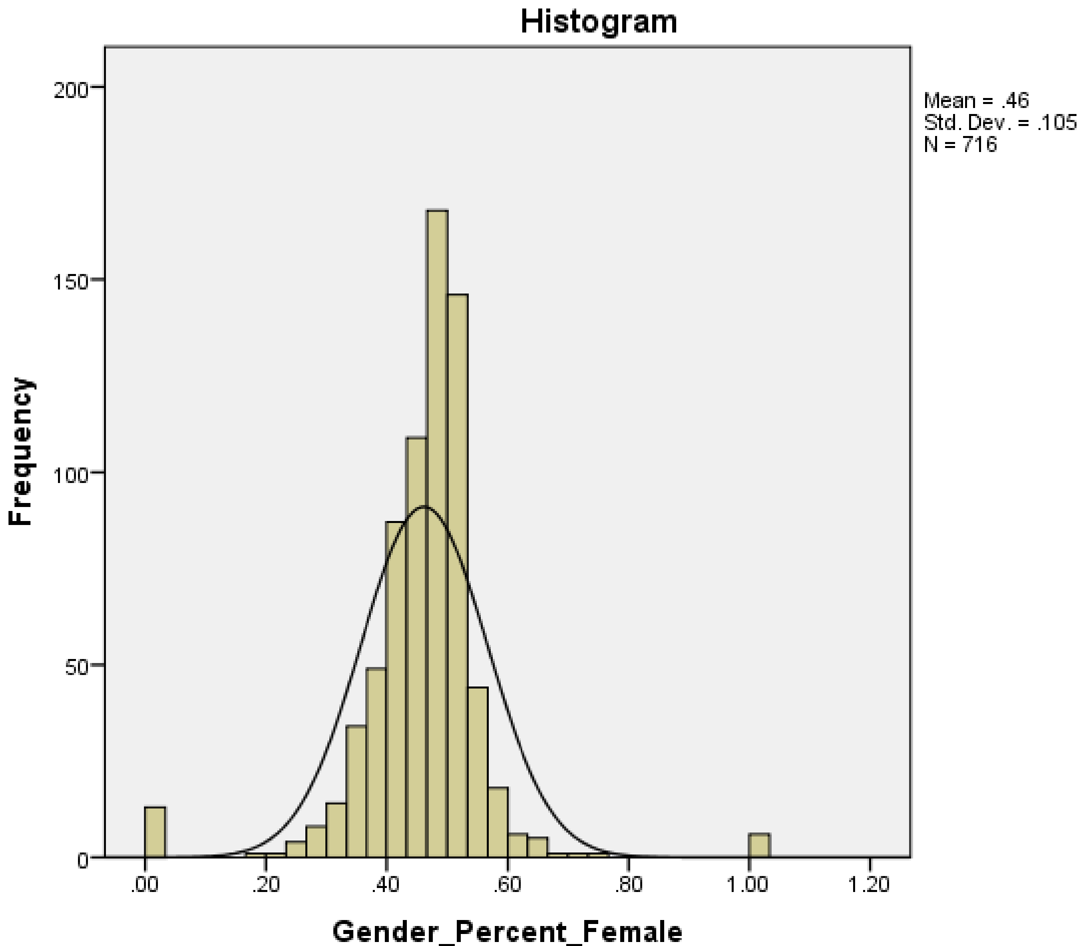

Figure 13. Histogram of the variable %Female for the 2013-2014 school year.

Data for the control variable school size (enrollment_total_from_TEA) demonstrated normal or nearly normal distribution for each school year. (See figures 14-16.) There were more schools with smaller enrollment. See Table 12 for a breakdown of school size by school type.

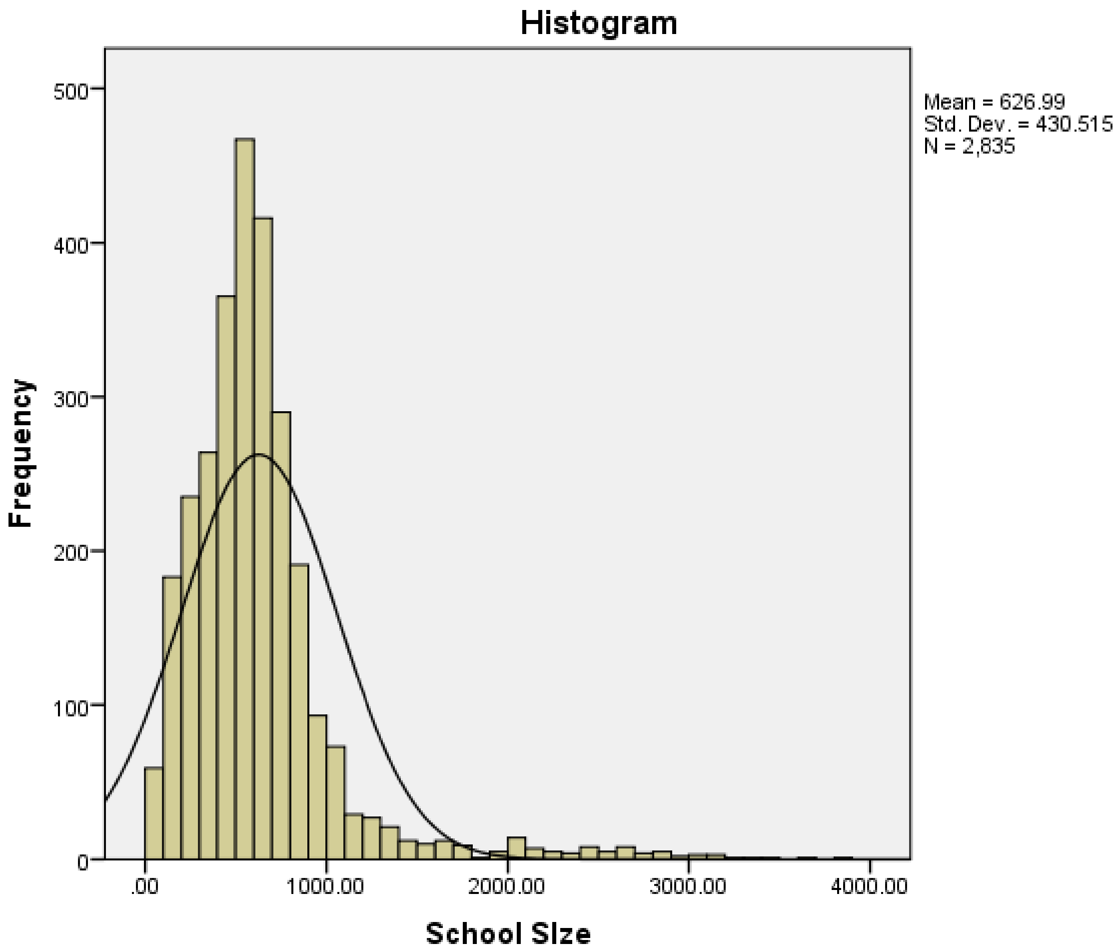

Figure 14. Histogram of the variable school size for the 2010-2011 school year.

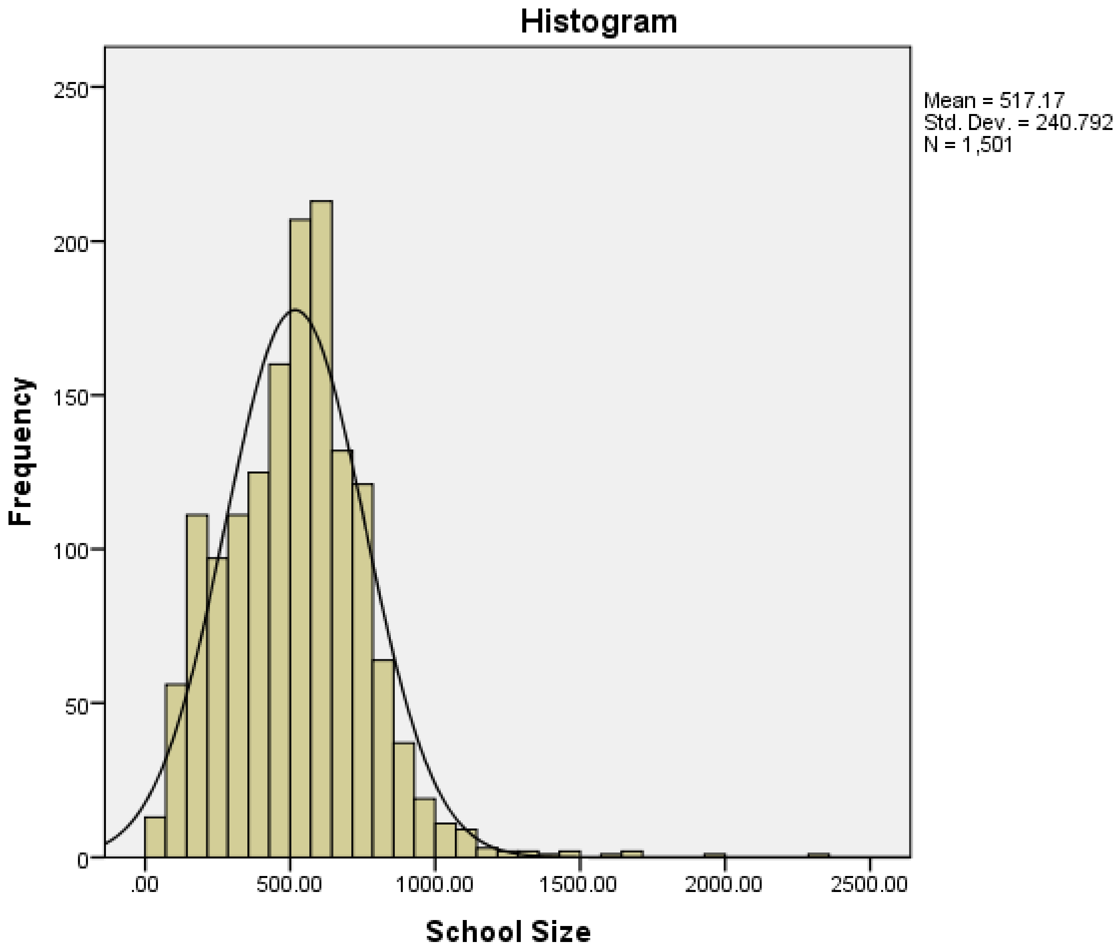

Figure 15. Histogram of the variable school size for the 2012-2013 school year.

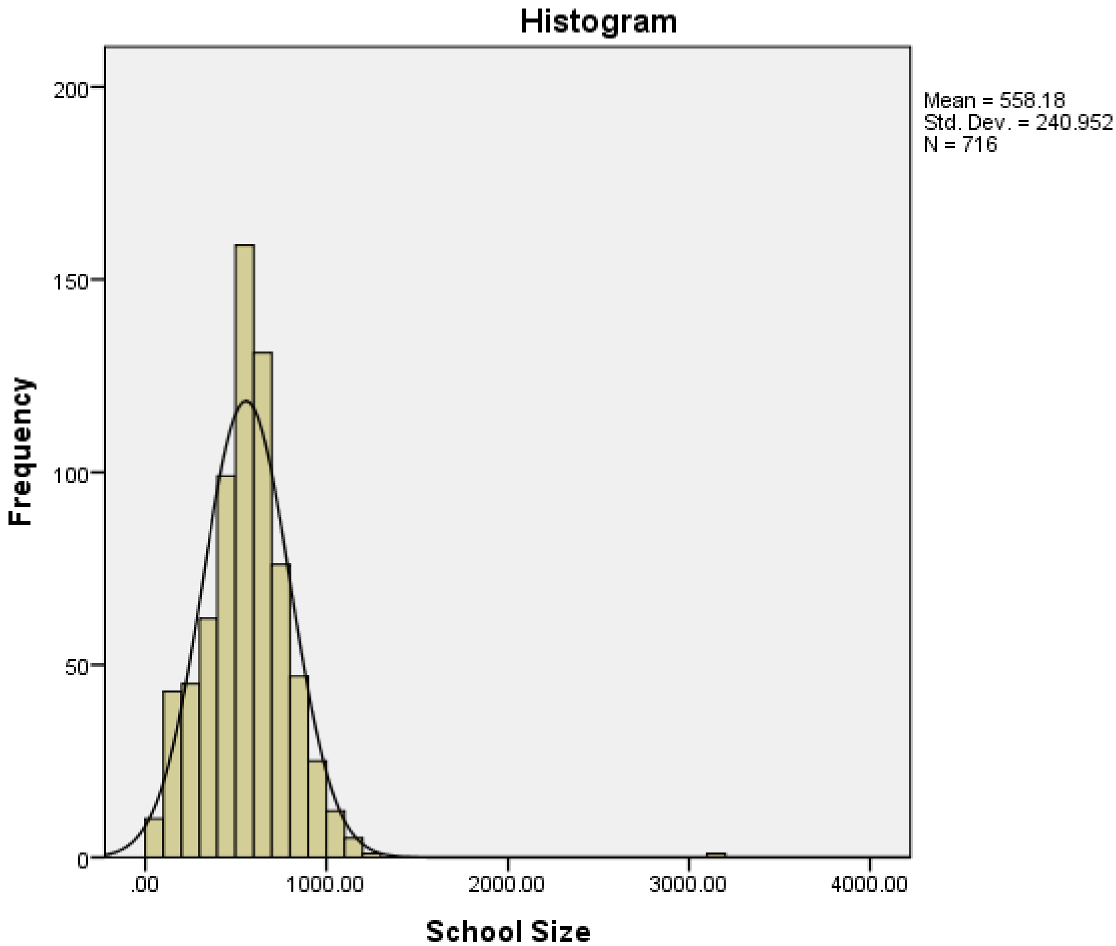

Figure 16. Histogram of the variable school size for the 2013-2014 school year.

Descriptive Analysis for Continuous Variables

BMI%. BMI% was the calculated percentage of the total number of students at a school who participated in the Fitnessgram test that were classified as having some-risk (overweight, BMI > 85th percentile) and high risk (obese, BMI > 95th percentile) for their age and gender based on the Fitnessgram definition that was the adapted standards obtained from the Center for Disease Control growth charts (Going, et al., 2013). For the 2010-2011 school year, the mean BMI% was 45.17%, and standard deviation was .11178 with the minimum and maximum between zero and 100%. For the 2012-2013 school year, the mean BMI% was 49.15%, and standard deviation was .09194 with the minimum and maximum between zero and 98%. The

2013-2014 school year mean BMI% was 49.16%, and standard deviation was .12172 with the minimum and maximum between zero and 86%. See table 7.

Table 7

BMI% Descriptive Statistics by School Year

	Year	N	Mean	Standard Deviation	Minimum—Maximum
BMI%	2010-2011	2,835	45.17%	.11178	0-100%
	2012-2013	1,501	49.15%	.09194	0-98%
	2013-2014	716	49.16%	.12172	0-86%

FIT%. FIT% was the calculated percentage of the total number of students at a school who achieved HFZ (rating) for six fitness activity tests administered during the Fitnessgram test, which is the maximum number a student can achieve that was reported in the data, divided by the total number of students who took the Fitnessgram test. For the 2010-2011 school year, the FIT% mean was 26.60%, and standard deviation was .14935 with a minimum and maximum of between zero and 78%. For the 2012-2013 school year, the FIT% mean was 22.99%, and standard deviation was .14005 with a minimum and maximum of between zero and 69%. The 2013-2014 mean was 20.39%, and the standard deviation was .13370 with a minimum and maximum of between zero and 59%. See table 8.

SES%. SES% was the calculated percentage of the total number of students who were classified as economically disadvantaged 01, economically disadvantaged 02, or economically disadvantaged 99 who participated in the Fitnessgram test divided by the total school enrollment number obtained from the TEA website. For the 2010-2011 school year, the SES% mean was 53.16%, and standard deviation was .26962 with the minimum and maximum between zero and

100%. For the 2012-2013 school year, the SES% mean was 55.70%, and the standard deviation was .24409 with the minimum and maximum between zero and 100%. The 2013-2014 school year SES% mean was 55.72%, and the standard deviation was .24261 with the minimum and maximum between zero and 100%. See table 9.

Table 8

FIT% Descriptive Statistics by School Year

	Year	N	Mean	Standard Deviation	Minimum–Maximum
FIT%	2010-2011	2,835	26.60%	.14935	0-78%
	2012-2013	1,501	22.99%	.14005	0-69%
	2013-2014	716	20.39%	.13370	0-59%

Table 9

SES% Descriptive Statistics by School Year

	Year	N	Mean	Standard Deviation	Minimum – Maximum
SES%	2010-2011	2,835	53.16%	.26962	0-100%
	2012-2013	1,501	55.70%	.24409	0-100%
	2013-2014	716	55.72%	.24261	0-100%

%Female. Percent Female (%Female) was the calculated percentage of the total number of females who took the Fitnessgram test divided by the total number of students who took the Fitnessgram test. For the 2010-2011 school year, the %Female mean was 48.91%, and the standard deviation was .07720 with the minimum and maximum between zero and 100%. For the

2012-2013 school year, the %Female mean was 46.86%, and the standard deviation was .09586 with the minimum and maximum between zero and 100%. The 2013-2014 school year %Female mean was 46.14%, and the standard deviation was .10465 with the minimum and maximum between zero and 100%. See table 10.

Table 10

%Female Descriptive Statistics by School Year

	Year	N	Mean	Standard Deviation	Minimum – Maximum
%Female	2010-2011	2,835	48.91%	.07720	0-100%
	2012-2013	1,501	46.86%	.09586	0-100%
	2013-2014	716	46.14%	.10465	0-100%

School size. School size was the total number of students enrolled in a school based on the enrollment information for a particular school year as reported on the TEA website. For the 2010-2011 school year, the school size mean was 626.9877, and the standard deviation was 430.51493 with a minimum and maximum between 16 and 3,858. For the 2012-2013 school year, the school size mean was 517.1692, and the standard deviation was 240.79244 with a minimum and maximum between 12 and 2,336. The 2013-2014 school year school size mean was 558.1774, and the standard deviation was 240.95179 with a minimum and maximum between 22 and 3,189. See table 11.

Descriptive Analysis for Categorical Variables

School type. School type was defined as an elementary, middle and junior high school, elementary and secondary combined, or secondary (high school) as classified and reported by

Table 11

School Size Descriptive Statistics by School Year

	Year	N	Mean	Standard Deviation	Minimum – Maximum
School Size	2010-2011	2,835	626.9877	430.51493	16-3,858
	2012-2013	1,501	517.1692	240.79244	12-2,336
	2013-2014	716	558.1774	240.95179	22-3,189

TEA on their website. For the 2010-2011 school year, 2,835 schools were included in the study. School types were coded zero for elementary schools, one for middle/junior high, two for schools serving all grades (K-12), and three for high schools. For the 2012-2013 school year, 1,501 schools were included in the study. For the 2013-2014 school year, 716 schools were included in the study. Only variables that pertained to the study were included in the final data sets that were analyzed, and each year was analyzed separately. See Table 5.

Each school represented one school type: elementary school, a middle or junior high school, a school that taught all grade levels (K-12), or a high school. There were more elementary schools than any other type. Schools that had all grade levels were the smallest school type in the study. See table 12.

Academic accountability school rating (AASR). This study examined the relationship between BMI, fitness, socioeconomics and academic accountability school rating. It is worth noting that for each year analyzed there was a small percentage of schools that failed to meet the academic standard during that school year. TEA recommends not comparing fitness score results with academic accountability ratings between years because of the change in the state standardized test students took between the years. The state standardized test was changed to raise the skill level students were required to meet for the minimum passing score, which made the test more rigorous and challenging.

Table 12

School Types Breakdown of the Numbers and Percentages of Schools Included in the Study by School Year

		Total Schools included in the study	Percent
Elementary	2010-2011	1,558	55.0
	2012-2013	845	56.3
	2013-2014	404	56.4
Middle/Junior High	2010-2011	596	21.0
	2012-2013	312	20.8
	2013-2014	163	22.8
Both (K-12)	2010-2011	130	4.6
	2012-2013	65	4.3
	2013-2014	23	3.2
High school	2010-2011	551	19.4
	2012-2013	279	18.6
	2013-2014	126	17.6

For the 2010-2011 school year, 2,663 schools were rated as having “met standard” (or 93.93%) and 172 schools (or 6.06%) were rated as did not meet the academic standard. For the 2012-2013 school year, 1,291 schools were rated as having “met standard” (or 86%) and 210 schools (or 13.99%) as did not meet the academic standard. For the 2013-2014 school year, 615 schools were rated as “met standard” (or 85.89%) and 101 schools (or 14.10%) as did not meet the academic standard. Table 13 shows the breakdown by year.

Table 13

Met Academic Standard Versus Did Not Meet Standard by School Year

	Met Standard	Percent	Did NOT Meet Standard	Percent
2010-2011	2,663	93.93	172	6.06
2012-2013	1,291	86.00	210	13.99
2013-2014	615	85.89	101	14.10

Overview of Research Variables

There are seven total variables in the study. The primary independent variables are BMI%, FIT%, and SES%. The dependent variable is AASR. Secondary variables used in research question four are %Female, school type, and school size. Table 14 is an overview showing the research variables categories. Table 15 is an overview showing the descriptive statistics for all continuous variables. Table 16 is an overview showing the totals for the continuous variables.

Table 14

Overview of Research Variables and Their Classification

Variable Classification	Variable	Category
Independent Variable	BMI%	Continuous
Independent Variable	FIT%	Continuous
Independent Variable	SES%	Continuous
Independent Variable	%Female	Continuous
Independent Variable	School Type	Categorical
Independent Variable	School Size	Continuous
Dependent Variable	AASR	Categorical

Table 15

Descriptive Statistics Overview for the Continuous Variables in the Study

Variable	Year	N	Mean	Standard Deviation	Minimum – Maximum
BMI%	2010-2011	2,835	45.17%	.11178	0-100%
	2012-2013	1,501	49.15%	.09194	0-98%
	2013-2014	716	49.16%	.12172	0-86%
FIT%	2010-2011	2,835	26.02%	.14935	0-78%
	2012-2013	1,501	22.99%	.14005	0-69%
	2013-2014	716	20.39%	.13370	0-59%
SES%	2010-2011	2,835	53.88%	.26962	0-100%
	2012-2013	1,501	55.70%	.24409	0-100%
	2013-2014	716	55.72%	.24261	0-100%
%Female	2010-2011	2,835	48.91%	.07720	0-100%
	2012-2013	1,501	46.86%	.09586	0-100%
	2013-2014	716	46.14%	.10465	0-100%
School Size	2010-2011	2,835	626.9877	430.51493	16-3,858
	2012-2013	1,501	517.1692	240.79244	12-2,336
	2013-2014	716	558.1774	240.95179	22-3,189

Table 16

Descriptive Statistics Overview for the Categorical Variables in the Study

Variable	Type	Year	N	Schools by Category	Total	Percent
School Type	Nominal	2010-2011	2,835	Elementary	1,558	55.0
				Middle/Junior High	596	21.0
				Both/K-12	130	4.6
				High School	551	19.4
		2012-2013	1,501	Elementary	845	56.3
				Middle/Junior High	312	20.8
				Both/K-12	65	4.3
				High School	279	18.6
		2013-2014	716	Elementary	404	56.4
				Middle/Junior High	163	22.8
				Both/K-12	23	3.2
				High School	126	17.6
AASR	Dichotomous	2010-2011	2,835	Met Standard	2,663	93.93
				Did NOT Meet Standard	172	6.06
		2012-2013	1,501	Met Standard	1,291	86.0
				Did NOT Meet Standard	210	13.99
		2013-2014	615	Met Standard	615	85.89
				Did NOT Meet Standard	101	14.10

Research Questions

Research questions one through three were analyzed using point biseral correlation tests. Question four was analyzed using binary logistic regression analysis.

Research question 1: Does BMI% predict AASR? Research has shown mixed results with regards to the correlation between BMI and academic achievement. Using SPSS software, bivariate correlation tests were run for each school year. The decision was to fail to reject the null hypothesis for the 2010-2011 school year. Although the data showed that as BMI% decreased AASR increased, the relationship was not statistically significant. However, for the 2012-2013 and 2013-2014 school years the decision was to reject the null hypothesis for BMI%. For both the 2012-2013 and 2013-2014 school years, as BMI% increased AASR increased. This means as BMI% increased the probability of a school meeting standard increased as well. Table 17 shows the results for each school year.

Research question 2: Does FIT% predict AASR? Research has also shown mixed results with regards to the correlation between fitness and academic achievement. However, most suggest a correlation whereas fitness increases academic achievement increases. Using SPSS software, bivariate correlation tests were run for each year. The decision was to reject the null hypothesis for FIT% for all three school years. For the 2010-2011 and 2013-2014 school years, as FIT% increased AASR increased. This means that as FIT% increased the probability of a school meeting standard increased as well. However, for the 2012-2013 school year, as FIT% decreased AASR increased. This means that as FIT% decreased the probability of a school meeting standard increased. Table 18 shows the results for each school year.

Table 17

Point Biserial Correlation Test Results for BMI%

		AASR
2010-2011	rPB	-.026
	p	.170
	N	2,835
2012-2013	rPB	.215**
	p	<.001
	N	1,501
2013-2014	rPB	.414**
	p	<.001
	N	716

Note: **Correlation is significant at the 0.01 level (2-tailed).

Table 18

Point Biserial Correlation Test Results for FIT%

		AASR
2010-2011	rPB	.038*
	p	.041
	N	2,835
2012-2013	rPB	-.079**
	p	.002
	N	1,501
2013-2014	rPB	.100**
	p	.008
	N	716

Note: *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).

Research question 3: Does SES% predict AASR? Research suggests that academic achievement is associated with parental income and education, but also that many obese are also economically disadvantaged (Cho, et al., 2009; Crosnoe & Muller, 2004). Using SPSS software, bivariate correlation tests were run for each school year. The decision was to fail to reject the null hypothesis for the 2010-2011 and 2012-2013 school years and reject it for the 2013-2014 school year. For the 2010-2011 school year, as SES% decreased AASR increased, however the data were not statistically significant. For the 2012-2013 school year, as SES% increased AASR increased, however the data again were not statistically significant. For the 2013-2014 school, though, as SES% increased AASR increased, and the data was statistically significant. This means as SES% increased the probability of a school meeting standard increased for that school year. Table 19 shows the results for each school year.

Table 19

Point Biserial Correlation Test Results for SES%

		AASR
2010-2011	rPB	-.022
	p	.246
	N	2,835
2012-2013	rPB	.038
	p	.143
	N	1,501
2013-2014	rPB	.115**
	p	.002
	N	716

Note: **Correlation is significant at the 0.01 level (2-tailed).

Research question 4: When controlling for school type (elementary, middle/junior high, both (K-12), and high school), %Female (gender), and school size (Enrollment) are BMI%, FIT%, and SES% associated with AASR? A binary logistic regression test was run with the addition of three control variables: school type (elementary, middle/junior high, elementary and secondary (K-12), and high school), %Female (gender), and school size (total number of students enrolled according to TEA website data). Tests were run separately for each school, 2010-2011, 2012-2013, and 2013-2014. In the interested of parsimony, non-significant variables were removed sequentially until only significant variables remained.

2010-2011 School year model. The 2010-2011 school year model Nagelkerke R Square equaled .053. The model explains 5.3% of the variance in the dependent variable AASR. The model demonstrated goodness of fit according to the Omnibus Test of Model Coefficents (Chi Square= 55.935, df=4, $p < .001$). The independent variables that were statistically significant were FIT% ($p=.036$) and school type, elementary ($p<.001$) and middle/junior high ($p=.010$). Although the variable Both/K-12 was not statistically significant, it would be inappropriate to exclude this variable from the model since it was within the block of dummy variables representing the categorical variable school type. The decision was to reject the null hypothesis. The odds of a school achieving the met standard rating increased by a factor of 3.072 for each one unit increase of FIT% after controlling for school type, gender (%Female), and school size. Schools were more likely to achieve a met standard school rating as the percentage of fit students increased. The adjusted odds ratio for the school type elementary was 3.874, indicating that the elementary schools were significantly more likely to have achieved a met standard school rating than high schools (the reference category). The adjusted odds ratio for the school type middle/junior high was 1.698, indicating that the middle and junior high schools were significantly more likely to have achieved a met standard school rating than high schools (the reference category). See Table 20.

2012-2013 School year model. The 2012-2013 school year model Nagelkerke R Square equaled .086. The model explains 8.6% of the variance in the dependent variable AASR. The model demonstrated goodness of fit according to the Omnibus Test of Model Coefficents (Chi

Square= 73.732, df=1, p < .001). The independent variable that was statistically significant was BMI% (p< .001). The decision was to reject the null hypothesis. The odds of a school having a met standard school rating increased by a factor of 1,916.735 for each one unit increase of BMI%. See Table 21.

Table 20

Variables in the Equation for the Multivariable Logistc Regression Test for the 2010-2011 school year

							95% C.I. for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
FIT%	1.122	.536	4.391	1	.036	3.072	1.075	8.777
Elementary	1.354	.192	49.815	1	<.001	3.874	2.660	5.643
Middle/Junior High	.530	.205	6.702	1	.010	1.698	1.137	2.536
Both/K-12	.299	.185	2.619	1	.106	1.349	.939	1.938
Constant	1.708	.186	84.602	1	<.001	5.518		

2013-2014 School year model. The 2013-2014 school year model Nagelkerke R Square equaled .252. The model explains 25.2% of the variance in the dependent variable AASR. The model demonstrated goodness of fit according to the Omnibus Test of Model Coefficents (Chi Square= 108.394, df=4, p < .001). The independent variables that were statistically significant are BMI% (p<.001) and school type, both/K-12 (p=.004). The decision was to reject the null hypothesis. The odds of a school having a met standard school rating increased by a factor of

4,920.142 for each one unit increase of BMI%. After controlling for school type, schools were more likely to have a met standard school rating as the percentage of overweight and obese students increased. The adjusted odds ratio for both/K-12 schools was .169, indicating that both/K-12 schools were significantly less likely to have a met standard school rating than high schools (the reference category). See Table 22.

Table 21

Variables in the Equation for the Multivariable Logistc Regression Test for the 2012-2013 School Year

							95% C.I. for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
BMI%	7.558	.955	62.642	1	<.001	1,916.735	294.901	12,457.981
Constant	-1.745	.441	15.666	1	<.001	.175		

Summary of the Findings

Despite the fact that the null hypotheses were rejected for all four questions, the results suggest that the relationship between BMI, fitness, socioeconomic level and academic accountability school rating is inconclusive. Although the relationships are significant, the relationships differ each year, and their Nagelkerke R Square effect size was small. Research question four gives the best indication of the relationship, which shows that as BMI% increased AASR increased for both the 2012-2013 and 2013-2014 school years. This indicates that as the number of overweight and obese students increase at a school the probability of the school having a met standard school rating increases. This is contrary to previous research findings.

In addition, the other significant relationship found in the study but only in the 2010-2011 school year was as FIT% increased AASR increased. This indicates that as the number of fit students increases at a school the probability of the school having a met standard school rating increases. Although this study found significant relationships, the nature of the relationship between BMI, fitness, socioeconomics, and academic accountability school rating was inconsistent and in some cases insignificant, which made the study results inconclusive. See Table 23 for an overview of the results.

Table 22

Variables in the Equation for the Multivariable Logistc Regression Test for the 2013-2014 school year

							95% C.I. for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
BMI%	8.501	1.099	59.801	1	<.001	4,920.142	570.481	42,434.012
Elementary	-.685	.409	2.805	1	.094	.504	.226	1.124
Middle/Junior High	-.680	.450	2.279	1	.131	.507	.210	1.225
Both/K-12	-1.780	.624	8.125	1	.004	.169	.050	.573
Constant	-1.461	.633	5.331	1	.021	.232		

Table 23

Overview of the Results for All Research Questions in the Study

Research Question	2010-2011	2012-2013	2013-2014
1. Relationship of DV and BMI%	NR	Increase	Increase
2. Relationship of DV and FIT%	Increase	Decrease	Increase
3. Relationship of DV and SES%	NR	NR	Increase
4. Relationship of DV and:			
BMI%	NR	Increase	Increase
FIT%	Increase	NR	NR
SES%	NR	NR	NR

Note: DV is the Academic Accountability School Rating (AASR); As the IV increases or decreases AASR increases; NR indicates no relationship.

Chapter Five: Discussion

This study examined the relationship between BMI, fitness, socioeconomics, and academic accountability school rating in Texas public schools. Relationships between the variables were found, however, the relationships were not consistent from year to year. In addition, due to missing or incorrect data a smaller percentage of schools were included in the study than originally planned. This makes it difficult to definitively declare a particular relationship between these variables in this study within Texas public schools.

Findings

BMI%. This study found that when the percentage of students at a school who were classified as having some risk or high risk for overweight or obesity is high it is more probable that the school will have a met standard academic accountability school rating, which is contrary to other research findings. Past research indicates that students who are overweight or obese tend to perform below or not as well as normal weight students (Campos, et al., 1996; Cho, et al., 2009; Christodoulou, 2010; Crosnoe & Muller, 2004; Cserjesi, et. al., 2007; Datar & Sturm, 2006; Davis & Cooper, 2011; Gurley-Cavez & Higginbotham, 2010; Han, 2012; Johnson, 2007; Krukowski, et al., 2009; Li, 1995; Li, et al., 2008; Mo-Suwan, et al., 1999; Shore, et al., 2008; Sigfusdottir, et al., 2007). Research question four, the question of most importance in this study since the analysis controlled for school type, gender (percent female), and school size (total enrollment), showed a positive relationship between BMI% and AASR for two of the three years examined in this study (2012-2013 and 2013-2014 school years). This suggests that when a school has a population of students that are more overweight or obese, the school is more likely to meet the academic standards as demonstrated through the state standardized academic test than if the school had more normal weight students.

FIT%. This study found a relationship between FIT% and AASR. However, the relationship was different each year (research question two), and when controlling for school type, gender (percent female), and school size (total enrollment) the relationship was found only in the 2010-2011 school year which was the first school year included in the study. Additionally, for research question two which asked if there was a relationship between FIT% and AASR (not controlling for other variables), in two of the three school years examined the data showed that as fitness increased so did the likelihood of the school having a met standard academic accountability school rating (2010-2011 and 2013-2014). This is consistent with past research (London & Castrechini, 2011; Welk, et al., 2010; Wittberg, et al., 2009). However, for the 2012-2013 school year, as the percentage of fit students decreased the likelihood of a school having a met standard rating increased, which is contrary to previous research.

SES%. This study found a relationship between SES and AASR but only for the 2013-2014 school year and only when analyzing for correlation between the two variables (research question three). The relationship found suggests that as the percentage of SES increases at a school so does the school's likelihood of having a met standard rating. This is contrary to what Crosnoe and Muller (2004) found, which was lower achievement in students who were at risk for overweight and whose parents earned less income when compared to other students in the study. In addition, when controlling for school type, gender (percent female), and school size (total enrollment) as in question four, no relationship was found between SES and AASR.

Data trends. Three interesting trends were noticed in the data. First, the data showed that BMI% decreased each subsequent year while at the same time in the statistical analysis schools with higher BMI% were more likely to have met the academic standard. For example, the 2010-2011 school year minimum and maximum BMI% was between zero and 100%. The 2012-2013 school year minimum and maximum was between zero and 98% (2% fewer students at some or high risk for overweight or obesity). The 2013-2014 school year minimum and maximum was between zero and 86%, or 14% lower than the first year in the study. This study found that as BMI% increased the likelihood of a school having met the academic standard also increased. While the data showed BMI% declined by subsequent years, the analysis showed schools with more students classified as overweight or obese are more likely to be academically successful.

Second, fitness level percentages as defined by the percent of students at a school who passed all six Fitnessgram fitness activity tests was also found to decrease with each subsequent year studied. For example, the 2010-2011 school year had a minimum and maximum FIT% of between zero and 78%. The next school year in the study, 2012-2013, had a minimum and maximum FIT% of between zero and 69%, which is a 9% decrease in fitness. The last year in the study, 2013-2014, had a minimum and maximum FIT% of between zero and 59%, or almost a 20% lower fitness percentage when compared to the first year in the study.

Third, the validity of the data, especially for the last two years in the study, was in question. With each subsequent year, it became clear that fewer and fewer schools could be included in the study due to lack of data or incorrect data. Texas Senate Bill 530 mandates that Texas public schools give every student the Fitnessgram test (with a few exceptions due to student physical limitations) and to publicly report that data. Out of 8,526 total schools in the 2010-2011 school year only 2,835 schools were included in this study, or 33.25%. For the second year included in the study (2012-2013), out of 8,555 schools only 1,501 schools were included, or 17.54%. For the third year included (2013-2014), out of 8,574 schools only 716 schools were included in this study, or 8.35%. It is unclear whether the personnel reporting the school data that could not be included in the study made mistakes in their reporting, failed to report correctly or at all, and/or lacked the time or resources to report correctly. Welk, Meredith, Ihmels, and Seeger (2010) found that there may be varying degrees of compliance with the Texas Senate Bill 530 mandate, and suggested the results from their Texas Youth Study may not be the best representation of schools. The same may have happened with this study. One question was whether the TEA has a vetting process to be sure what schools report is truly accurate. It may be that personnel mistakes, funding issues, or other matters prevent Texas school personnel and the TEA from being able to corroborate the validity of the data.

Discussion

The results of this study show a yearly snapshot of the relationship between BMI, fitness, socioeconomics, and academic achievement for the Texas schools examined. Due to changes in the state academic standardized test, the separate school year data cannot be analyzed and compared to each other due to changes in the state standardized academic test, which TEA advises against on its website. In addition, similarly to what Morrow, et al. (2010) reported in the overview of the Texas Youth Fitness Study individual data for the state standardized test and Fitnessgram results cannot be collected or obtained for analysis due to the federal FERPA law. Despite these limitations, this study analyzed the most recent and comprehensive data available and is the most current to date.

The only research available that examined BMI and academic data longitudinally (over an 8-year period of time) was that completed by Datar and Sturm (2006), Johnson (2007), and Li and O'Connell (2012). However, these researchers used data from the same ECLS-K kindergarten cohort collection obtained from the National Center for Education Statistics (NCES). The data contains information on kindergarteners from the 1998-1999 school year through the eighth grade (National Center for Educational Statistics, *n.d.*), which may be a better reflection of the relationship between BMI and student achievement than this study. However, it is not certain whether these researchers used the same cases from the data in their analysis, and therefore found the same results for those same cases which supported a relationship between weight and academic achievement.

For example, Datar and Sturm (2006) found that overweight students not only had lower test scores but students who became overweight had similar scores to those who had always been overweight. Johnson (2007) also used the data from the kindergarten cohort group. She also found that higher BMI was significantly associated with lower scores on a longitudinal basis for both reading and math. Li, et al. (2008) found an association between BMI and cognitive function in school-age children and adolescents; the data also came from the kindergarten cohort group. The association with BMI was specifically for cognitive impairment in visuospatial organization and general mental ability. However, when adjusting for family socioeconomics, television watching, psychosocial development, physical activities, and other possible confounders the association remained.

The data from the kindergarten cohort group is now almost 10 years old. Perhaps the changes and updates in education from the passing of the No Child Left Behind Act, standardized test changes, and other school programs have made it possible for students to overcome any academic, health, or socioeconomic challenges that may have otherwise been a detriment to school achievement. It may also be that in more recent times overweight and obese students can perform as well or even better than normal students.

The difference between this study when compared to other studies is that this study examined data for the likelihood of a relationship between BMI, fitness, socioeconomics, and academic achievement for individual schools in a particular school year (as opposed to studying individual data longitudinally) using percentages. In addition, based on the statistical analysis of the public data used, the relationship between BMI and academic achievement found in this study disagrees with what other researchers found. This study found that as BMI% increased, the probability for a school to have a met standard rating also increased. It is worth noting that only a small percentage of schools received a failing academic accountability school rating.

Comparison with the original study. The framework for this study was based on the work of Welk et al. (2010). Their study found an association between fitness and school academic achievement, though like this study, they state that the magnitude of the correlations was low according to traditional classification (Welk, et al., 2010, p. S21). They also found a correlation between BMI and the state academic standardized test scores, but that relationship was with corresponding counties, i.e. a particular county with a high level of obesity was more likely to have lower academic achievement (The Cooper Institute, *n.d.*, slide 7). The results found by these researchers is similar to what this study found for the 2010-2011 school year with regards to fitness. For the 2010-2011 school year, this study found that schools with fit students were more likely to have a "met standard" academic accountability school rating. The Welk et al. (2010) study used data from the 2007-2008 school year. At that time, schools used the same state standardized academic test as the one used during the 2010-2011 school year, which was the first school year included in this study. However, the results from this study cannot be compared with the study results from the Welk et al. study because of changes in the Fitnessgram test standards as suggested on the TEA website.

At least for the 2010-2011 school year, the results from this study supported what other researchers found with regards to fitness. Wittberg et al. (2009) found an association between physical fitness and academic performance. Fitter children in the study were more likely to master language arts, math, sciences, and social studies skills than children who scored in the "needs improvement" zone. This is similar to the work of London and Castrechini (2011) who also found differences in math and English language arts scores when comparing students who were persistently fit to students who were persistently unfit.

Study data limitations. As this study progressed, it became evident that there may be limitations within the data itself. The first school year examined in this study (2010-2011) was the most complete data set. Therefore, the 2010-2011 school year findings may best represent the Texas public school population and trends with regards to obesity, fitness, socioeconomics, and academic accountability school rating. It was also the year that was consistent with current research findings, with regards to fitness. Each subsequent year had fewer useable cases due to missing data. The second and third school years' data may not be as good, due in part because there was more missing or inaccurate data. In fact, the second year in the study (2012-2013) had 47.6% fewer cases than the first, and the last year (2013-2014) had 74.75% fewer cases than the first. There is no way to know for sure why fewer schools reported their data and/or reported their data accurately. For the purposes of this study, the data was assumed to be good, because TEA publicly reported it.

It is also unclear why there was less data overall for the last two years. It may be that reporting and/or the Fitnessgram test itself is taking a backseat to other school priorities. That is speculative and should not be construed causally. Clearly, there is less data being inputted into the data bank system that TEA uses to report to the public, but it may be that schools are reporting by other means which may not have been reflected in the public database. Also noted was the lack of Fitnessgram fitness data for the 2014-2015 school year, which was not included in this study due to data availability. In previous years, data for the most current previous school year was released just before the start of the next school year. However, at the time of this report (March 2016) the Fitnessgram data for the most recent past school year (2014-2015) still has not been released. When TEA was contacted, the representative did not know the release date for the data, except to indicate it would be available sometime during the spring of 2016. This is almost a year later than previous fitness data was released to the public.

Other factors to consider. There are many factors to consider when studying BMI, fitness, socioeconomic levels, and academic achievement of students. Some individuals may be able to self-manage and make positive changes that affect any of these areas at any time in their lives. Others may experience physical, mental, or emotional challenges that prevent them from making choices to improve their BMI, fitness, and/or socioeconomic level. Children also may be limited by the latter but additionally by their parents. Hence, this study illustrates the need for more quantitative and qualitative studies that examine the relationship between BMI, fitness, socioeconomics, and academic achievement.

Recent data also indicate changes in the funding of programs supporting schools serving more economically disadvantaged students. According to TEA's Title I, Part D report (2015), funding declined from 2011 to 2014 by nearly 17%. The same report showed a national reduction of almost 6%. Nationally, the number of economically disadvantaged students served fell by 14% but fell only 4% in Texas. For the 2013-2014 school year only, this study found that if a school had more socioeconomically disadvantaged students, the school was more likely to have met the academic standard. This supports the Gurley-Calvez and Higginbotham (2010) study which found no statistically significant relationship between spending and student performance. The Hamilton Study also found that math and reading scores remained relatively constant despite more per pupil spending (Greenstone, et al., 2012).

Implications

For two of the three years examined in this study, it was found that schools with higher percentages of overweight and obese students were more likely to have a "met standard" academic accountability school rating than other schools with more normal weight students. It should be noted that there was a relatively small percent of schools who did not meet the academic standard as rated by TEA. Nonetheless, the findings disagree with previous research. It also may suggest that weight, fitness, and socioeconomic levels may not impact academics as previous research suggests, or it may be that these factors do not impact academic success as much as they did in the past.

The reasons students gain weight or reduce weight, are fit or lack fitness, are economically advantaged or disadvantaged, and/or succeed in school or do not are as individual, unique, and diverse as the students themselves. Suggesting that changing students' weight, fitness, or economic status can "fix" schools so that every student meets national or state academic standards may not be the answer. The heart of academic success is not at the school, district, state, or country level, but instead at the individual level. However, parents are part of that individual experience, since they are legally and economically responsible for the physical, social, educational, and perhaps even spiritual well-being of their child(ren). Like students, parents also have their own individualities and preferences for their own lives and for raising their children. Teachers, other family members, friends, and other community members also all contribute to students' development. This is why it is irresponsible to suggest that any single element (such as BMI, fitness, or socioeconomic level) can improve or hinder students' academic success. There may be far more variables to learning and academic success than any of us realize, which also affect each student differently. This makes it difficult for school leadership to apply a blanket strategy that will address all students' academic needs effectively.

Suggestions for Future Research

New quantitative research is needed to examine the relationship of BMI, fitness, socioeconomics, and academic achievement longitudinally and at the individual level. Studying BMI, fitness, socioeconomics, and academic achievement within a cohort of students from kindergarten through their high school graduation may give a better picture of the associations of these variables longitudinally. However, limitations with privacy protection laws as well as the availability of student participants and/or student data may prevent researchers from studying these variables to the depth that would create new knowledge and provide new understanding.

Although this study found significant relationships, the large sample size may have made it easy to obtain statistical significance, but practical significance may be limited. The Nagelkerke R Square effect size was small, thus minimalizing the relationship between the variables. This was also true of the Texas Youth Study (Welk, et al., 2010, p. S21). In addition, the relationship that was found between BMI% and AASR disagreed with previous research. The contradiction itself was the most significant finding of this study and begs the question, *why*.

This demonstrates the need for more quantitative research pertaining to individuals or cohort groups studied longitudinally. It also demonstrates the need for qualitative research when examining the relationship between BMI, fitness, socioeconomics, and academic achievement within academic settings. Currently, there are few longitudinal studies (and no recent ones) and no qualitative studies that address these variables. However, finding research participants to conduct new studies might be difficult, since weight, fitness, socioeconomic levels, and academic achievement are sensitive topics that many people may not feel comfortable discussing openly, especially within a qualitative interview setting.

In addition, obtaining access to the K-12 student population is difficult. The process to secure approvals requires three to four times the paperwork, plus additional time for all the appropriate individuals to complete forms. Participation approval first must come from the district and school level before the individual level. Since students are under the legal adult age of 18, permission is required from their parents. Once permission and approval is acquired, though, students and/or teachers may permanently leave the school. In addition, students (and a teacher's freedom to talk about students) are protected by the U.S. government's FERPA law.

Conclusion

More research is needed that examines the relationship between individuals' or groups' BMI, fitness, socioeconomics, and academic achievement. However, many factors contribute to a person's weight, fitness level, socioeconomic status, and academic success. Even more important is the mere fact that any of these areas can be changed at any time in a person's life, if a person makes the choice. Other circumstances may also occur that are outside of someone's control but directly affect these areas. Though educational stakeholders want a quick and easy way to reach every student and make them successful as demonstrated by passing state academic accountability exams, there may not be an easy solution or any at all.

The relationships found in this study contradict what past researchers found, with the exception of fitness for one school year in the study. The contradictions themselves were the most impressive findings of this study. The results of this study suggest that the relationship between these variables is inconsistent. Perhaps the personal nature of BMI, fitness, socioeconomics, and academic achievement as well as other factors affecting them limit researchers from identifying what truly prevents academic success. However, it is the duty of researchers to at least try to ascertain possibilities, so that one day all students will be academically proficient and find success in their lives.

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Appendices

Appendix I: Study Code Book for SPSS Applications

Campus_ID	The number given to a Texas school for identification purposes
Total_Students_Tested_Sum	Total students at a school who took the Fitnessgram fitness Test
Total_Students_Achieving_HFZ_Exactly_6_Times_sum_1	Total students at a school who took the Fitnessgram fitness test and passed all six test activities, which is the goal of Texas public schools.
BMI_Total_Students_Tested_sum	Total students at a school who took the Fitnessgram fitness test and were tested for BMI
BMI_Total_Students_at_Some_Risk_sum	Total number of students at a school that were tested for BMI and were classified as having some risk for being over weight
BMI_Total_Students_at_High_Risk_sum	Total number of students at a school that were tested for BMI and were classified as having high risk for being over weight
Enrollment_Total_from_Fitnessgram	Total number of students enrolled at a school obtained from Fitnessgram data
Econ_Disadv_1_sum	Total students at a school who were classified as economically disadvantage 01 (qualifying for the federal free lunch program)
Econ_Disadv_2_sum	Total students at a school who were classified as economically disadvantage 02 (qualifying for the federal reduced lunch program)
Econ_Disadv_99_sum	Total students at a school who were classified as economically disadvantage 99 (qualifying for other federal program(s) based on financial need)
Gender_Total_Female_sum	Total number of female students at a school
SES_Total_Sum	Total number of students who were classified as economically disadvantaged at a school
BMI_Total	Total number of students at a school who were classified as either as some risk or high risk for BMI

Charter_School	Indicates whether a school is a charter school, (0= not a charter school, 1=charter school)
School_Type	Indicates what grade levels are taught at a school (0=elementary, 1=middle/junior high school, 2=Both/K-12 school, 3=high school/secondary)
Academic_Accountability _School_Rating	Indicates whether a school met standard or did not meet standard (0=did not meet standard, 1=met standard)
BMI_Percent	Percentage of students at a school who were classified as having some risk or high risk for overweight and obesity
SES_Percent	Percentage of students at a school who were classified as economically disadvantaged 01, 02, or 99
FIT_Percent	Percentage of students at a school who passed all six Fitnessgram fitness tests, the goal of Texas public schools
Gender_Percent_ Female	Percentage of students at a school who were female
Elementary	Indicates whether a school was an elementary school (0=other school type, 1= elementary)
MiddleJuniorHigh	Indicates whether a school was a middle or junior high school (0=other school type, 1= middle/junior high)
Both_K-12	Indicates whether a school had all grade levels (0=other school type, 1= both/K-12)
HighSchool	Indicates whether a school was a high school (0=other school type, 1= high school)
Enrollment_Total _From_TEA	Total number of students enrolled at a school obtained separately from TEA website (by individual year)

Appendix II: University of the Incarnate Word IRB Approval Form

UNIVERSITY OF THE INCARNATE WORD

11/23/2015

Serena Bahe
[redacted]

Dear Serena:

Your request to conduct the study *The Relationship of BMI, Fitness, Socioeconomics, and Academic School Rating: A Texas K-12 Study* was approved by exempt review on 11/23/2015. Your IRB approval number is 15-11-003.

Please keep in mind these additional IRB requirements:

- This approval is for one year from the date of the IRB approval.
- Request for continuing review must be completed for projects extending past one year. Use the **IRB Continuation/Completion form**.
- Changes in protocol procedures must be approved by the IRB prior to implementation except when necessary to eliminate apparent immediate hazards to the subjects. Use the **Protocol Revision and Amendment form**.
- Any unanticipated problems involving risks to subjects or others must be reported immediately.

Approved protocols are filed by their number. Please refer to this number when communicating about this protocol.

Approval may be suspended or terminated if there is evidence of a) noncompliance with federal regulations or university policy or b) any aberration from the current, approved protocol.

Congratulations and best wishes for successful completion of your research. If you need any assistance, please contact the UIW IRB representative for your college/school or the Office of Research Development.

Sincerely,

Ana Wandless-Hagendorf

Ana Wandless-Hagendorf, PhD, CPRA
Research Officer
University of the Incarnate Word IRB