

# Childhood Fitness and Academic Performance

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An Investigation into the Effect of Aerobic  
Capacity on Academic Test Scores

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## Author Note

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**TABLE OF CONTENTS**

ABSTRACT		4
CHAPTER 1	INTRODUCTION	6
	Statement of the Problem	6
	Significance of the Study	6
	Hypothesis	6
	Research Questions	7
	Research Design	8
	Rationale for Research Design	8
CHAPTER 2	REVIEW OF LITERATURE	10
	Physical Activity and Obesity	10
	Physical Activity and Cognition	12
	Physical Activity and Classroom Behavior	12
	Physical Activity and Academic Performance	13
	Increased Time for Physical Education	19
	The Need for Physical Education	20

CHAPTER 3	METHODS	23
	Participants	23
	Academic Performance	24
	Aerobic Capacity	25
	Research Design	26
CHAPTER 4	RESULTS	28
	Healthy Fitness Zone for Aerobic Capacity	28
	Overall Math MAP RIT Scores	30
	Math MAP RIT Scores for Met and Not Met Healthy Fitness Zones	31
CHAPTER 5	DISCUSSION AND CONCLUSIONS	33
	Aerobic Capacity and Math MAP Achievement: A Correlation	33
	Healthy Fitness Zone for Aerobic Capacity	35
	Math MAP RIT Scores	35
	Links to Other Research	36

CHILDHOOD FITNESS AND ACADEMIC PERFORMANCE	3
Limitations of the Study	37
Recommendations for Action	37
Recommendations for Further Study	38
Overall Significance of the Study	39
WORKS CITED	40
APPENDICIES	47
Appendix A: Picture of SECA <sup>®</sup> Scale	47
Appendix B: Graphs of MAP Scores for Met and Not Met Healthy Fitness Zones	48
Appendix C: Graph of Met Healthy Fitness Zone for Aerobic Capacity	49
Appendix D: Graph of Mean Math MAP RIT Scores	50

### Abstract

The purpose of this quantitative study was to determine whether or not students in fifth grade who meet the healthy fitness zone (HFZ) for aerobic capacity on the fall 2013 FITNESSGRAM<sup>®</sup> Test scored higher on the math portion of the 2013 fall Measures of Academic Progress (MAP) test, than students that failed to reach the HFZ for aerobic capacity on the fall 2013 FITNESSGRAM<sup>®</sup> Test. Ninety-six fifth grade students at a public elementary school in Greenville, SC participated in MAP testing, and the fifteen meter FITNESSGRAM<sup>®</sup> PACER (Progressive Aerobic Cardiovascular Endurance Run). Their body mass index (BMI) and number of laps ran on the PACER was put into the FITNESSGRAM<sup>®</sup>'s computer based program which will calculate their aerobic capacity and show whether or not they met the HFZ requirements as determined by the FITNESSGRAM<sup>®</sup>. These students were then placed into two groups, those who met the HFZ and those who did not meet the HFZ. The corresponding math MAP scores for the two groups was averaged and compared to one another. The data was disaggregated by race and gender. The demographic data for the study's participants are enumerated as follows. Male participants numbered fifty-three, with forty-one being Caucasian, seven African American, and five other (includes Hispanic, more than one ethnicity, Asian/Pacific Islander, and American Indian/Alaskan). Female participants numbered forty-three, with twenty-eight being Caucasian, ten African American, and five other. The average math MAP RIT score for students that met the HFZ for aerobic capacity was 226.9, while the average score for those that did not meet the HFZ for aerobic capacity was 218.4. This is a difference of 8.5 points. Having a health enhancing level of aerobic fitness was a positive influence for academic achievement regardless of gender or race. School districts need to allocate sufficient funds, resources, personnel, and facilities in order to provide students with

quality physical education at the elementary level. (Contains 45 works cited, 5 tables, 4 appendices, and 4 graphs)

## **Chapter 1**

### **Introduction**

#### **Problem Statement**

The obesity rate in American youth has been steadily rising over the past three decades. According to the Centers for Disease Control and Prevention (CDC), childhood obesity has almost tripled since 1980 (CDC, 2009). Is there a relationship between children's fitness and their academic achievement?

#### **Significance of the Study**

If a positive correlation is shown to exist between students who meet the healthy fitness zone (HFZ) for aerobic capacity as determined by the FITNESSGRAM<sup>®</sup> Test and student achievement scores on the math portion of the Measures of Academic Progress (MAP) Test, then perhaps more emphasis could be placed on student physical fitness and physical education policy recommendations by providing more funding and more opportunities for physical education in schools.

#### **Hypothesis**

It is the hypothesis of this researcher that for those fifth grade regular education students (non-self-contained, but includes students with 504 plans and Individual Education Plans (IEPs)) who meet the HFZ for aerobic capacity as determined by the spring 2014 FITNESSGRAM<sup>®</sup> Test will have a higher mean math score as measured by MAP than those

who failed to reach the HFZ for aerobic capacity as determined by the spring 2014

FITNESSGRAM<sup>®</sup> Test.

### **Research Questions**

- 1) What difference, if any, is there between male participants that met the HFZ for aerobic capacity as determined by the spring 2014 FITNESSGRAM<sup>®</sup> Test and those male participants that did not meet the HFZ?
- 2) What difference, if any, is there between female participants that met the HFZ for aerobic capacity as determined by the spring 2014 FITNESSGRAM<sup>®</sup> Test and those female participants that did not meet the HFZ?
- 3) What difference, if any, is there between Caucasian participants that met the HFZ for aerobic capacity as determined by the spring 2014 FITNESSGRAM<sup>®</sup> Test and those Caucasian participants that did not meet the HFZ?
- 4) What difference, if any, is there between African American participants that met the HFZ for aerobic capacity as determined by the spring 2014 FITNESSGRAM<sup>®</sup> Test and those African American participants that did not meet the HFZ?
- 5) What difference, if any, is there between Other (includes Hispanic, more than one ethnicity, Asian/Pacific Islander, and American Indian/Alaskan) participants that met the HFZ for aerobic capacity as determined by the spring 2014 FITNESSGRAM<sup>®</sup> Test and those Other participants that did not meet the HFZ?
- 6) What difference, if any, is there between all participants that met the HFZ for aerobic capacity as determined by the spring 2014 FITNESSGRAM<sup>®</sup> Test and those participants that did not meet the HFZ?



7) Did fifth grade regular education students who met the HFZ for aerobic capacity as determined by the spring 2014 FITNESSGRAM<sup>®</sup> Test score higher in math as measured by MAP than those who failed to reach the HFZ for aerobic capacity as determined by the FITNESSGRAM<sup>®</sup> Test?

### **Research Design**

All of the participants will participate in MAP testing. The students will also be tested on the fifteen meter FITNESSGRAM<sup>®</sup> PACER (Progressive Aerobic Cardiovascular Endurance Run). Their height and weight will be measured to calculate their body mass index (BMI). Their BMI and the number of laps they completed on the PACER will be entered into the FITNESSGRAM<sup>®</sup> computer based program which will calculate their aerobic capacity and show whether or not they met the HFZ requirements as identified by the FITNESSGRAM<sup>®</sup>. Only complete data for participants that are regular education students will be used for this study. Once all the data has been collected it will be disaggregated by gender and race.

### **Rationale for Research Design**

The MAP test and the FITNESSGRAM<sup>®</sup> Test are both mandated by the state of South Carolina for fifth grade students. The MAP Test is a diagnostic test designed to pinpoint what a student has learned, is still learning, and needs to learn. A RIT (Rasch Unit) score is generated by the MAP Test for the student. The more information a student has learned the higher the RIT score. The FITNESSGRAM<sup>®</sup> is a criterion-referenced test based on health standards. A student that scores in the HFZ would be considered as having sufficient fitness for good health. Aerobic capacity was chosen as the health standard to determine the level of fitness for students because

research has shown, as documented by the Center for Disease Control (CDC) (2009), that appropriate levels of aerobic capacity are associated with a reduced risk of high blood pressure, obesity, coronary heart disease, diabetes, some forms of cancer, and other health problems in adults. By comparing the two set of scores, one can see if there is any correlation between aerobic capacity and academic performance in math.

## **Chapter 2**

### **Review of Literature**

In this section, previous studies that relate to this study will be discussed and reviewed. The following topics that will be discussed in this chapter are: physical activity and obesity, physical activity and classroom behavior, the need for increased time for physical education, physical activity and academic performance, and the need for physical education.

#### **Physical Activity and Obesity**

Obesity rates among all groups in society, regardless of age, sex, race, socioeconomic status, education level, or geographic region have noticeably increased within the last twenty years (Centers for Disease Control, 2009). Since the 1960's, obesity rates in the United States have more than quadrupled among children ages six to eleven (Koplan, Liverman, & Kraak, 2007). Obesity is not just a personal matter; it is also a public health epidemic that affects education achievement outcomes, economic productivity, and state budgets (Cline, Plucker, & Spradlin, 2005). Summerbell, C.D., Waters, E., Edmunds, L., Kelly, S.A.M., Brown, T., and Campbell, K.J. (2005) echo these findings noting that obesity prevention is an international public health priority; that the prevalence of obesity and overweight is increasing in child populations throughout the world, having an impact on short and long-term health.

Preventing obesity during childhood is of critical importance because habits formed during childhood and adolescence usually persist into adulthood, making overweight children and adolescents more likely to become overweight adults (Story, n.d.). Freedman, D.S., Khan, L.K., Dietz, W.H., Srinivasan, S.R., and Berenson, G.S. (2001) noted that of overweight children

(body mass index  $\geq$  95<sup>th</sup> percentile), 77% of them remain obese (body mass index  $\geq$  30 kg/m<sup>2</sup>) as adults. Dehghan, M., Akhtar-Danesh, N., and Merchant, A.T. (2005) suggested that while about fifty percent of adults are overweight, it is difficult to lose or reduce weight once it has been obtained; therefore, children should be the primary focus of overweight and obesity prevention.

Potential strategies for intervention and prevention of obesity for children should be implemented in a school setting as a natural environment for influencing diet and exercise. Menschik, D., Ahmed, S., Alexander, M.H., and Blum, R.W. (2008) showed that for each weekday that normal weight adolescents participated in physical education, the odds of becoming an overweight adult decreased by five percent. Physical education is paramount to preventing lifestyle diseases. . . “A regular, preferably daily regimen of at least 30-45 minutes of brisk walking, bicycling, or even working around the house or yard will reduce your risks of developing coronary heart disease, hypertension, colon cancer, and diabetes” (U.S. Department of Health and Human Services, 1996, p. 5). According to Tompkins, Soros, Sothorn, and Vargas (2009), physical activity has numerous benefits to a person’s health:

In addition to diet, physical activity is a proven form of diabetes management and is considered a cornerstone in the prevention of diabetes. Participation in physical activity is shown to improve body composition and decrease resting heart rate and blood pressure in children and adolescents. In children with diabetes, however, physical activity may provide additional advantages. By improving both insulin sensitivity and glucose uptake in skeletal muscle, physical activity may have the potential to reduce the incidence of type 2 diabetes in children and adolescents. (p. 286-287)

### **Physical Activity and Cognition**

Beyond disease prevention, studies suggest that physical activity directly benefits cognition and academic achievement. In one study, in which children jogged for thirty minutes two to four times per week, researchers measured an increase in activity in the prefrontal cortex, suggesting greater cognitive function. However, the cognitive gains were only sustained while children maintained the jogging regimen (Harada, Okagawa, & Kubota, 2004). The cognitive gains from increased physical activity can be seen in students of all ages and of varied physical and cognitive abilities, including children with special needs and/or learning disabilities (Sibley & Etnier, 2003).

### **Physical Activity and Classroom Behavior**

Additional benefits of physical activity include increased self-esteem, which may influence positive academic achievement and better classroom behavior (Tremblay, Inman, & Williams, 2000). Recent studies have demonstrated that integrating even a simple physical activity such as walking into the curriculum improves children's ability to pay attention in the classroom and results in better performance on academic achievement tests (Hillman, 2009). One study suggest that regular participation in a physical activity program may increase cognitive function, level of information processing, and reduce negative behaviors associated with Attention Deficit Hyperactivity Disorder (ADHD) (Verret, Guay, Berthiaume, Gardiner, & Beliveau, 2012, January). A study by Blom, Alvarez, Zhang, and Kolbo (2011) noted that

students who achieved more HFZs on the FITNESSGRAM<sup>®</sup> had better attendance rates, and higher academic achievement scores for mathematics and English language arts as measured by second version of the Mississippi Curriculum Test (MCT2). Other ways in which physical activity opportunities in schools, like extracurricular activities, are indirectly associated with academic achievement are lower dropout rates, better classroom behavior and self-esteem, and more engagement in and connectedness to school and on-task behavior (Mahar, M., Murphy, S., Rowe, D., Golden, J., Shields, T., & Raedeke, T. 2006; Trudeau & Shephard, 2008; Blom et al., 2011).

### **Physical Activity and Academic Performance**

A research study piloted by the California Department of Education (2001) took on the endeavor to ascertain the relationship between physical fitness and academic achievement. According to this research study, reading and mathematics scores from the Stanford Achievement Test were individually matched with the fitness scores from the FITNESSGRAM<sup>®</sup> (Cooper Institute for Aerobics Research, 1999) of 353,000 fifth graders, 322,000 seventh graders, and 279,000 ninth graders. A positive relationship was observed between physical fitness scores from the FITNESSGRAM<sup>®</sup> and the Stanford Achievement Test scores for all three grade levels. This study showed that higher levels of fitness were associated with higher levels of academic achievement. Similar research conducted in a school setting by Coe, Pivarnik, Womack, Reeves, & Malina, (2006) extended the findings of the California Department of Education (2001) because they observed a positive relationship between vigorous physical activity and higher academic grades in school.

Grissom, J.B. (2005) performed a study to compare physical fitness test scores to academic achievement scores. The subjects for his study were all fifth, seventh, and ninth grade California school children enrolled in public school in the spring of 2002 for which there was complete data on both the physical fitness and academic achievement tests. This resulted in a sample size of 884,715 students. The physical fitness test that was used was the FITNESSGRAM<sup>®</sup>. Academic achievement scores were generated by the Stanford Achievement Test 9<sup>th</sup> edition, a standardized norm-reference test.

Using the FITNESSGRAM<sup>®</sup>, which requires students to complete six different tests: one for aerobic capacity, one for body composition, the curl-up test, the trunk lift test, one of the options for upper body strength, and one of the options for flexibility Grissom (2005) assigned an overall physical fitness test score ranging from zero to six. The overall physical fitness test score was determined by the number of fitness tests where an individual met or exceeded the HFZ as determined by the FITNESSGRAM<sup>®</sup>. For each overall physical fitness test score, which ranged from zero being the lowest to six being the highest, the average Stanford Achievement Test 9<sup>th</sup> edition for reading and mathematics were calculated in normal curve equivalent units.

Grissom (2005) discovered that as the number of physical fitness tests met increased so did the average of reading and mathematics scores. The average scores on the Stanford Achievement Test 9<sup>th</sup> edition for students that did not meet the HFZ for any of the physical fitness tests on the FITNESSGRAM<sup>®</sup> was thirty-seven for reading and forty-two for mathematics. The average scores on the Stanford Achievement Test 9<sup>th</sup> edition for students that met or exceeded the HFZ for only one physical fitness test on the FITNESSGRAM<sup>®</sup> was thirty-eight for reading and forty-four for mathematics. The average scores on the Stanford Achievement Test 9<sup>th</sup> edition scores for students that met or exceeded the HFZ for two physical

fitness tests on the FITNESSGRAM<sup>®</sup> was forty for reading and forty-six for mathematics. The average scores on the Stanford Achievement Test 9th edition for students that met or exceeded the HFZ for three physical fitness tests on the FITNESSGRAM<sup>®</sup> was forty-two for reading and forty-eight for mathematics. The average scores on the Stanford Achievement Test 9th edition for students that met or exceeded the HFZ for four physical fitness tests on the FITNESSGRAM<sup>®</sup> was forty-four for reading and fifty-one for mathematics. The average scores on the Stanford Achievement Test 9th edition for students that met or exceeded the HFZ for five physical fitness tests on the FITNESSGRAM<sup>®</sup> was forty-seven for reading and fifty-five for mathematics. The average scores on the Stanford Achievement Test 9th edition for students that met or exceeded the HFZ for all six physical fitness tests on the FITNESSGRAM<sup>®</sup> was fifty-two for reading and sixty for mathematics. These results indicate a positive relationship between academic achievement and physical fitness.

A similar study to Grissom's (2005) found a positive relationship between number of fitness tests passed on the FITNESSGRAM<sup>®</sup> and standardized scores for mathematics and ELA for fourth-, sixth-, and eighth-grade students in Massachusetts (Chomitz, Slining, McGowan, Mitchell, Dawson, & Hacker, 2009).

Castelli, Hillman, Buck, and Erwin (2007) conducted a study of four elementary schools in an Illinois school district. They chose two schools that were "academically effective" and two that were not (p. 242). The study involved a total of 259 participants composed of third and fifth grade students. The FITNESSGRAM<sup>®</sup> was used to determine students' physical fitness as either met or not met for the HFZ for the five different components of the FITNESSGRAM<sup>®</sup> physical fitness test. Academic achievement was measured by the Illinois Standards Achievement Test (ISAT) for ELA and mathematics. This study found that "higher academic achievement scores



were associated with greater total fitness” (p. 246). This report also discovered that age, sex, and school were not associated with overall academic achievement (combined scores for ELA and mathematics). Furthermore, Castelli et al. (2007) noted that “greater total academic achievement scores were associated with lower body mass index and higher aerobic fitness” (p. 246). This was also found to be true for reading achievement and mathematics achievement when analyzed individually.

Another study conducted by Wittberg, Northrup, and Cottrell (2009) focused on 968 fifth grade students enrolled in Wood County School District in West Virginia to examine potential associations of socio-economic status, gender, student body mass index, and the various fitness tests featured in the FITNESSGRAM<sup>®</sup>, with children’s academic performance on four standardized subscales: mathematics, reading/language arts, science, and social studies.

Using the FITNESSGRAM<sup>®</sup> students were tested for aerobic capacity, abdominal strength, upper body strength, flexibility, and trunk lift. The students were scored as either met or not met the HFZ for each component of the FITNESSGRAM<sup>®</sup>. Wittberg et al. (2009, January/February) provided a table that described each FITNESSGRAM<sup>®</sup> component and defined the HFZ for each component. The majority of the students scored in the HFZ for each component of the FITNESSGRAM<sup>®</sup> with 67.2% in the HFZ for aerobic capacity, 85.8% for abdominal strength, 72.5% for upper body strength, 86.0% for flexibility, and 91.1% for trunk lift.

The West Virginia Educational Standards Test was used to determine students’ academic performance. The West Virginia Educational Standards Test gives students one of five possible classifications in each area: novice (scored as “1”), partial mastery (scored as “2”), mastery

(scored as “3”), above mastery (scored as “4”), and distinguished mastery (scored as “5”).

Students mean test scores for the West Virginia Educational Standards Test were 3.212, 3.337, 3.350, and 3.292 for reading/language arts, mathematics, science, and social studies, respectively.

When the FITNESSGRAM<sup>®</sup> data was compared to the West Virginia Educational Standards Test data it was shown that students in the HFZ for aerobic capacity and abdominal strength scored significantly higher on every academic achievement test than those in the needs improvement zone. Students that were in the HFZ for upper body strength and flexibility scored significantly higher in mathematics. Students in the HFZ for flexibility scored significantly higher in science. There was no noticed effect on academic performance based on the trunk lift performance. When body mass index, gender, and social economic status variables were controlled being in the HFZ for aerobic capacity test was the only fitness category associated with significant achievement in all West Virginia Educational Standards Test components. Social economic status was the only other variable that was significantly associated with every West Virginia Educational Standards Test component.

Another study that was done to determine what affects different fitness components have on test scores by Van Dusen, Kelder, Kohl III, Ranjit, and Perry (2011) focused on a convenience sample of 254,743 students in grades three through eleven from thirteen different school districts in Texas. The purpose of this study was the need for “empirical research evaluating the connections between fitness and academic performance . . . to justify curriculum allocations to physical activity programs” (p. 733).

Van Dusen et al. (2011) used the FITNESSGRAM<sup>®</sup> to measure students' aerobic capacity, body composition, abdominal strength and endurance, trunk extensor strength and flexibility, upper body strength and endurance, and flexibility. The results from the FITNESSGRAM<sup>®</sup> were categorized by quintile rather than a sum of binary results, thus allowing for detection of linear dose-response or nonlinear associations. The covariates of gender, ethnicity, grade level, and economic disadvantage were controlled to isolate the effects of different fitness levels for the different FITNESSGRAM<sup>®</sup> tests.

Academic performance was determined by the Texas Assessment of Knowledge and Skills. The Texas Assessment of Knowledge and Skills is administered to Texas public school students according to grade level for grades three through eleven. The Texas Assessment of Knowledge and Skills tests students in reading language arts, mathematics, writing, social studies, and science, however only reading language arts and mathematics are tested every year. It is for this reason that only reading and math were used for academic performance.

Van Dusen et al. (2011) found that aerobic capacity had the strongest direct associations with academic achievement. The greatest significant differences in tests scores based on aerobic capacity were noted in grades seven through ten. For all grade-test-gender combinations there was a positive association except for fourth and sixth grade boys in reading. Further findings showed no non-significant or inverse associations between fitness variables and academic achievement.

Multiple studies have recognized a positive connection between physical fitness and academic achievement (Shephard et al., 1984; Maynard, Coonan, Worsley, Dwyer, & Baghurst, 1987; Shephard, LaVallee, Volle, LaBarre, & Beaucage, 1994; Tremblay et al., 2000; California

Department of Education, 2001; Grissom, 2005; Coe et al., 2006; Nelson & Gordon-Larsen, 2006; Castelli et al., 2007; Chomitz et al., 2009; Hillman, 2009; Wittberg et al., 2009; Blom et al., 2011; Van Dusen et al., 2011), whereas other studies have noted minimal (Dwyer, Coonan, Leitch, Hetzel, & Baghurst, 1983; Daley, & Ryan, 2000) or adverse relationships (Tremblay, Inman, & Williams, 2000). Furthermore, physical activity has been positively linked with cognition (Shephard, 1997; Sibley & Etnier, 2003; Tomporowski, 2003; Harada et al., 2004; Coe et al., 2006; Verret et al., 2012) and classroom behavior (Tremblay et al., 2000; Mahar et al., 2006; Trudeau & Shephard, 2008; Hillman, 2009; Blom et al., 2011; Verret et al., 2012).

### **Increased Time for Physical Education**

One study showed that adolescents who reported either participating in school activities, such as physical education and team sports, or playing sports with their parents were twenty percent more likely than their sedentary peers to earn a letter grade of “A” in English or mathematics (Nelson & Gordon-Larsen, 2006). A review of studies concludes that up to an hour of daily physical activity programs can be added to a school curriculum by taking time from other subjects without hurting students' academic achievement in those subjects (Trudeau & Shephard, 2008). Sallis, McKenzie, Kolody, Lewis, Marshall, & Rosengard (1999) noted that taking time away from academic courses and replacing it with physical education curricula did not affect academic performance in a negative way.

Sallis et al. (1999) implemented the Sports, Play, and Active Recreation for Kids (SPARK) program which required three, thirty minute lessons a week that focused on increasing physical activity engagement to improve health-related fitness, motor-skills, and enjoyment.

Academic performance was measured by the Metropolitan Achievement Tests (MAT6 and MAT7). Carlson, Fulton, Lee, Maynard, Brown, Kohl, & Dietz (2008) support the findings of Trudeau & Shephard (2008), and Sallis et al. (1999) noting that taking time away from traditional educational pursuits to spend an hour devoted to physical activity will not adversely influence performance of traditional educational skills.

### **The Need for Physical Education**

Despite the demonstrated benefits of physical activity, studies show that most youth do not meet physical activity guidelines, which recommend an hour or more of moderate-to-vigorous physical activity a day (Centers for Disease Control and Prevention, 2003, 2008). Moreover, recent budgetary constraints and increasing pressure to improve standardized test scores in core subject areas have caused school officials to substantially reduce the time available for physical education. In some schools, physical education programs have been completely eliminated (National Association for Sport and Physical Education & American Heart Association, 2006).

A 2007 study found that in a nationally representative survey of 349 school districts, 62% of elementary schools and more than 20% of middle schools reported increased time for ELA and mathematics since the 2001 - 2002 school year (when No Child Left Behind was enacted). However, to accommodate for this increased time in ELA and mathematics, 44% of districts reported cutting time from one or more other subjects or activities such as social studies, science, art, music, physical education, or recess at the elementary level. The decrease

was a 32% reduction on average in the total instructional time devoted to these subjects since 2001 - 2002 school year (McMurrer, 2007).

Former Coordinator for Physical Education and Health of Greenville County Schools has expressed her concern for diminishing physical education, when asked the question of how many physical education positions did Greenville County Schools lose due to budget cuts (P. Bostain, 2013):

We lost thirty physical education positions and those positions have not returned. We lost them mostly in elementary schools. However, secondary schools cut physical education positions during that time as well. You know this all too well, however, some physical education people ended [up] in physical education positions and other folks did not. If a PE teacher had any other teaching certification, THAT is where HR [human resources] was looking for them a job....not in PE.

Recent studies have demonstrated that integrating even a simple physical activity such as walking into the curriculum improves children's ability to pay attention in the classroom and results in better performance on academic achievement tests (Hillman, 2009). The Centers for Disease Control and Prevention (2011) recommends that children and adolescents participate in at least sixty minutes of physical activity every day. According to the U.S. Centers for Disease Control and Prevention and the National Association of State Boards of Education, all elementary school-aged students should participate in at least 150 minutes of Physical Education per week (National Association for Sport and Physical Education, 2011). The South Carolina Students Health and Fitness Act of 2005 recommends that elementary school-aged students participate in physical education for sixty minutes per week, which is far below the amount

recommended by the U.S. Centers for Disease Control and Prevention and the National Association of State Boards of Education.

The elementary school at which the students attend currently (2013 – 2014 school year) provides physical education once per week for forty-five minutes for first, second, third, fourth, and fifth grade students; while kindergarten receives thirty minutes once per week. This is not the only school in South Carolina that is not achieving the State's recommended amount of physical education. According to a report issued by the South Carolina Department of Education (2011), seventy-two percent of South Carolina's elementary schools that responded to a survey met the physical education requirement during the 2007 - 2008 school year. By the 2010 - 2011 school year, the compliance rate slipped to fifty-two percent, a twenty percent decrease (South Carolina Department of Education, 2011, p. 2). Implementation of all the components required by law for physical education is difficult when it is not valued and drastically underfunded.

Quality physical education demands 150 minutes of class time per week (National Association for Sport and Physical Education, 2011). Convincing school authorities to implement such a target has often been met with resistance. Morrow, Jackson, and Payne (1999) reported that many schools have reduced the amount of time allowed for physical education in order to allow more time for academics. Morrow et al. (1999) argued that time spent in physical education does not adversely impact academics, even when classroom time is reduced to allow for more physical education class time. Despite all of these positive associations, not all research has maintained these findings (Dwyer et al., 1983; Daley, & Ryan, 2000; Tremblay et al., 2000), thus necessitating additional research.

## **Chapter 3**

### **Methods**

The participants of this study had their aerobic capacity tested, as well as their academic performance in mathematics. Previous research has shown a correlation between these two variables. This study is an attempt to replicate, in part, previous studies and determine if the findings of those studies still hold true for the participants in this study.

#### **Participants**

The participants selected in this study consist of all ninety-six, fifth grade students enrolled in regular education classes at a public elementary school in Greenville, SC. These participants were chosen as a convenience sampling because they were assigned to the researcher's physical education classes for the academic year 2013-2014.

The demographic data for the study's participants includes gender, and ethnicity. They are enumerated as follows. Male participants numbered fifty-three, with forty-one being Caucasian, seven African American, and five other (includes Hispanic, more than one ethnicity, Asian/Pacific Islander, and American Indian/Alaskan). Female participants numbered forty-three, with twenty-eight being Caucasian, ten African American, and five other. These figures are shown in Table 1.



<b>Demographics</b>			
	Male	Female	<b>Total</b>
Caucasian	41	28	<b>69</b>
African American	7	10	<b>17</b>
Other	5	5	<b>10</b>
<b>Total</b>	<b>53</b>	<b>43</b>	<b>96</b>

**Table 1:** Demographics for fifth grade regular education students during the 2013 -2014 school year.

### **Academic Performance**

Study participants' level of academic performance was determined by their individual MAP Math RIT score. The MAP test was administered to the study's participants by their classroom teacher in May, 2014. According to the Northwest Evaluation Association (2013b):

Every test item on a MAP assessment corresponds to a value on the RIT Scale (for Rasch Unit), so educators gain a deep understanding of what a student knows. RIT assigns a value of difficulty to each item, and with an equal interval measurement, so the difference between scores is the same regardless of whether a student is at the top, bottom, or middle of the scale. RIT measures understanding regardless of grade level, so the information helps to track a student's progress from year to year (para. 2).

The MAP test is a computerized test that “dynamically adapts to a student's responses as they take the test” (Northwest Evaluation Association, 2013a, para. 2). If the student answers a

question correctly then the next question will be more challenging, however, if the student answers the question incorrectly then the test will present an easier item.

The MAP assessment is aligned to state and national standards for relevancy. This is the only nationally norm referenced test that these students take. This test allows the school to compare how their students are performing at the district, state, and national level. The students' performance on the MAP test will aid educators in their development of an understanding of a student's level and academic proficiency as well as serve as a diagnostic tool that reveals a student's areas of academic needs.

### **Aerobic Capacity**

Aerobic capacity was chosen to test the participants' fitness levels based on previous research showing that this fitness factor had the strongest correlation to academic achievement in mathematics. According to The Cooper Institute (2010), "A laboratory measure of maximal oxygen uptake ( $VO_2max$ ) is generally considered to be the best measure of aerobic capacity" (p. 27), but due to time constraints, costs, access to a laboratory, and sample size a measure of  $VO_2max$  was not performed for this study. Aerobic Capacity was determined by using the FITNESSGRAM<sup>®</sup> 15 meter PACER test. The Cooper Institute (2010) argues that the PACER test "demonstrated strong reliability and validity against measured  $VO_2max$ " (p. 27). In order to calculate aerobic capacity, a BMI is also needed for each participant. To determine the participants' BMI, their height and weight were measured using a SECA<sup>®</sup> 769 digital column scale with height rod by the researcher (See appendix A). The 15 meter PACER test was also administered by the researcher during the participants' regular physical education classes from

March 31, 2014 to April 11, 2014. Once all the data was collected it was entered into FITNESSGRAM<sup>®</sup> 9.0, a computer software program, to calculate the participants' aerobic capacity. Once aerobic capacity was calculated, FITNESSGRAM<sup>®</sup> 9.0 also determined whether or not the students met the HFZ. A student that meets the HFZ for the PACER test would be considered as having sufficient fitness for adequate health related to aerobic capacity.

The researcher received training on how to administer the various FITNESSGRAM<sup>®</sup> tests through the auspices of the Physical Education program at Appalachian State University from 2000 to 2005. Since then, the researcher has participated in in-service training on administering the 15 meter PACER test, and proper technique for measuring height and weight provided by Greenville County School District, facilitated by a professor from Furman University on October 18, 2012, and September 17, 2013.

## **Research Design**

The purpose of this quantitative study is to test academic performance by comparing students that meet the HFZ for aerobic capacity with students that did not meet the HFZ for aerobic capacity in terms of MAP Math RIT scores for fifth grade regular education students at a public elementary school in Greenville, SC. Each participant is classified in terms of aerobic capacity as either met or not met based on their individual results from the May, 2014 FITNESSGRAM<sup>®</sup> test. The averages of the participants' May 2014 MAP Math RIT scores were calculated for each category and disaggregated by gender and ethnicity. This was done to control all of the covariates and isolate the variable of aerobic capacity. If there is a difference of 6 RIT points between the averages of May 2014 MAP Math RIT scores for the met and not met

categories, then one can determine that there is a significant relationship between aerobic capacity and academic performance.

Previous research has shown a positive connection between physical fitness and academic achievement (Shephard et al., 1984; Maynard, Coonan, Worsley, Dwyer, & Baghurst, 1987; Shephard, LaVallee, Volle, LaBarre, & Beaucage, 1994; Tremblay et al., 2000; California Department of Education, 2001; Grissom, 2005; Coe et al., 2006; Nelson & Gordon-Larsen, 2006; Castelli et al., 2007; Chomitz et al., 2009; Hillman, 2009; Wittberg et al., 2009; Blom et al., 2011; Van Dusen et al., 2011). This study is created in an attempt to expand and support current research.

## **Chapter 4**

### **Results**

In this chapter, the findings of a study that examined the correlation between students who met or did not meet the HFZ for aerobic capacity as determined by the FITNESSGRAM<sup>®</sup> Test and student achievement scores on the math portion of the MAP Test for fifth grade regular education students at a public elementary school in Greenville, SC during the 2013 – 2014 school year are presented. The quantitative data is presented below in the form of tables followed by a narrative presentation of the same data. Specifically, this study addressed three separate and distinct research questions. One, did students meet the HFZ for aerobic capacity; two, how well did the students perform on the math portion of the MAP Test; and three, is there a correlation between aerobic capacity and academic performance on the math portion of the MAP Test. First, the number of students that met the HFZ for aerobic capacity will be presented. Second, the average math RIT scores from the MAP test administered in May 2014 will be presented. Lastly, the average math MAP RIT scores for those that met and those that did not meet the HFZ for aerobic capacity will be presented.

#### **Healthy Fitness Zone for Aerobic Capacity**

Aerobic Capacity was determined by using the FITNESSGRAM<sup>®</sup> 15 meter PACER (Progressive Aerobic Cardiovascular Endurance Run) test. The PACER test was administered

from March 31, 2014 to April 11, 2014. There were a total of ninety-six participants, seventy-nine (82.3%) of the participants met the HFZ for aerobic capacity (Met) while seventeen (17.7%) did not meet the HFZ for aerobic capacity (Not Met). There were fifty-three male participants, forty-six (86.8%) of the male participants met the HFZ for aerobic capacity while seven (13.2%) of the male participants did not meet the HFZ for aerobic capacity. There were forty-three female participants, thirty-three (76.7%) of the female participants met the HFZ for aerobic capacity while ten (23.3%) of the female participants did not meet the HFZ for aerobic capacity. This information is presented in Table 2.

**Table 2:** Students that met (Met) or did not meet (Not Met) the healthy fitness zone for aerobic capacity disaggregated by gender.

	<b>Met</b>	<b>Not Met</b>	<b>Total</b>
<b>Male</b>	46 (86.8%)	7 (13.2%)	53
<b>Female</b>	33 (76.7%)	10 (23.3%)	43
<b>Total</b>	79 (82.3%)	17 (17.7%)	96

Out of the ninety-six participants, sixty-nine of them were Caucasian with fifty-eight (84.1%) of them meeting the HFZ for aerobic capacity while eleven (15.9%) of them did not meet the HFZ. Out of the seventeen African Americans that were included in the study, fourteen (82.4%) met the HFZ while three (17.6%) did not meet the HFZ for aerobic capacity. There were ten students in the study that were classified as a race other than Caucasian or African American (Other). Out of the ten Other participants, seven (70%) met the HFZ while three (30%) did not meet the HFZ. This information is presented in table 3.

**Table 3:** Students that met (Met) and did not meet (Not Met) the healthy fitness zone for aerobic capacity disaggregated by race.

	<b>Met</b>	<b>Not Met</b>	<b>Total</b>
<b>Caucasian</b>	58 (84.1%)	11 (15.9%)	69
<b>African American</b>	14 (82.4%)	3 (17.6%)	17
<b>Other</b>	7 (70%)	3 (30%)	10

**Overall Math MAP RIT Scores**

Study participants' level of academic performance was determined by their individual math MAP RIT score. The MAP test was administered to the study's participants by their classroom teacher in May, 2014. The average math MAP RIT score for the ninety-six participants was 222.7. The average math MAP RIT score for the Caucasian participants was 224.7. The average math MAP RIT score for the African American participants was 213.7. The average math MAP RIT score for the Other participants was 222.7. The average math MAP RIT score for the male participants was 223.6. The average math MAP RIT score for the female participants was 223.3. This information is presented in table 4.

**Table 4:** Average math MAP RIT scores disaggregated by race and gender.

<b>Average Math MAP RIT Scores</b>	
All	222.7
Caucasian	224.7
African American	213.7
Other	222.7
Male	223.6
Female	223.3

**Math MAP RIT Scores for Met and Not Met**

Lastly, the average math MAP RIT scores were calculated for students that met and did not meet the HFZ for aerobic capacity. These results were disaggregated by gender and then by race. The average math MAP RIT score for students that met the HFZ for aerobic capacity was 226.9, while the average score for those that did not meet the HFZ for aerobic capacity was 218.4. This is a difference of 8.5 points. The average math MAP RIT score for male participants that met the HFZ for aerobic capacity was 226.7, while the average score for males that did not meet the HFZ for aerobic capacity was 220.4. This is a difference of 6.3 points. The average math MAP RIT score for female participants that met the HFZ for aerobic capacity was 227.1, while the average score for females that did not meet the HFZ for aerobic capacity was 219.4. This is a difference of 7.7 points. The average math MAP RIT score for Caucasian participants that met the HFZ for aerobic capacity was 228.2, while the average score for Caucasians that did not meet the HFZ for aerobic capacity was 221.1. This is a difference of 7.1 points. The average math MAP RIT score for African American participants that met the HFZ for aerobic capacity was 219.7, while the average score for African Americans that did not meet the HFZ for aerobic capacity was 207.6. This is a difference of 12.1 points. The average math MAP RIT score for Other participants that met the HFZ for aerobic capacity was 226.3, while the average score for Others that did not meet the HFZ for aerobic capacity was 219. This is a difference of 7.3 points. This information is presented in table 5.



**Table 5:** Average math MAP RIT scores for participants that met the healthy fitness zone (Met) and those that did not meet the healthy fitness zone for aerobic capacity (Not Met) and the differences between the two disaggregated by gender and then by race.

	<b>Met</b>	<b>Not Met</b>	<b>Difference</b>
<b>All Participants</b>	226.9	218.4	8.5
<b>Male</b>	226.7	220.4	6.3
<b>Female</b>	227.1	219.4	7.7
<b>Caucasian</b>	228.2	221.1	7.1
<b>African American</b>	219.7	207.6	12.1
<b>Other</b>	226.3	219	7.3

The findings of this study and the data presented will be further discussed in Chapter 5 Discussion/Conclusions. Additionally, conclusions will be drawn and recommendations for further action and further study will be offered.

## Chapter 5

### Discussion and Conclusions

This study that was conducted on the effect of aerobic capacity on academic test scores of fifth grade regular education students at a public elementary school in Greenville, SC was guided by thirteen separate and distinct research questions. Quantitative data was collected to determine if fifth grade students who met the HFZ for aerobic capacity as determined by the FITNESSGRAM<sup>®</sup> Test scored higher in math as measured by MAP test than those who failed to reach the HFZ for aerobic capacity as determined by the FITNESSGRAM<sup>®</sup> Test. This chapter will discuss these findings and make recommendations for further research and why the findings are significant for students today.

This researcher hypothesized that for those fifth grade regular education students who meet the HFZ for aerobic capacity, as determined by the FITNESSGRAM<sup>®</sup> Test, will score higher in math, as measured by the MAP test, than those who failed to reach the HFZ for aerobic capacity as determined by the FITNESSGRAM<sup>®</sup> Test. The results of the study confirm this hypothesis.

#### **Aerobic Capacity and Math MAP Achievement: A Correlation**

The results of this study suggest that students who have a health enhancing level of aerobic fitness perform better on math standardized tests than for those students that do not have a health enhancing level of aerobic fitness. The participants who met the HFZ for aerobic

capacity had a mean RIT MAP math score of 226.9, while the participants that did not meet the HFZ had a mean RIT MAP score of 218.4. The difference between the two groups was 8.5 RIT points.

These findings hold true for all subgroups involved in this study. Male participants who met the HFZ for aerobic capacity had a mean RIT MAP math score of 226.7, while the male participants that did not meet the HFZ had a mean RIT MAP score of 220.4. The difference between the two groups was 6.3 RIT points. Female participants who met the HFZ for aerobic capacity had a mean RIT MAP math score of 227.1, while the participants that did not meet the HFZ had a mean RIT MAP score of 219.4. The difference between the two groups was 7.7 RIT points.

Caucasian participants who met the HFZ for aerobic capacity had a mean RIT MAP math score of 228.2, while the participants that did not meet the HFZ had a mean RIT MAP score of 221.1. The difference between the two groups was 7.1 RIT points. African American participants who met the HFZ for aerobic capacity had a mean RIT MAP math score of 219.7, while the participants that did not meet the HFZ had a mean RIT MAP score of 207.6. The difference between the two groups was 12.1 RIT points. Other participants who met the HFZ for aerobic capacity had a mean RIT MAP math score of 226.3, while the participants that did not meet the HFZ had a mean RIT MAP score of 219. The difference between the two groups was 7.3 RIT points. This information was presented in Table 5 (See Appendix B).

A special note of interest is that while the African American subgroup had the lowest mean RIT MAP math score for students that met the HFZ as compared to other subgroups they had the largest difference between met and not met RIT MAP math scores. This suggests that

while aerobic fitness may prove to be beneficial for all students it may prove to be more beneficial for African American students.

### **Healthy Fitness Zone for Aerobic Capacity**

Aerobic Capacity was determined by using the FITNESSGRAM<sup>®</sup> 15 meter PACER test administered from March 31, 2014 to April 11, 2014. Out of the ninety-six participants, seventy-nine (82.3%) achieved the HFZ for aerobic capacity. When this data was disaggregated by gender and race, the results were similar. Male participants had the highest percentage (86.8%) that reached the HFZ, followed by Caucasian participants (84.1%), African American participants (82.4%), female participants (76.7%), and then lastly the Other participants (70%). These findings show that the majority of the participants achieved the HFZ for aerobic capacity regardless of gender or race. This information was presented in chapter four in Table 2 and Table 3 (See Appendix C).

### **Math MAP RIT Scores**

The mean math MAP RIT score for all participants was 222.7. All subgroups except African Americans, which had a mean math MAP RIT score of 213.7, had a mean math MAP RIT score that equaled or exceeded the all participant mean math MAP RIT score. Caucasian participants had the highest mean math MAP RIT score of 224.7. Next were the male participants with a mean math MAP RIT score of 223.6 followed by females with a mean math MAP RIT score of 223.3 then Others with a mean math MAP RIT score of 222.7 which is the

exact same as the mean math MAP RIT score for all participants. Gender did not have a significant effect on the math MAP RIT scores while race for the subgroup of African Americans had a negative effect on the math MAP RIT scores (See Appendix D).

### **Links to Other Research**

The findings of this study help support the findings of the study that was piloted by the California Department of Education (2001) which showed that higher levels of fitness were associated with higher levels of academic achievement. Secondly, this study also helps support the findings of Grissom's (2005) and Chomitz et al. (2009) studies which showed a positive relationship between academic achievement and physical fitness, as the number of physical fitness tests met increased so did the average of reading and mathematics scores. Thirdly, this study supports the findings of Castelli et al. (2007) which noted that "higher academic achievement scores were associated with greater total fitness. . . [and] greater total academic achievement scores were associated with lower body mass index and higher aerobic fitness"(p. 246). Lastly, this study corroborates multiple studies that have recognized a positive connection between physical fitness and academic achievement (Shephard et al., 1984; Maynard et al., 1987; Shephard et al., 1994; Tremblay et al., 2000; California Department of Education, 2001; Grissom, 2005; Coe et al., 2006; Nelson & Gordon-Larsen, 2006; Castelli et al., 2007; Chomitz et al., 2009; Hillman, 2009; Wittberg et al., 2009; Blom et al., 2011; Van Dusen et al., 2011).

### **Limitations of the Study**

Some factors that may or may not have affected the outcomes of this study include the following: not having complete data for all the participants, the low number of African American participants, the large diversity of the participants in the Other group and the low number of participants in the Other group, and the regulations from the school district of when the FITNESSGRAM<sup>®</sup> and MAP testing did not coincide.

Some of the participants had incomplete data due to several different factors. They may have moved and changed schools before all testing was completed. Some participants were injured and could not perform the PACER test, while others may have been absent the date(s) that testing occurred.

This study only had seventeen African American participants out of a total of ninety-six participants. Therefore, African Americans only accounted for 17.7% of the participant population.

The group listed as Other had a high degree of diversity within itself even though it had the lowest number of participants of all subgroups at ten. This group consisted of three students were classified as being of more than one race, two Hispanic children, two Japanese students, one student was from India, one was from Pakistan, and one student was from Bangladesh.

### **Recommendations for Action**

The data from this study suggests that achieving a health enhancing level of aerobic fitness promotes student achievement. Having a health enhancing level of aerobic fitness was a

positive influence for academic achievement regardless of gender or race. Other research (Menschik et al. 2008; U.S. Department of Health and Human Services, 1996; Hillman, 2009; Verret et al., 2012; Trudeau & Shephard, 2008; Sallis et al., 1999) endorses the importance of physical education and its positive influence on academic achievement. Quality physical education demands 150 minutes of class time per week (National Association for Sport and Physical Education, 2011). This researcher strongly recommends that school districts allocate sufficient funds, resources, personnel, and facilities in order to provide students with quality physical education at the elementary level.

### **Recommendations for Further Study**

More data is needed to support the findings of this study. One of the main limitations was the number of participants. Having more participants would allow for more data. Other suggestions for future study would be to disaggregate the data by socio-economic status. It would also be agreeable to include special education students in the study as well. Sibley & Etnier (2003) noted that cognitive gains from increased physical activity can be seen in students of all ages and of varied physical and cognitive abilities, including children with special needs and/or learning disabilities. Comparing data from other schools and other grade levels may support the findings of this study even further. Lastly, the two tests used for this study did not occur at the same time. If possible, it would be more desirable to obtain all data for all participants on the same day. This may require the cooperation of the school district, building supervisor, and teachers. Changes may need to be made to the days schedule to accommodate for the study.

**Overall Significance of the Study**

While physical education is a required subject for public schools in South Carolina, it is not considered in the school's state report card. Physical education is a fundamental element in developing the whole child to increase their academic potential and become productive citizens. Investing in physical education programs and children's fitness is essential for improving their health and helping to decrease their risk of developing lifestyle diseases, and it may also most likely help to improve their academic achievement as well.



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**Appendix A**

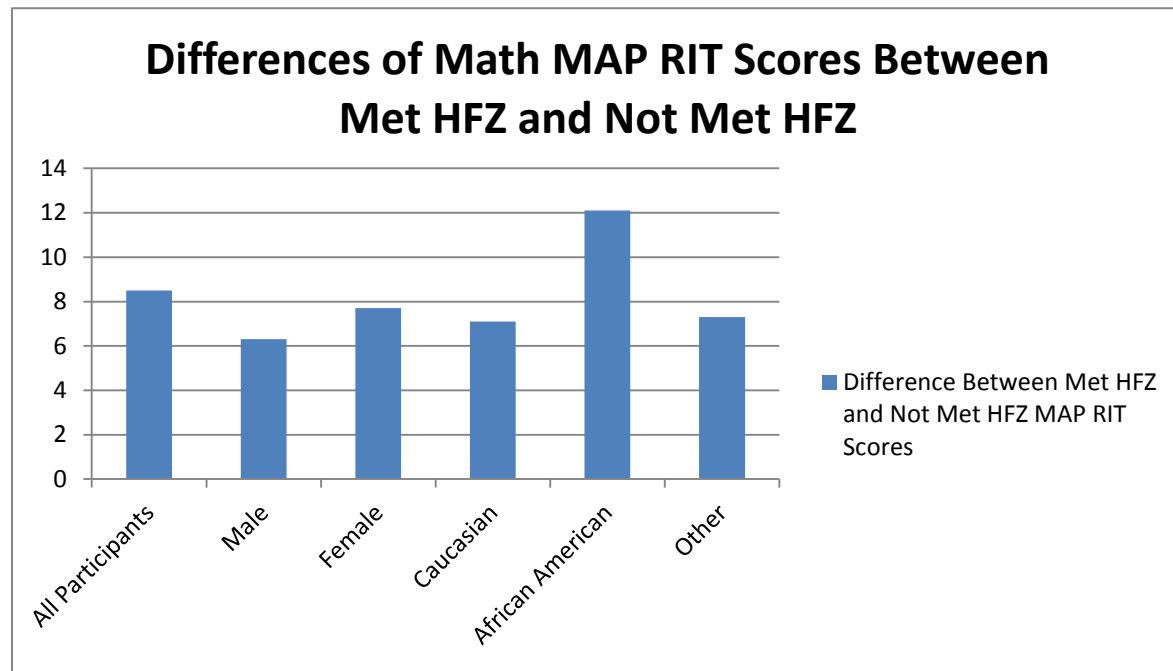
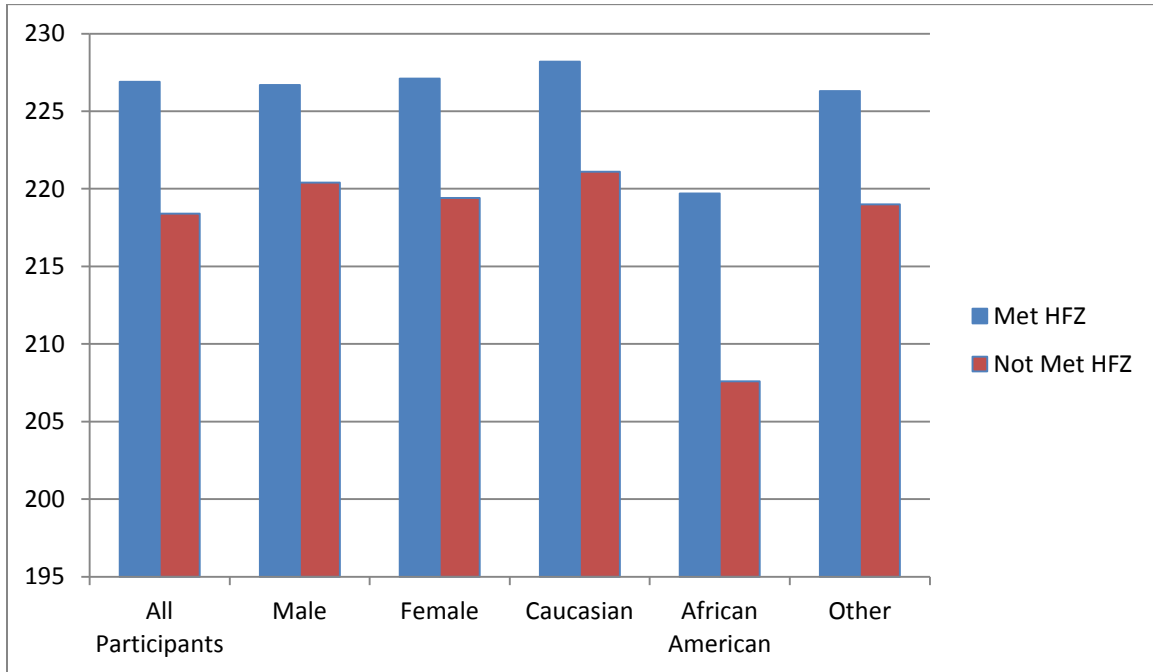
Pictures of the SECA<sup>®</sup> scale and height stick used for the study.





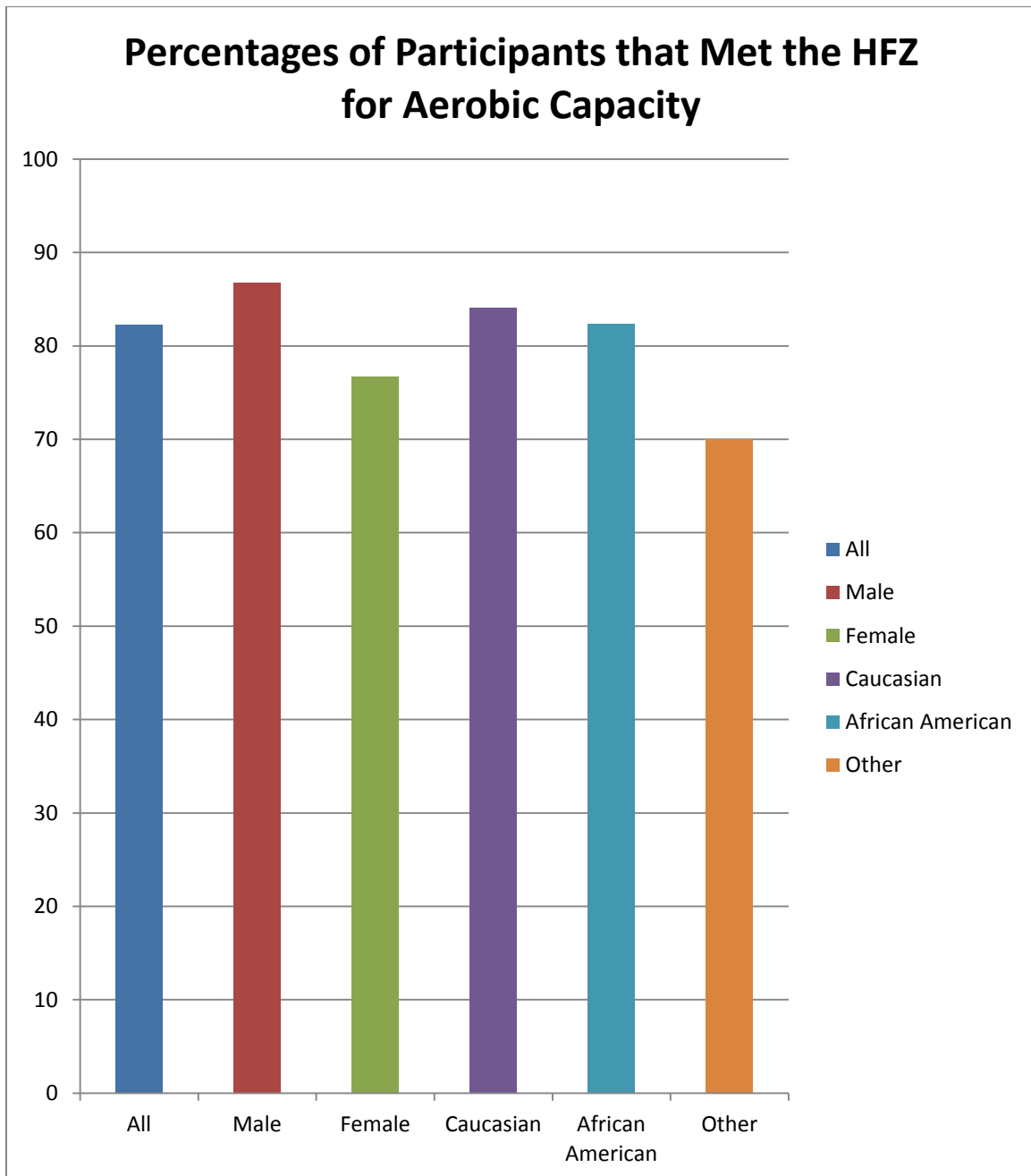
**Appendix B**

Mean Math MAP RIT scores for participants in the Met Healthy Fitness Zone (Met HFZ) and Not Met Healthy Fitness Zone (Not Met HFZ), and the differences between the two.



**Appendix C**

Graph of met healthy fitness zone for aerobic capacity disaggregated by gender and by race.



**Appendix D**

Graph of mean math MAP RIT scores disaggregated by gender and by race.

