THE RELATIONSHIP BETWEEN PHYSICAL FITNESS FACTORS AND ACADEMIC SKILLS AMONG OFFICER AIRCREW

by

Michael Lopez

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

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ABSTRACT

The purpose of this study was to explore the relationship between physical fitness and academic skills among a group of 110 aircrew flight officers. The study compared Air Force flight officers' physical fitness scores to academic skills. Prior research suggests a person's physical fitness levels are directly related to academic skills; however, current research has not addressed a military aviation population. This study used regression analysis to examine the relationship between physical fitness scores as tested by the Air Force physical fitness test (predictor instrument) and academic skills as tested by the Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test (criterion instrument). The participant population for the study was aircrew flight officers, age range 22 to 40. Recruitment occurred at flying units using a hard copy letter provided for all potential recruits. This study is significant in that it explored the relationships between physical fitness and academic skills in an understudied population of young to middle aged adults. The study results could serve as a decision tool for policy on Air Force physical fitness education programs and the allotment of time for physical fitness during duty hours. Overall, the analysis showed no detectible predictive relationship between physical fitness and academic skills in the officer aircrew sample. A ceiling effect of the measurement instruments given the high achievements in the study sample is a possible explanation. Future studies are recommended with larger sample sizes and broader population demographics.

Keywords: academic skills, young adult, military, muscular endurance, physical fitness

Disclaimer

"The views expressed here are those of the authors, and do not necessarily reflect official U.S. Government, Department of Defense, or U.S. Air Force positions or policies."

Dedication

This dissertation is dedicated to my wife and son. Without their patience, encouragement, and love I would not have been able to finish this long journey.

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I would like to express my sincerest appreciation to my committee Chair Professor D.J. Mattson. His patience, dedication, and unwavering support have made this journey possible for me. Without his scholarship and guidance, this dissertation would not have come to fruition.

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CHAPTER ONE: INTRODUCTION

Overview

This study explored the relationship between physical fitness and academic skills in a sample of 110 flight officers. The study assessed the relationship between physical fitness and academic skills in the support of implementing an Air-Force-wide physical fitness education program (PFEP).

Background

Current United States Air Force physical fitness education programs are designed and implemented at the discretion of unit commanders (AFI 36-2905, 2013). This creates vastly different physical fitness education programs from organization to organization, including not having a physical education program. Analyzing the effects of physical fitness and academic skills can provide Air force leaders with critical information about the usefulness of a widespread PFEP.

As stated in its physical fitness instruction AFI 36-2905 (2013), “Being physically fit allows you to properly support the Air Force mission” (p. 6). The United States Air Force also promotes fitness according to AFI 36-2906 (2013), as a means to “increase productivity, optimize health, and decrease absenteeism while maintaining a higher level of readiness” (p. 6). The current United States Air Force physical fitness program instruction has no formal requirement for regular physical fitness education and training sessions. In contrast, the United States Marine Corps physical fitness instruction MCO 6100.13 (2008), explicitly states “Commanders and officers in charge will ensure Marines perform at least five combat conditioning sessions, of 30 minutes duration, per week” (pp. 1-2). The only mandated physical fitness event in the Air Force physical fitness instruction is a bi-annual or annual physical fitness assessment.

Underpinning this study is the theory of brain neuroplasticity. Brain neuroplasticity provides the brain with the ability to adapt by generating new neuro connections at a faster rate, in contrast to genetic or epigenetic changes (Pascual-Leone, et al., 2011). The increase of blood flow to the brain from physical fitness may potentially enhance brain functions through activation of brain neuroplasticity (Bass et al., 2013). In particular, better cognitive abilities and brain plasticity have been noted in subjects with higher performing aerobic fitness (Sardinha, Marques, Martins, Palmeira, & Minderico, 2014). Davenport (2010) presented several alternate constructs on the relationship between physical fitness and academic skills: (a) motivation, (b) overall health, (c) improvement in concentration and behavior, and (d) improvement in mental health and self-esteem (p. 12).

Positive correlations between physical fitness performance and academic skills have been found in younger demographics, average age of 13.1 years (Bass, Brown, Laurson, & Coleman, 2013); however, there has been limited research addressing the relationship between physical fitness and academic skills in an adult population (Judge et al., 2014). Assessing the relationship between physical fitness and academic skills among flight officers will provide Air Force leaders focused research to inform future decision making with respect to PFEP. The results of this study could serve as a decision tool for policy on Air Force PFEP.

This study will affect the Air Force community at large by providing data to decision makers on how to resource aircrew flight officer time to maximize academic skills and physical fitness, potentially resulting in reduced flight training wash-outs and the sustainment of military readiness. The *DoD Physical Fitness and Body Fat Program* objectives are intended to ensure that each service member sustains the military readiness to accomplish both their service-specific mission and military specialty duties (DoDD 1308.1, 2004). By creating a formal fitness program, the Air Force could potentially reduce the number of lost work days, reported as 33,645 in 2001 (Roshetko, 2010). Personal determinants of performance and success play a critical role in the armed forces (Sellman, Born, Strickland, & Ross, 2010); more so given the unique physical demands in the United States armed forces compared to civilian society (Gindhart, 1999; Shamir, 2011).

Historical Background of Fitness Strategies

Theories on the positive effects physical fitness can have on health of the mind as well as on academic achievement have existed since ancient Greece. However, formal research on the subject matter did not gain momentum until the latter part of the 20th century. Castelli et al. (2014) divided the research into three distinct periods (1967-1999; 2000-2009; 2010-2013).

1967-1999. The descriptive analysis initiated by Castelli et al. (2014) revealed various limitations to the research about physical fitness and its impact on achievement in this era. Many studies lacked a quantifiable measure of physical fitness. Furthermore, academic test validation was also limited during this period. However, there were few studies that reflected the educational climate prevailing in the era, which included national initiatives and state mandates.

Ismail (1967) studied the effects of a well-organized physical education program on intellectual performance. The Ismail study found statistically significant improvement on the Stanford Achievement Test by children (10-12 years, $N = 142$) who participated in the enhanced physical education program.

Dwyer, Coonan, Worsley, and Leitch (1979) specifically looked at the effects cardiovascular health had on academic achievement. A large number of studies followed, and today cardiovascular performance is one of the most studied measures of physical fitness as it relates to academic achievement. However, this did not extend to other measures of physical fitness such as body composition and muscular endurance.

In the 1980s research began to center around sport participation and academic performance (Castelli et al., 2014). This type of research lacked quantifiable variables and had mixed results in linking physical fitness to academic performance.

By the 1990s, research moved on to randomized control trials of specific sports programs (Castelli et al., 2014). Some studies during this period showed positive effects, while other showed no effect. The majority of studies during this period came to a consensus, showing that no negative effects were associated with the relationship between physical fitness and academic achievement (Castelli et al., 2014). Research during this period ushered in standard practices still in use today in measuring both physical fitness and academic achievement on quantifiable scales through standardized testing.

2000-2009. During this period, the introduction of the No Child Left Behind legislation had the unintended consequence of precipitating large increases in research between physical fitness and academic achievement. This was based on the notion of schools being under pressure to have students pass newly mandated standardized testing. Elective physical education courses began to be replaced with remedial courses in preparation for standardized exams, leading to a decrease in physical education programs across the United States. In addition, reduction in economic resources in many educational departments across the country also contributed to schools curtailing their physical educational programs (Bass et al., 2013). According to the National Association for Sport and Physical Education, physical education attendance by students dropped from 42% to 28% between 1991 and 2003 (Van Dusen et al., 2011). By the end of the decade, the research began to divide in two distinct directions. Castelli et al. (2014) noted that the first direction assessed mental-functioning improvements directly from physical fitness, while the second direction assessed cognitive-control functions such as attention spans as an underlying function to attaining academic performance.

2010-Present. Recently, research in the field has vastly increased, including 12 literature reviews from 2010-2012 (Castelli et al., 2014). However, the majority of the research continues to be tailored toward school-aged children and adolescents. Recently there has been an expansion into studies with adults. Burzunksa et al. (2014) researched the relationship between cardiovascular fitness and white brain matter in older adults. Similarly, Stephens, Dong, and Durning (2015) studied the academic performance of military medical students in relation to their physical fitness. This dissertation research study adds to the body of research on the relationship between physical fitness and academic performance among military personnel, specifically flight officers in the young to middle age adult range.

Problem Statement

Relationships between physical fitness and academic skills have been understudied in the young to middle aged adult population, yet these factors have a high impact on human physical and cognitive performance. Prior studies have attempted to relate physical fitness and academic skills, but have reported reached inconsistent conclusions (Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Castelli, Hilman, Buck, & Erwin, 2007), or have not adequately addressed the full scope of the issue (Torrijos-Niño et al., 2014; Chen, Fox, Po-Wen, & Chih-Yang, 2013). The significance of the problem investigated is the current limited and inconsistent research on the young to middle aged adult population when it comes to physical fitness and academic skills.

Purpose Statement

The purpose of this study is to explore the relationship between fitness levels and academic skills through a quantitative, non-experimental, predictive, correlational study among 110 officer aircrew participants. The predictor variables were physical fitness components scores as measured by the Air Force Physical Fitness Test (AFPFT). The AFPFT consists of waist measurement, pushups, sit-ups, and a 1.5-mile run (See Appendix C for fitness assessment chart example). Total fitness, muscular endurance, and cardio-respiratory scores were the predictor variables analyzed. The criterion variable was academic skill as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test (WFASNOT).

Significance of the Study

Academic skills are critical to success in many facets of life. This study adds to the existing body of literature by examining the relationship between physical fitness and academic skills in an understudied population (young to middle aged adults). As a result, educators will have a better understanding of how fitness relates to academic skills in this age group.

The targeted population for this study was flight officers. By exploring the relationship between physical fitness and academic skills for flight officers, senior Air Force leaders can be provided data that could be used as part of a reevaluation of AFEP.

The relationship between individual factors such as aerobic fitness and academic skills was studied, as was the relationship between muscular fitness and academic skills. Currently, the research on the relationship between physical fitness and academic skills lacks consistency (Chen, et al., 2013).

Research Questions

RQ1: How well does total physical fitness (aerobic and muscular) as measured by the Air Force physical fitness test predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

RQ2: How well does aerobic fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

RQ3: How well does muscular fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

RQ4: Does the age of the subject influence the predictive capability of total physical fitness (aerobic and muscular) and academic skill level as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

Definitions

1. *Aerobic Capacity (Aerobic Fitness or Cardio-Respiratory Endurance*) - The functional capacity of the heart, lungs, and blood vessels to deliver oxygen to the working muscles, and its utilization by the muscles to oxidize nutrients to generate energy over sustained periods of time (DoDD 1308.1, 2004).
2. *Body Composition* - Relative portion of the body comprised of fat and fat-free tissue (AF 36-2905, 2013).
3. *Body Mass Index* - A mathematical expression that describes the supposed normal proportions between weight and height (DoDI 1308.3, 2002).

4. *Muscular Endurance* - The ability of a skeletal muscle or group of muscles to perform repeated contractions for an extended period of time. It is measured as the number of submaximal contractions performed or submaximal sustained contraction time. Most of the practical "strength" tests (e.g., push-ups and sit-ups) are measures of muscular endurance (DoDD 1308.1, 2004).
5. *Muscular Strength* - The maximal force that can be exerted in a single voluntary contraction of a skeletal muscle or skeletal muscle group (DoDD 1308.1, 2004).
6. *Physical Fitness*- The capacity to perform physical exercise, consisting of the components of aerobic capacity, muscular strength, and muscular endurance in conjunction with maintaining body fat content within an optimal range (DoDD 1308.1, 2004).
7. *VO2 Max* **-** The maximum volume of oxygen taken in, transported to and used by the pulmonary, cardiovascular, and muscular systems measured in milliliters of oxygen per kilogram of body weight per min (AFI 36-2905, 2013).

CHAPTER TWO: LITERATURE REVIEW

Overview

This review of the literature uses various peer-reviewed journals, books, and military instruction manuals as resources to provide a critical review of key topics directly related to the research. Topics considered include theoretical framework, physical fitness, flight officer academics, and related research.

Theoretical Framework

The theoretical framework assessed brain neuroplasticity, hippocampus, and alternate constructs to provide a basis for the relationship between physical fitness and academic skills.

Theory of Brain Neuroplasticity

Brain neuroplasticity is the ability of the brain to adapt, change and establish new connections. The brain operates similar to muscles, expanding with physical activity and withering without it (Ratey & Hagerman, 2008). Plasticity is an ongoing process in the brain throughout an individual's life span. Plasticity allows the brain to adapt to changing environments and conditions more quickly than by genetic or epigenetic changes (Pascual-Leone et al., 2011). Brain neuroplasticity also plays a critical role in learning through an increase in cognition, which is vital to academic skills. The term neural plasticity was created by the Polish neurophysiologist Jerzy Konorski. He is considered to be one of the founders of neuroscience and is a significant contributor to the understanding of complex behaviors. Other major theorists in the field of brain neuroplasticity include Marian Diamond, Michael Merzenich, and Jon Kaas.

Due to physical exercise, the brain grows new connections between neurons like a tree growing new "leaves" (Ratey & Hagerman, 2008). On the cellular level, muscles produce proteins such as Insulin-Like Growth Factor (IGF-1) and Vascular Endothelial Growth Factor

(VEGF), which travel to the brain and play a critical role in higher-order thought processes (Ratey & Hagerman, 2008). Other mechanisms that may affect brain neuroplasticity through physical fitness include the balancing of neurotransmitters that optimize the mind and improve attention, the binding of nerve cells, and the development of new nerve cells from stem cells in the hippocampus portion of the brain (Bass et al., 2013).

Bass et al. (2013) associate fitness with neurocognitive factors that increase blood flow to the back of the brain after exercise, which may enhance brain function (p. 836). Bass et al.'s findings suggested that fitness is positively associated with both attention and working-memory neuro-electric activity (p. 836). Brain neuroplasticity deviates completely from the competing theory of limited developmental periods, a theory that views the brain as a non-renewable organ (Rakic, 2002).

Hippocampus

The hippocampus plays a critical role in both the creation and storage of memories, specifically in the creation of episodic and autobiographical memories. Additionally, some researchers believe the larger medial temporal lobe memory system, of which the hippocampus is part, is responsible for general declarative memory (Squire, 1992). Memory storage is a critical component of academic skills.

The significance the role the hippocampus plays as it relates to memory is highlighted in the study of the patient Henry Gustav Molaison, commonly referred to as H. M. by Scoville and Brenda Milner (1957). In an attempt to relieve H. M of epileptic seizures, surgery was conducted to destroy his hippocampus. An unintended consequence of the surgery was severe anterograde and partial retrograde amnesia. H. M could not create new episodic memories and could not remember events just prior to his surgery. Since H. M's surgery, there have been many cases of associated memory degradation as it relates to hippocampal damage, and today it is commonly agreed upon in the scientific community that the hippocampus plays a critical role in memory.

Factors that have effects on hippocampus performance include its size and stress. Stress can be defined as potential differences of the bodily functions, either from internal or external sources, which are processed in the brain (Joëls, 2008). Research has shown that there is a positive relationship between the size of the hippocampus and memory performance (Prull, Gabrieli, & Bunge, 2000). Chronic stress has been shown to lead to atrophy in region III of the hippocampus proper (Joëls, 2008). Additionally, stress suppresses neurogenesis in the dente gyrus portion of the hippocampus (Joëls, 2008). Neurogenesis (new neuron production) is critical in the functions of learning and memory.

Research has shown a strong positive relationship between an individual’s level of physical fitness and the size of his or her hippocampus. A study was conducted with a randomized control group of 120 older adults to investigate the effects of aerobic exercise on their hippocampal volume (Erickson et al., 2011). The study showed that aerobic exercise increased the volume of the hippocampal by 2%. Specifically, the results showed an increase in the size of the anterior hippocampus including the dentate gyrus, which plays a critical role in neurogenesis. This finding supports a previous study in which increased aerobic activity showed an increased circulation of blood volume in the dentate gyrus (Pereira et al., 2007). Pereira et al. determined that the increase in hippocampal volume and dentate gyrus, supplemented by the increased blood circulation due to aerobic exercises and memory function was aided by the increase of brain-derived neurotrophic factor (BDNF). The BDNF protein is located between nerve cells, where it plays a critical role in synapses. Synapse allows nerve cells to pass electrical or chemical signals between themselves. BDNF supports many neuronal subtypes, such as glutamatergic neurons, by aiding in both expansion and survival (Cotman & Berchold, 2002).

An increase in hippocampal volume from exercise is not exclusive to older adults. A study of young to middle aged adults showed similar hippocampal volume increases (Thomas et al., 2016). The results showed that after a six-week period of aerobic exercise there was a statistically significant increase of hippocampal volume among the test subjects. However, in contrast to a previous study's findings which showed increased circulating blood volume in the dentate gyrus, Thomas et al.'s study was unable to replicate such results. Rather, Thomas et al.'s results showed myelination of gray matter within the anterior hippocampus as the main contributor to the increase in volume. This difference between the contributing factors as they relate to the increase in volume within the hippocampus could be attributed to several factors. The young to middle aged adult study was limited to a six-week aerobic test period. The short period could have been insufficient to have a significant effect on the circulation blood volume of the patients' hippocampi in contrast to previous studies, which lasted over a year. Second, the effects of circulation blood volume increase in the hippocampus are only pronounced in a significant manner in older adults. A possible factor could be the annual deterioration of the hippocampus by 1-2% in volume among older adults (Erickson, et al, 2011).

Research using laboratory mice has shown a strong relationship between neurogenesis and hippocampus learning and memory, specifically flexible memory expression (Klien et al., 2016). The results showed an increase of newborn mature neurons was strongly associated with long-term exercise, specifically, hippocampus neurogenesis in the dentate gyrus region sub-granular zone. Growth led to neural stem-like cells maturing into neurons and integrating into already existing neuronal circuits. Furthermore, Klien et al. concluded that exercise was able to reverse the impairment that a high fat diet induced on flexible memory expression.

Research has shown physical fitness not only improves performance of the hippocampus by increasing its volume, but also by reducing stress. A study of young male adults in randomly assigned groups found highly trained men with higher aerobic fitness were associated with lower cortisol responses and less stress (Zschucke, Renneberg, Dimeo, Wüstenberg, & Ströhle, 2015). By reducing stress, physical fitness plays a critical role in the reduction of atrophy in region III of the hippocampus proper, thus supporting neurogenesis in the dente gyrus portion of the hippocampus (Joëls, 2008).

More than ever before, with today's advances in human neuroimaging technology, researchers can look ever closer at specific subcomponents of the brain (Tardif et al., 2015.) This breakthrough in technology has led to an ever-greater understanding of the role that physical fitness plays in brain neuroplasticity.

Alternate Constructs

The theory of brain neuroplasticity provides a strong foundation explaining the mind-body connection and how it relates to the positive relationship between academic skills and physical fitness. However, researchers have developed alternate constructs about how physical fitness affects academic skills.

Davenport (2010) presented several alternate constructs regarding why an increase in physical fitness has a positive relationship with academic skills: (a) Motivated students may demonstrate an overall skills-orientation that influences both the cognitive and psycho-motor domains; (b) Fitness may reflect overall health, which could contribute to academics; (c) Physical activity or fitness could positively influence academic skills by improving concentration and classroom behavior; and (d) Physical activity may improve mental health and self-esteem (p. 12). Trudeau and Shephard (2010) established the possibility that physical education may not have a direct impact on the academic achievement, but indirectly affects the performance of a student by facilitating good health.

The results of several studies have also suggested that children participating in additional physical activities during school hours receive a positive influence on their academic performance via increased brain function, better social behavior, and self-esteem. As asserted by Strong, Malina, and Blimkie (2005), positive cognitive behaviors are exhibited by those individuals who are actively engaged in aerobics, flexibility activities, and other coordinative activities. Such activities positively affect self-esteem, which is believed to contribute indirectly to academic achievement (Tremblay, Inman, & Willms, 2000; Bayani, 2013).

Mental health problems such as depression, anxiety, and stress impact the lives of young adults to include the area of academic achievement (Bayram & Bilgel, 2008). Numerous studies highlight the importance of physical exercise on mental health, concluding that physical exercise is conducive in enhancing positive emotions such as pleasure and energy, and decreasing anxiety, tension, anger, and stress (Thayer, 1987; Woo, Kim, Kim, Petruzzello, & Hatfield, 2009). In addition, a meta-analysis research study asserted that exercise contributes to the improvement of mental health and cushions the negative impact of stress (Salmon, 2001). In a study conducted by Edward (2006), it was found that people who engaged in physical exercise possessed fewer systems of stress than those who avoided such participation in exercise.

Kleiber, Hutchinson, and Williams (2002) pointed out that positively toned emotion leads to cognitive reappraisal in the face of stress. Leisure or physical exercise generate positively toned emotions, contributing to optimum function during stress, and act as an effective coping method for taxing situations (Kim & McKenzi, 2014). Lastly, positively toned emotion gained from physical exercise can restore hope or self-esteem, which buffer the negative impacts of stress (Kleiber et al., 2002). Both brain neuroplasticity and the alternate constructs present possible contributing factors to the relationship between personal fitness and academic skills.

Related Research

Related research in the study includes flight officer training, military physical fitness, Air Force & other services physical fitness programs, aerobic capacity, V02 Max, body mass index (BMI), muscular strength & endurance, physical fitness & academic skills, physical education & academic performance, and research gap.

Flight Officer Training

Reviewing the academic rigors of flight officer training aids in the understanding of the importance and benefits physical fitness can have on improving academic skills in officer aircrew. Flight officers attend academically rigorous courses throughout their careers. Each aircrew member goes through a different set of academic trainings based on crew position. Before the start of formal flight training, all flight officers must have a bachelor's degree from an accredited institution and be commissioned as officers.

Flight officers who serve as bomber pilots start their careers as student pilots and first attend introductory flight screening in Pueblo, Colorado. This course is 40 days long and consists of 58 hours of ground school with 25 hours of flight instruction in a DA-20 Mitsubishi Diamond (small single-engine piston aircraft). The next flight program in a bomber pilot's career is Undergraduate Pilot Training (UPT).

The first phase is academic and pre-flight training, which consists of non-flying foundational skills required prior to flight-line training. Academic courses in phase one include aerospace physiology, aircraft systems, basic instruments, mission planning, navigation, and aviation weather. Pre-flight training during phase one consists of altitude chamber training, ejection seat training, egress training, and parachute landing fall training.

Phase two is flown in the T-6 Texan II and consists of 90 hours of flight training during a 22-week period. The purpose of phase two is to teach student pilots basic flying skills. Phase two focuses on basic aircraft handling skills, instrument flying, formation flying, navigation, and low-level flying. One student pilot is randomly selected each morning during this phase and must complete a verbal exam on emergency procedures known as a “stand up,” while in front of his peers. Failure in a standup will result in the student pilot being grounded for the day and forced to review his emergency procedures. All students also complete a written Emergency Procedure Quiz (EPQ) weekly. Phase two has four check rides which are known as flight evaluations (two in the basic flying skills phase, one in the instrument phase, and one in the formation phase); no instruction is given on these sorties. Following the flight portion of the check ride, a one-on-one question-and-answer session is completed with an evaluator pilot. Failure in any check ride results in a progress check and can influence whether the student pilot stays in the course.

Phase three is flown in the T-38C Talon and consists of 120 flight-training hours in a 24-week period. The purpose of phase three is to prepare students for bomber and fighter assignments. The focus of the phase is on basic aircraft handling skills, instrument flying, formation flying, navigation, and low-level flying. Standups and EPQs continue during this phase. Student pilots must complete a series of check rides in this phase under the same format as in the T-6 Texan II. Following phase three, student pilots attend land and water survival-training courses,where they learn the basics of surviving and evading capture on land and sea.

After UPT, the next phase of bomber pilot training is Initial Qualification Training (IQT). B-52 bomber IQT is a 112-day course with 241 hours of academic instruction, including 16 written exams. Flight instruction consists of 122 hours of flight training and two check rides. The purpose of IQT is to create qualified co-pilots for the B-52 community. The focus of IQT is on basic aircraft handling skills, weapon delivery, employment tactics, threat system identification, and bomber counter tactics. Upon completion of the IQT course, the student pilot becomes a bomber co-pilot.

After IQT, the student is flight training complete and assigned to an operational bomb squadron. While on operational status, bomber pilots are responsible for both reoccurring ground academic training and evaluations. Reoccurring ground academic training consists of mission certification, annual weapon refresher courses, laser safety training, night vision goggles academics, situational emergency procedures training, instrument refresher course, flying safety training, and military intelligence training.

Continued evaluations occur with check-rides every 16 months. During this evaluation period, bomber pilots complete a series of ground examinations in general knowledge, critical action procedures, qualification, weapons, and instruments; a flight evaluation is also required. Once a co-pilot reaches 320 B-52 pilot hours and 48 B-52 sorties, he or she is eligible to attend the United States Air Force Operations Training B-52 Aircraft Commander Upgrade Course. According to the Air Force Global Strike (2015), a potential aircraft commander candidate must "demonstrate adequate airmanship, mastery of basic piloting skills and crew coordination. Proficiency in general knowledge of systems and emergency procedures" (p. 14) before being selected to attend.

Aircraft commander upgrade is a 37-day course with 40.5 hours of academic instruction and several exams. Flight instruction consists of 44 flight hours with one check ride. The purpose of the aircraft commander upgrade course is to produce aviators ready to lead their aircrews. The focus of the aircraft commander upgrade course is on aircrew leadership, left-seat operations, and aerial refueling. Upon completion of the course, the aircraft commander is returned to operational flying and is responsible for his reoccurring academic training.

After a few years of flying as an aircraft commander, a pilot will be eligible for upgrade to instructor pilot. The hours requirements are 1,200 total flying hours of which 800 hours must be in a B-52 and 144 B-52 missions. B-52 instructor pilot upgrade is a 24-day course with 62 hours of academic instruction, including several written exams and a 15-minute graded presentation. Flight instruction consists of 32 flight hours. The purpose of the course is to create an instructor pilot who is knowledgeable and credible regarding the B-52. The focus of the instructor pilot upgrade is subject matter expertise, advanced flying skills, and instructor team coordination.

The final upgrade for a bomber pilot is becoming a weapons officer. A small number of pilots are competitively selected to attend the United States Air Force Weapons School. Students are hand selected from a central selection board based on flying, service, and personal fitness records. Entry requirements include a minimum of 50 instructor hours in the B-52, mission lead qualification, and less than 10 years of commissioned service. The United States Air Force Weapons School is a rigorous 21-week graduate level aerial warfare tactics course. The course consists of 122 elements, 414 academic hours, 21 exams and 17 flights. Each student must also prepare and present a formal research paper that examines a current issue or technical development in the B-52. The purpose of the course is to graduate highly qualified tactical aviators. The course focuses on leadership skills and the art of tactical employment of air, space, and cyberspace power. Graduates are awarded the coveted weapons school patch authorized for wear on their uniform. In addition, they are awarded 12 hours of graduate degree credit from Air University.

This section highlighted the academic rigors of flight officer training with regularly scheduled academic examinations and evaluations. A robust PFEP could potentially provide another tool to increase academic skills from initial flight screening through weapons school.

Military Physical Fitness

Military physical fitness requirements are governed by Department of Defense (DoD) instructions and directives. DoD dictates that each of the services (including the United States Air Force) develop a physical fitness program composed of cardio-respiratory endurance, muscular strength, muscular endurance, and body composition components (DoDD 1308.1, 2004). The stated DoD physical fitness components serve as the foundation for assessing physical fitness in this study.

Current DoD policy creates a culture within the military community valuing fitness, while encouraging individuals and organizations to achieve optimal health (DoDI 1010.10, 2014). Further research showing a relationship between physical fitness and academic skills could benefit DoD physical fitness policy by providing further evidence of the relationship between physical fitness and military readiness as represented by academic skills.

Air Force and Other Services Physical Fitness Programs

The United States Air Force Physical Fitness program is governed by Air Force Instruction (AFI) 36-2905. The goal of AFI 36-2905 (2013) is to “motivate all members to participate in a year-round physical conditioning program” (p. 6). In support of DoD instructions, the Air Force emphasizes the importance of total fitness, which includes aerobic conditioning, muscular strength, and muscular endurance. Furthermore, AFI 36-2905 (2013) directs commanders and supervisors to incorporate fitness into the Air Force culture (p. 6). However, current Air Force policy does not require physical fitness education or training during duty hours for airmen.

Since its creation as a separate service in 1947, the United States Air Force has had fluctuating physical fitness policies. In 1947, the USAF created its first publication on physical fitness, which aimed at having individuals perform their duties more efficiently. The first publication did not have standards or requirements. From 1947 to 1959, the Air Force fitness program was three paragraphs long, delegating physical fitness implementation to its major commands (Roshetko, 2010). A vague physical fitness policy led the Air Force School of Aviation Medicine to announce, "The overall state of physical fitness in Air Force personnel is poor" (as cited in Roshetko, 2010, p. 4). This led to a revision of policy in 1959, which required commanders to prescribe regular weekly exercises (Human Systems Information Analysis Center, 2010).

The efforts of Major (Dr.) Kenneth Cooper and his focus on aerobic conditioning led to a major shift in the physical fitness policy of the United States Air Force during the 1960s (Roshetko, 2010). In 1969, the U.S. Air Force instituted the 1.5-mile run that is still in use today as a measure of cardio-respiratory endurance. The 1.5-mile run has remained a part of the Air Force fitness test for 23 years. During this period, much like today, Air Force-wide personal fitness education programs were nonexistent (Roshetko, 2010).

In 1992, the Air Force changed its physical fitness examination to a cycle ergometry assessment. Much of the research during this period concluded that using a cycle ergometry test to assess VO2 Max was reliable (Fitchett, 1985; Storer, Davis, & Caiozzo, 1990). In addition, a push for greater safety and the development of new science led the change to a new physical fitness assessment (Roshetko, 2010). After the implementation of the new ergometry bike test, many research journals began to question its reliability. Research from this period (Willford, Sport, Wang, Olson, & Blessing, 1994; Lockwood, Yoder, & Deuster, 1997) concluded that cycle ergometry VO2 tests had an approximate 15-17% error in underestimating VO2 Max, making the assessment unreliable. With research showing ergometry's ineffectiveness in assessing VO2 Max reliably, the Air Force abandoned the cycle ergometry test in 2004 with an exception made for individuals who were medically excused from running. By 2010, the ergometry cycle test was completely removed from all physical fitness assessments in the U.S. Air Force. In 1995, it was discovered through a DoD survey, that 50% of airmen self-reported they were not meeting the required exercise standard, and by 2002, the number reporting this spiked to 65%. A possible contributing factor to the high percentage of airmen falling below exercise standards was the continued U.S. Air Force practice of not mandating a physical fitness education program. The previous year (2001), a DoD study found similar rates of obesity between active duty males and civilian males (Roshetko, 2010). The same DoD study concluded that the cost for the lack of personal fitness resulted in $23.9 million dollars from direct medical costs, $4.2 million from lost productivity, and 33,645 lost-work days (Roshetko, 2010). Unaccounted for in the study was the potential cost to combat readiness caused by a decrease in academic skills from the lack of physical fitness. Based on the staggering cost and obesity rates in the study, Air Force Space Command (AFSPC) initiated its own physical fitness program called WarFit. The program mandated duty time for three individual workouts and one group workout weekly. The program was a great success, with 40% of airmen designated as high health risks achieving a low health risk assessment after three months in the WarFit program. AFSPC marketed the WarFit program across the Air Force; however, issues with the mandatory physical fitness policy arose (Roshetko, 2010). The WarFit staff addressed the concerns by highlighting studies from both the National Aeronautical Space Administration and General Electric, which showed that mandatory fitness during duty hours, resulted in increased productivity, increased retention, and fewer sick days (Roshetko, 2010). An additional benefit unmentioned in the study was the possible increase in academic skills.

A combination of the WarFit program and the wars in Iraq and Afghanistan led to a new Air Force physical fitness program in 2004. The new physical fitness program ushered in the fitness components still assessed today: cardio-respiratory endurance, body composition, and muscular endurance.

Since its inception, the Air Force has had challenges implementing an Air Force-wide fitness program, even though one of its well-known medical officers, Major (Dr.) Kenneth Cooper (known today around the world as the “Father of Aerobics”) strongly advocated for daily personal fitness conditioning as the key to increased health and wellness (Roshetko, 2010).

In contrast to the Air Force, the Army has a mandatory requirement for a physical fitness program based on the premise that it is essential to individual, unit, and force readiness (FM 7-22, 2012). The Army training program calls for five workouts per week with two days of strength and mobility, two days of endurance and mobility, and one day of endurance with mobility focusing on speed running.

Navy physical fitness regulation mandates commanding officers to establish and maintain an effective year round physical fitness program (OPNAVINST 6110.1J, 2011). Furthermore, it also directs commanding officers to integrate their annual physical fitness plan into the workweek. Navy guidelines recommend 150 minutes of moderate physical activity weekly and twice per week of strength training.

The United States Marine Corps (USMC) personal fitness regulation mandates all Marines be physically fit. The USMC directs Marines to participate in both an organizational and individual combat conditioning program. Commanders are responsible for ensuring all Marines under their command perform a minimum five conditioning sessions per week and each session must last at least 30 minutes (MCO 6100.13, 2008).

Each military service has implementation methods for physical fitness education; however, they all have a mandatory physical fitness education program, in contrast to the United States Air Force. As an outcome of researching relationships between physical fitness and academic skills, a mandatory physical fitness program in the United States Air Force could be reexamined.

Aerobic Capacity

Aerobic capacity is the cardio-respiratory endurance or capacity of an individual. Aerobic capacity has been observed to have a positive impact on the physiological and physical well-being of young adults, and contributes towards good health (Janssen & Leblanc, 2010). Aerobic fitness is also a determinant that affects both cardiovascular capabilities and mental health. Studies have determined aerobic fitness and capacity facilitate good health among all age groups, and has a consequential impact on the academic achievement of young students (Bass et al., 2013).

Wittberg, Northrup, and Cottrell (2012) evaluated the academic achievement of students when they were subjected to regular aerobic fitness classes. FitnessGram was used to evaluate aerobic capacity and WESTEST was utilized for judging the academic scores of students. The study found students who engaged in high levels of aerobic exercises performed well in their tests when compared to those who were less engaged. A similar revelation was made by Desai, Kurpad, Chomitz, and Thomas (2015), in which the researchers found an association between academic performance and aerobic fitness among Indian students. Aerobic fitness of the students was judged by studying their demographics, physical activity duration, fitness (through shuttle test), and micronutrients. For academic performance, test results of mathematics and Kannada language, a Dravidic dialect spoken in parts of India, were assessed. In order to determine the relationship between the two, a correlation and logistic regression tests were conducted. After the analysis, the researchers found a positive relationship between aerobic capacity (VO2 peak) and academic achievement, wherein the students with higher aerobic capacities were found to have higher scores on the examinations. The results remained significant after adjusting for other variables, such as micronutrient deficiency, socioeconomic status, and gender.

Bellar, Judge, Petersen, Bellar, and Bryan (2014) undertook an investigation to determine the role of aerobic activities and fitness using the performance of nursing and kinesiology students. The participants in the study completed a Leisure and Physical Activity Questionnaire comprised of questions pertaining to GPA, class ranking, aerobic exercises, physical activities, gaming, gender and other leisure activities. Correlation analysis and Pearson's Chi-square test were carried out on SPSS. The results revealed higher levels of aerobic activity corresponded to better academic performance as assessed by grade point average.

This study will build on the existing body of literature by assessing aerobic fitness and its relationship to academic skills among officer aircrew, a young to middle aged adult demographic.

VO2 Max

VO2, the maximum oxygen consumption during exercise, is an important variable when assessing the aerobic fitness of an individual. Andersen et al. (2016) conducted a research study to assess the impact of physical fitness on academic performance, which included considering the socioeconomic status and ethnicity of students. For evaluating VO2 max, the researchers deployed a watt-max cycle ergometer test. For assessing academic performance, a series of mandatory examinations were conducted. The aspect of academic achievement is divided into three variables: humanities, which included six exams (writing, reading, spelling, oral, structured Danish and oral English); sciences, which included three exams (science and oral and written mathematics); and obligatory defined exams, which involved 10 exams (a combined measure that was inclusive of all the exams from humanities and science variables along with a project exam). To evaluate the relationship, linear regression models were used. Results showed a positive association between physical fitness and academic achievement. The VO2 max for girls was found to be higher than boys and corresponded to better test (academic) results. Of note, the reliability of cycle ergometer test in measuring VO2 max has come into question, based on the latest research.

Maghsoudi, Kandiah, Kong, Yusof, and Appukutty (2014) assessed the association between physical fitness and academic performance among college students. An evaluation was completed on the impact of body composition (morphological fitness), metabolic fitness, and VO2 max (aerobic fitness) on the academic scores of the students. For the physical fitness assessment portion of the study, fitness field tests were deployed and anthropometric measurements were done. For academic performance evaluation, the CGPA (Cumulative Grade Point Average) of the students was extracted from school records. The researchers found a moderately negative association between VO2 max and academic performance from the linear regression analysis completed. In addition, a weak negative association was found between body composition and academic achievement. The researchers concluded that there was no significant relationship between academic performance and physical fitness.

In summary, inconsistent findings have been noted in a variety of populations. The research findings had mixed results in the relationship between VO2 max and academic skills, highlighting the need for further research into the subject matter with particular focus on aerobic capacity.

Body Mass Index (BMI)

BMI (i.e., body composition) is a major component of physical fitness. BMI is a measurement used to determine the relative thinness or thickness of an individual's body (Flegal, Graubard, William, & Gail, 2005). When considering the academic performance of young adults, BMI has been observed to exhibit either a negative, positive or a neutral impact on academic achievement, thus presenting ambiguity. A 2009 study found a negative impact of BMI on students' academic skills (Kristjansson, Sigfusdottir, Allegrante, & Helgason, 2009). In another study, Wingfield, McNamara and Janicke (2011) assessed the relationship between body mass index, physical fitness and academic skills of school-aged children. Standardized reading and math test scores were used to assess academic performance of the students. BMI and fitness scores were gauged through a physical fitness test. The study employed correlation and regression analysis to evaluate the impact of BMI and fitness on academic skills. The researchers found low academic performance of students was associated with high BMI and low physical fitness, thus demonstrating the negative impact of BMI on academic skills. In contrast, a study by Baxter, Guinn, Tebbs, and Royer (2013), researched the relationship between BMI and academic skills among students. The study assessed parameters such as socioeconomic status and race. Students were segregated into three categories, low, medium, and high socioeconomic status. The height and weight of the students was measured and recorded. Test scores from English, math and science classes were extracted to assess academic performance. After performing a marginal regression analysis, BMI was found to have no relation to academic skills. However, other variables such as socioeconomic status and race had a positive relationship with academic achievement. An investigation by Atare and Nkangude (2014) revealed no relationship between the two variables. The researchers studied the association between BMI and academic performance of university students by using a BMI calculator and GPA scores. The data for 30 males and 60 females were gathered and a multivariate analysis was performed. The results demonstrated no significant relationship between body mass index and the academic achievement of the students; however, the researchers found possible relationships with learning ability, genetic endowments, and learning environment. Kaestner and Grossman (2009) studied the association between body weight and academic achievement of students. The study assessed the skills tests scores of students in reading and mathematics. The researchers observed that there was no significant relationship between the two variables, as the students with high body weight also had similar grades to those with average weight. Franz and Feresu (2013) assessed the relationship between BMI, physical activity, and academic skills among college students studying biochemistry. The height and weight of the students were recorded and the BMI was calculated. Average GPA and ACT exam scores were the academic performance measures used for students. The numeric means of sex, age, BMI, fitness score, frequency and grade level were compared with test scores. Comparisons were made by using linear models and the Tukey multi-test procedure. The researchers found that the students with average BMI and/or normal weight were found to have statistically significant higher results in both GPA and ACT scores than those who were overweight. The dissertation study being described incorporated BMI measurements within total fitness to assess the relationship between academic skills and total fitness.

Muscular Strength and Endurance

Muscle strength refers to the maximum exertion a muscle can perform in a single effort, while endurance is sustained effort over resistance for a period of time. Both are critical aspects of total fitness. The majority of standardized fitness assessments reviewed, including the APFT, have a muscular sub-component test as part of a total fitness assessment.

A study by Bass et al. (2013) considered muscular endurance among middle school students. The researchers utilized the Illinois Standardized Achievement Test (ISAT); the scores from reading and math test portions were used to measure academic achievement. For the physical fitness assessment the FitnessGram test was used. Muscular strength and endurance were tested through push-ups and one-minute curl-up tests. Logistic regression and correlation analysis were completed to determine the relationship between the physical fitness variables and academic achievement. The study found that muscular endurance had a positive relationship to academic achievement. Eveland-Sayers, Farley, Fuller, Morgan, and Caputo (2009) studied the impact of physical fitness and its related variables on academic achievement of school age children. Muscle strength and muscular endurance were evaluated. Muscular endurance was evaluated using a curl-up and sit and reach test battery. The TerraNova achievement test was performed by the students to assess their academic achievement. The test included mathematics and language questions. Pearson's Product Moment Correlations test was performed to determine the association among the study variables. The analysis found that muscle strength and endurance had a positive relationship with the academic achievement of the students. The results of these two studies show positive relationships between muscular fitness and academic achievement. In contrast, other studies such as Esteban-Cornejo et al. (2014), found muscular strength was not associated with academic performance.

This dissertation study aims to expand the age range studied by assessing whether the positive relationship between muscular fitness and academic skills is also present in a young to middle aged adult population in officer aircrews.

Physical Fitness and Academic Skills

Physical fitness refers to the physical capacity and capabilities of individuals to perform under different situations. Physical health is also believed to be a critical factor in affecting an individual's ability to learn by influencing the intellectual and contextual variables (Basch, 2011). Several researchers have assessed physical fitness and its role in well-being (Hillman, Erickson & Kramer, 2008). The extensive literature on physical fitness assessment suggests physical activity reduces the risks of acquiring cardiovascular diseases, obesity, stroke etc., while increasing the chances of curing inherited diseases (Keeley & Fox, 2009). Physical activity has also been observed to be beneficial for mental health and for promoting cardiovascular health of people when they are engaged in consistent activity. As asserted by Eveland-Sayers et al. (2009), being physically fit has a positive influence on the physiological well-being, while reducing the chances of mental illness (such as depression, dementia, and cognitive damage). Moreover, it has been observed that higher levels of physical fitness contribute to improved brain function, memory, and cognition, all of which facilitate academic skills (Shelton, 2009; Keeley & Fox, 2009). Understanding the role of physical fitness in improving concentration and thinking abilities among officer aircrew, and considering whether and how it can increase academic skills is of great interest to military fitness policy makers.

Researchers have reported on the positive impact physical fitness and physical activity have on cognitive ability (Sattelmair & Ratey, 2009). Adesa et al. (2014) suggested physical fitness and activity (movement and exercises) have positive effects on improved cognitive functions, reduction of stress and depression, and the reduction of anxiety. Moreover, physical fitness has been found to boost self-esteem, which is also believed to be associated with academic achievement. Sibley and Etnier (2003) evaluated the impact of aerobic physical fitness on cognitive functionality of students, which included academic performance tests in different subjects, intelligent quotient, and academic skills. After the assessment, a positive relationship was found, thus it was inferred that aerobic physical fitness increases the cognitive performance of the students, which helps in achieving better academic grades. Furthermore, Tomporowski, Davis, Miller, and Naglieri (2008) investigated the role of physical fitness and exercises in affecting cognition functionality among youths. The researchers found in systematic physical exercising programs that the mental processing of the students increased, which is not only essential for increasing the learning abilities but also for improving academic performance. Other studies have emphasized the impact of fitness on brain cognitive functioning (Schott & Liebig, 2007). Regular physical activity is not only essential for health but for improving brain cognitive functioning.

Research on young adults in medical school has shown a statistically strong relationship between physical activity and academic achievement as measured by GPA. The study conducted in the United Arab Emirates assessed 200 students, which found a significant positive correlation between academic achievement and physical activity with no statistically significant difference when adjusted for age, race, or nationality (Elmagd et al., 2010). Data reported were verified by university officials.

The current research literature on adult fitness and its relationship to academic achievement has specifically addressed the need for further research (Hillman et al., 2008). Judge et al. (2014) stated, “The trends in physical activity among younger adults remain underrepresented in the research literature” (p. A-73). The lack of research on young to middle aged adult populations is likely attributed to the lack of standardized fitness and academic achievement testing once a person reaches adulthood. By researching flight officers, this study will have an adult population that continues to take standardized physical and academic assessments on a regular basis. Moreover, by using the Air Force physical fitness assessment, it will provide data on body composition through waist measurement versus body mass index, thus providing data from an underused fitness instrument; further aiding research on the relationship between physical fitness and academic achievement. Current inconsistencies in the literature on the relationship between body composition and academic achievement also suggest the need for more study on the subject (Chen et al., 2013). Assessing three separate fitness predictor variables (cardiovascular, muscular, and body composition) will provide valuable insight into the specifics of individual components as they relate to physical fitness for flight officers, thus providing critical data on tailoring future fitness education programs aimed at optimizing both health and academic achievement related to ensuring military readiness.

Relationship between physical fitness and academic skills. According to the Center for Disease Control and Prevention (2011) regular physical activity can provide many benefits such as “control weight, reduce risk of cardiovascular disease, reduce risk for type two diabetes and metabolic syndrome, reduce risk of some cancers, strengthen bones and muscles, improve mental health and mood, and increase chances of living longer” (para. 1). However, current research shows another potential positive relationship between physical fitness and academic skills.

Van Dusen, Kelder, Kohl, Ranjit, and Perry (2011) evaluated the association between academic achievement and physical fitness by collecting the test records of Texas students studying in elementary, middle, and high school encompassing students from third through 11th grade. For comparison between the two variables, regression models were used, and it was found that all the fitness variables had a positive impact on the test scores of the students. However, BMI had a negative impact and cardiovascular fitness had a dose-response (the patterned physiological response in accordance with the variables); the fitter the person, the higher the test scores were.

Du Toit, Pienaar and Truter (2011) pursued a study to assess the physical fitness of students in primary school in fourth, fifth, and sixth grade in South African primary schools and examined the correlation of such fitness with academic achievement. For this, the researchers utilized different methods to test the fitness of the students. The physical fitness variables assessed in this study were muscular strength and endurance, cardiovascular endurance, and flexibility of the individuals. The measures utilized were the FitnessGram, percentage body fat, Bruininks-Oseretsky Test of Motor Proficiency II, and BMI. The measure of academic performance of the students was their average annual grades as stated on report cards; the relationship between these variables was evaluated by carrying out correlation analysis in Statistica software package. The researchers found a positive association between the academic achievement of the students and all the physical fitness variables. Comparing the results between girls and boys, the girls were found to have a higher positive correlation. Additionally, both the older boys and girls had high positive correlation between their academic performance and physical fitness.

In an empirical study, Chomitz et al., (2009) investigated the association between physical fitness and academic achievement among schoolchildren in primary education, ranging from third through eighth grade, by assessing the score on achievement tests in mathematics and English subjects. The Massachusetts Comprehensive Assessment System (MCAS) test was used. For evaluating the relationship between physical fitness and academic performance, the researchers carried out multivariate logistic regression analysis. Physical fitness was measured as the performance of students in fitness tests conducted during the physical education class. The students BMI scores, grades, gender and socioeconomic status were assessed for determining the probability of passing the tests. The investigation revealed that the probability of passing the tests in both subjects increased incrementally with the number of fitness tests passed.

London and Castrechini (2011) examined the relationship between academic achievement and overall physical fitness, tracking the performances of the students from fourth grade to ninth. The researchers investigated the relationship between physical fitness longitudinally and academic achievement by assessing individual growth modeling. It was observed that the students who showed continuous fitness performed better on tests when compared to the unfit students. When assessing the body mass index, obese students exhibited poor academic performance. Grissom (2005) used the FitnessGram test to compare the physical fitness of students with their academic achievement. The sample of students was taken from students in fifth, seventh and ninth grade in a California public school. The FitnessGram test was selected, as it offers accurate measurement of aerobic capacity, BMI, muscle strength, muscle endurance and flexibility. The academic performance of the students was assessed by extracting math test scores from the Stanford Achievement Test 9th (SAT) reports. The researcher observed that the hightest scores in physical fitness corresponded with high scores on the SAT, thus noting a positive association of physical fitness with academic achievement. Moreover, after evaluating the socioeconomic status of the students, it was found that students with high socioeconomic status were more physically fit than students of low socioeconomic status. In addition, the relationship was stronger for females.

Wittberg et al. (2012) researched fifth- and seventh-grade students, and found students who maintain a healthy fitness zone based on their aerobic capacity, have the highest mean scores in academic achievement. In contrast, students who have the lowest means scores in academic achievements were outside the healthy zone for physical fitness performance.

In a study by Adesa, Rani, and Bussa (2014), the association between physical fitness and academic achievement was evaluated among the students in sixth grade. To evaluate the relationship, researchers assessed students' test scores before and after a 12-week physical fitness regime, in a pre and posttest pattern. After completing the pretest, the students were subjected to a physical fitness training program for 12 weeks. At the end of the program, academic tests were re-administered. The analysis of data was completed as correlations using SPSS software. The results revealed posttest scores were better than pretest scores. In addition, muscular strength and flexibility variables of physical fitness were found to have a positive relationship with academic achievement and cardiovascular endurance showed a strong positive correlation. In contrast, body composition was found to negatively relate to academic achievement.

Most of the studies reviewed used cardiovascular fitness as the predictor variable when researching physical fitness as it relates to academic achievement. However, Bass et al. (2013) researched both aerobic fitness and muscular endurance as it correlates to academic achievement in the sample population of students from a public middle school (grade 6-8). The study found that boys who are in the healthy fit zone for aerobic fitness or muscular endurance are 2.5-3 times more likely to pass their math and reading exams. This study also found that girls are 2-4 times more likely to meet or exceed reading and math test standards if they are in the high fit zone for aerobic performance. Sardinha et al., (2014) addressed cardio fitness and weight status among students in fifth, sixth, and seventh grade as it relates to academic achievement. The study showed students who have good cardiovascular fitness have a 127% increased chance of reaching high academic achievement when compared to their unfit counterparts. Additionally, the study showed students with normal weight are 3.72 times more likely to be high academic achievers.

Liao, Chang, Wang, and Wu (2013) assessed the impact of changing physical fitness patterns among students and the relationship to academic performance. The study examined the relationship across the 3-year spectrum of senior high school, from tenth through twelfth grade. The physical fitness test performance and the students' entrance exam scores were evaluated over a two-year time span. Linear regression tests were executed to assess relationships. Socio-economic status, age of the students, and aerobic flexibility were considered. Aerobic flexibility incorporates intense anaerobic physical exercise that elicits the increases in levels of brain-derived neurotrophic factor, dopamine and epinephrine. Such flexibility encourages a broad range of neural and chemical adaptations in the brain that augment critical thinking. These mediators induced by anaerobic physical exercise are related to better learning success. The findings of the study revealed that physical fitness within the mentioned period increased the scores on entrance examinations. Moreover, aerobic flexibility was found to have a significant positive association with the results.

Research into populations closer to the target age demographic of this study were conducted by Stephens et al. (2015) on students pursuing military medical education. The researchers assessed correlations between physical fitness and academic test scores of military medical students. For measuring academic performance, the GPA of students was utilized; fitness was measured using aerobic assessments. The study revealed that the average aerobic fitness score showed a positive relationship with academic performance. The researchers also concluded that the fitness scores of students could be used to determine if they would succeed on academic tests.

The majority of the current research reviewed focused on adolescent-aged subjects and aerobic fitness. The purpose of the current study was to assess aircrew flight officers in the age range of 22-40 years and determine whether physical fitness is linked to their academic skills, while providing some valuable insight into a demographic (young to middle aged adults) that has received limited consideration in the research literature.

Physical Education and Academic Performance

Formal physical education programs in an academic institution are integral in promoting physical activities among students. As asserted by Mahar et al. (2006), apart from the cognitive benefits acquired through physical fitness, the encouragement of physical education, activity, and general sports in the school environment could also boosts academic skills. An Air Force physical educational program like this may provide similar benefits to officer aircrew.

The benefits acquired by students from physical activity such as improved mental health, social behavior, interaction, concentration, and feeling of connectedness, have a potential positive impact on their academic performance. These positive effects could also be beneficial to officer aircrew in flight training and continuation training.

Budde, Voelcker-Rehage, Pietrayk-Kendziorra, Ribeiro, and Tidow (2008) conducted a study for estimating the impacts of physical education on the academic achievement of students. The researchers found that with physical fitness, exercises and sports lessons, mental attributes, such as concentration and attention, increased. This conclusion was reached following a study in which researchers selected 115 adolescent students from 13-16 years of age and tested their attention and concentration after they participated in a sports lesson or selected coordinative exercises. It was observed students performed better in their tests when they performed coordinative exercises before sitting for the examination. On the other hand, when tested for attention and concentration after a regular school lesson, the students were found to perform with average results. Therefore, improvement was made in academic performance after performing coordination exercises. In alignment with these results, Hillman et al. (2009) found the cognitive control of attention among students was increased if they were allowed to exercise regularly, which further increased academic achievement. In contrast, when the same students were tested for attention and concentration after a regular school lesson, the students were found to perform with no statistically significant difference.

A limited set of studies have determined physical education has no impact on academic skills. In a study by Ahamed et al. (2007), the researchers investigated the role of physical education in affecting academic achievement on students at intervention schools. For the study, students were subjected to 10 minutes of additional physical activity during school days for 16 months. The researcher found no significant changes in the academic test scores of the students. The researchers concluded that 10 minutes of additional exercise may not have been enough to have an impactful effect; however, an increase in fitness did improve the overall health of the students.

Research Gap

A review of the literature has shown that many studies over several decades have researched the relationship between physical fitness and academic achievements, with the majority of the studies focusing on adolescent aged subjects. The current literature is limited in respect to research using adult subjects, along with no research on the Air Force physical fitness program and its implication on academic performance.

Several studies have shown a negative association between physical fitness and academic skills (Kristjansson et al., 2009; Wingfield et al., 2011), while others have shown positive associations (Bellar et al., 2014; Eveland-Sayers et al., 2009). Other studies have discovered no significant relationship between the aforementioned variables (Baxter et al., 2013). Therefore, there is ambiguity in the literature, which offers no definitive conclusions on whether physical fitness and its individual components have a direct association with academic skills. The author's dissertation study aimed to fill the research gap by studying the effects of physical fitness on academic performance among officer aircrew.

Summary

Flight officers play a critical role in the defense of our nation and must maintain high levels of readiness to achieve their missions. DoD policy extends this concept to both physical and mental preparation. By assessing the connection between physical fitness and academic skills in this population, the merits of a formal program of physical fitness education can be understood. A formalized fitness education program may provide peak performance across the entire spectrum of military duties, thus creating a more efficient and mission-ready aviation corp. Furthermore, by studying a young to middle aged adult population, new understandings can be added to the literature. By demonstrating the relative value physical fitness has in relationship to academic skills among flight officers, this dissertation study initiates consideration of a topic of critical importance. Continued research into the mind and body connection will be critical to verify and extend the findings of this study and to provide information applicable to reaching peak performance among flight officer aircrew.

CHAPTER THREE: METHODS

Overview

The purpose of this study is to determine if a predictive relationship exists between physical fitness and academic skills among flight officers. To determine if such a relationship exists, regression analysis was used to assess the relationship between the predictor variable (physical fitness) and the criterion variable (academic achievement; Warner, 2008). See Figure 3.1 for a visual flow chart of the predictor and criterion variables.

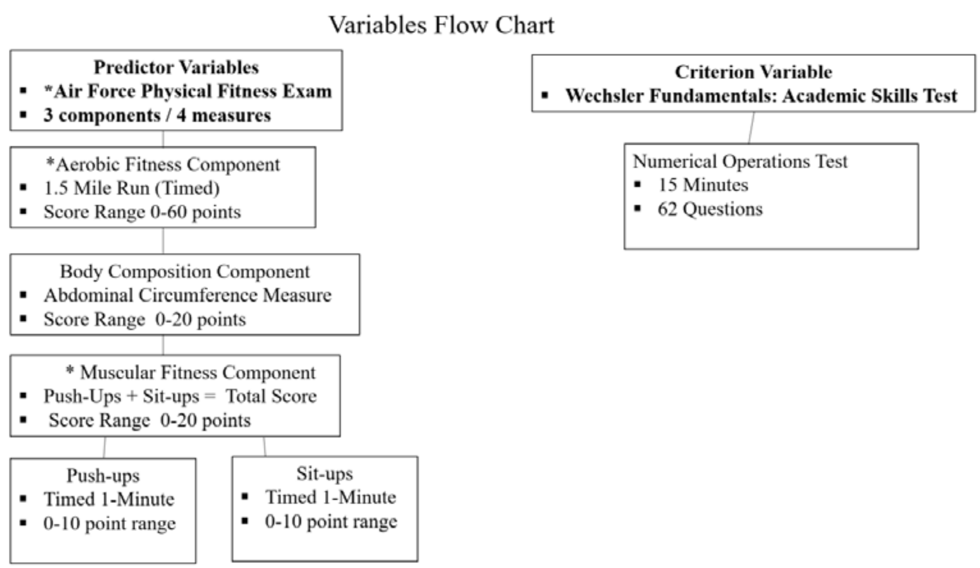

Figure 1. Visual flow chart of the predictor and criterion variables

Design

A quantitative correlational design was selected for this study. This study design assessed the predictive relationship between physical fitness and academic skills. The criterion variable was academic skills as measured by the WAFSNOT. The predictor variables are total physical fitness, aerobic fitness, and muscular fitness as measured by the AFPFT in a population of Air Force officers with an age range of 22 to 50. The WAFSNOT is an achievement sub-test instrument used to assess broad based numerical operations (PsychCorp, 2008). The AFPFT is a total fitness assessment instrument; components include a 1.5-mile assessment, push-up assessment, sit-up assessment, and waist measurement (AFI 36-2905, 2013). A correlational, predictive study research design was selected for this study based on its ability to discover relationships between variables (Gall, Gall, & Borg, 2007).

Research Questions

RQ1: How well does the total physical fitness (aerobic and muscular) as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

RQ2: How well does aerobic fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

RQ3: How well does muscular fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

RQ4: Does the age of the subject influence the predictive capability of total physical fitness (aerobic and muscular) and academic skill level as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

Hypotheses

$H_0$1: Total physical fitness will not predict academic skill level as measured by the Air Force Physical Fitness Test and Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test.

$H_0$2: Aerobic fitness will not predict academic skill level as measured by the Air Force Physical Fitness Test and Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test.

$H_0$3: Muscular fitness will not predict academic skill level as measured by the Air Force Physical Fitness Test and Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test.

$H_0$4: Subject age will not significantly impact the predictive ability of total physical fitness on academic skill level as measured by the Air Force Physical Fitness Test and Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test.

Participants and Setting

The participants for this study were a convenience sample of aircrew flight officers assigned to bomber aircraft, located in the continental United States in 2018. Participants were recruited from a major operating base in the southern United States. The base provided an ample target population, having nine squadrons and two wings, in addition to headquarters elements. Permission to solicit participants was obtained from unit leadership. The assessments took place in office and auditorium settings across the operating base.

For this study, the minimum number of participants needed in the sample was 109; the sample size was 110. According to Warner (2008), the minimum required for multiple regression analysis is 104 plus the number of predictor variables (N>104+K) based on a medium effect size at the 0.05 alpha level and the presence of five predictor variables, n=109 (p. 456). The sample consisted of 106 males and 4 females. Currently, 20.7% of the officers in the United States Air Force are women. They are part of a force with 12,669 pilots and 3,301 navigators in the grade of lieutenant colonel and below. Thirty five years of age is the average age of the officer corps, with 12% of officers below 26 years of age. The participant population under sampled women.

Instrumentation

The Air Force Physical Fitness Test (AFPFT) is the measuring instrument for physical fitness. The purpose of this instrument is to measure the predictor variables of total fitness, aerobic fitness, and muscular fitness among aircrew flight officers. The events include a waist measurement, push-ups, sit-ups, and a 1.5-mile run (See Appendix D for instrument). The current version of the AFPFT was developed using criterion and scientific standards. Over two million fitness assessments were accomplished from July 2010 to April 2015 (Baumgartner, 2015). The first Air Force wide standardized AFPFT was a 1.5-mile run established in 1969. By 1992 the assessment was changed to a cycle ergometry test. In 2004 the AFPFT was changed to its current components based on the unreliability of the cycle ergometry test. The AFPFT has been used in numerous studies (e.g., Thomas, 2012; Mitchell, 2014; Bell, 2015).

Aerobic fitness is measured using a timed 1.5-mile run, with a maximum score of 60 and a minimum score of 0. The muscular endurance fitness score is a combination of push-up and sit-up scores, with a maximum score of 20 points. Push-ups and sit-ups each have a maximum point value of 10 individually and a minimum point value of 0. Points assigned vary based on gender and age charts, and are arranged on charts (See Appendix D for example). Resting is authorized in the up position for both push-ups and sit-ups; however, the one minute authorized per event does not pause. The body composition score is determined by a waist measurement with a maximum point value of 20 and a minimum point value of 0. Three subscales are used to determine overall categories for airmen based on total fitness: 90 to 100 score is excellent, 75-89.99 is satisfactory, and 74.9 and below is unsatisfactory (AFI 36-2905, 2013). Biomedical experts established the point system to indicate level of fitness in all components (AFI 36-2905, 2013). Air Force exercise physiologists and preventive medicine physicians developed the physical fitness test from science-based criteria (AFI 36-2905, 2013).

Point scales are adjusted based on gender and age. There is an under 30 age chart, age range 30 to 39 chart, age range 40 to 49 chart, age range 50 to 59 chart, and a 60-plus years age chart. Males and females have separate scoring charts within each subdivided age group. In addition, there is also an altitude adjustment for taking assessments above 5,250 feet sea level.

The physical fitness assessment is exclusively conducted in Air Force base gyms. Certified fitness assessment monitors with a basic certification as a physical training leader conduct and score the assessments. To receive physical training leader basic certification, a fitness assessment monitor is required to complete basic life support and a fitness assessment training course. For this study, the research participants' fitness scores were self-retrieved and self-reported from the Air Force Fitness Management Data Base II. All Air Force members are required to take a physical fitness exam annually or semi-annually. Only the most recent testing data were used in this study. If a member has a cumulative score of 90 or higher, they test once a year. A cumulative score of 89.9 or lower requires semi-annual testing of fitness.

The fitness exam usually takes around 30-45 minutes to complete, depending upon the number of personnel taking the exam and the number of fitness assessment monitors. The maximum time allotted for the fitness assessment is a three-hour window. The *body composition* portion of the physical fitness assessment must be the first event accomplished. Three separate waist circumference measurements are taken and each measurement is rounded down to the nearest half inch. The three measurements are added and divided by three, then rounded down to the nearest half inch. Intra-class correlation coefficient values for waist measurements ranged from 0.85 to 0.95 and were lower for overweight than for lean subjects (Nordhamn et al., 2000). The *muscular fitness* portion of the assessment (push-ups and sit-ups) is assessed before or after the 1.5-mile run. Both the push-up and sit-up assessments have a one-minute time limit. Push-up stability reliability coefficients were obtained at .90-.93 for women and .95 for men (Baumgartner, Oh, Chung, & Hales, 2002). One-minute abdominal half sit-ups retest reliability (r = 0.98), inter-apparatus reliability (r = 0.71), and inter-tester reliability (r = 0.76; Diener, Golding, & Diener, 1995).

The *cardio-respiratory* (aerobic) assessment has high test reliability based on its administration by certified fitness assessment monitors and its development from databases used by the Cooper Institute and recognized by the American College of Sports Medicine. This instrument has been used in several research studies (e.g., Stephens et al., 2015; Wordon & White, 2012). Criterion-related validity of the 1.5 mile run tests for estimating maximum oxygen uptake is 0.79 (Mayorga-Vega, Bocanegra-Parrilla Ornelas, & Viciana, 2016). Additionally, McNaughton, Hall, and Cooley (1998) found the 1.5 mile running assessment to have a strength of relationship with VO2 max with a 0.87 correlation (McNaughton, Hall, & Cooley, 1998). Total fitness, muscular endurance, and cardio-respiratory scores, as measured by these tests, were the three physical fitness predictor variables to be analyzed.

Academic skills (criterion variable) was measured using the WAFSNOT. The Wechsler Fundamentals: Academic Skills test is an updated version of the Wechsler Individual Skills Test-II. The purpose of the WFASNOT is to measure academic performance in the broad skills of numerical operations. Areas assessed include addition, subtraction, multiplication, division, geometry, algebraic equations, and calculus equations. There are different versions of the exam based on age category. For this study, the adult version of the numerical operations was employed with a usable age range of 18 to 50. The assessment has 62 questions and a 15-minute time limit to complete. The combined possible score range is 30 to 170 points. A score of 70 and below places an individual well below expectations. A score above 130 points places an individual at the mastery level. The assessment can be completed individually or in group settings according to administrative procedures outlined in the Wechsler Fundamental Skills Administration and Scoring Manual (PsychCorp, 2008). The assessment uses a fill in the blank format to answer all mathematical problems. The researcher secured Pearson level B qualification for authorization to purchase and use the assessment. The instrument has been used in numerous studies (e.g., Poitras, 2012; Klajdi, 2016; Danguecan, 2017).

During the development phase of the exam, five pilot studies were conducted (*n*=15 to *n*=100) and one national pilot study (*n*=950) was conducted. Internal consistency reliability averaged .88 to .96 for the adult version of the test (Brookhart, 2010). The WFASNOT has been examined extensively for reliability in consistency across items, time, and scorer (Brookhart, 2010). Test validity is based on test content, internal structure, and external structure (Brookhart, 2010). Scoring was accomplished by personnel with Pearson qualification level B.

Procedures

The researcher secured Institutional Review Board (IRB) approval before starting subject recruitment (See Appendix A for IRB approval). The researcher secured leadership approval before soliciting volunteers. Following unit approval, the researcher solicited volunteers from approved units during daily morning announcements meeting (See Appendix C for Participant Consent Form). The researcher scheduled a mass testing session with volunteers or single-person testing on a case-by-case basis in order to capture academic skills data as measured by the Wechsler Fundamentals Academic Skills test. All testing was conducted in accordance with the

Wechsler Fundamentals: Academic Skills testing procedures (PsychCorp, 2008). The researcher trained to administer the test by reviewing the Wechsler Fundamental Academic Skills Administration and Scoring Manual (PsychCorp, 2008).

Following the examination, each participant filled out a questionnaire, which included a location to enter physical fitness assessment scores (See Appendix E). Participants self-reported their physical fitness scores on the data collection form provided. Each participant had network access to their fitness score data. Following the collection of data, all research material was kept in a portable case equipped with a lock and key. The data were then manually transferred to an Excel spreadsheet on a password protected laptop and stored for statistical analysis. Unique identification numbers were assigned to each subject and personal identity data were not collected to ensure anonymity and IRB compliance. Once stored, backed up electronically, and cross checked, hard copy data forms in the possession of the researcher were destroyed.

Data Analysis

Descriptive statistics, mean (M), standard deviation (SD), and frequency were reported using a combination of text and visual images such as charts, graphs, and other appropriate figures. Data were screened for any unusual scores and inconsistencies. Extreme outliers were assessed using a box and whisker plot for each variable. Bivariate linear regression was used to assess null hypotheses one and two. Based on the non-parametric nature of the predictor variable of research question three; a Spearman's rank correlation coefficient was accomplished. Multiple regression was used to examine null hypothesis four.

Bivariate linear regression was used for examining relationships between the predictor variable and the criterion variable. This dissertation assessed total fitness and muscular fitness separately to predict academic skills using bivariate linear regression. Multiple linear regression was used in assessing the linear relationship and strength between multiple predictor variables and criterion variables for research question four (Green & Salkind, 2010). Linear regression provides versatility and yields significant information on relationship strength among variables (Gall et al., 1996). A Spearman's rank correlation coefficient was used for examining relationships between the predictor variable and the criterion variable for research question three.

Assumption of bivariate outliers was checked using scatterplots between the predictor variables (x) and criterion variable (y), looking for the existence of extreme outliers, which could skew the data set and not provide a normal shape (Warner, 2008). Assumption of multivariate normal distribution was checked by graphically assessing the linear relationship between each pair of variables. If the variables are not linearly related, the power of the test is reduced. Testing for the assumption of normality was accomplished by scatterplot between each pair of predictor variables (x, x) and between the predictor variables (x) and the criterion variable (y), looking for the classic "cigar shape". Assumption of normality among scores is required in parametric statistics such as *t*-test and regression (Warner, 2008). Kolmogorov-Smirnov and Shapiro-Wilks assessments were also used to assess assumptions of normality of the criterion variable (WAFSNOT) and the predictor variables (AFPFT) to determine if they differ significantly (Warner, 2008). An assumption of non-multicollinearity among the predictor variables was accomplished for research question four. If a predictor variable (x) is highly correlated with another predictor variable (x), they could potentially be providing similar data about the criterion variable. Assumption of non-multicollinearity can assess if one predictor variable is a perfect predictor from another predictor variable in multi-regression (Warner, 2008). If the variance inflation factor (VIF) is too high (greater than 10), multicollinearity exists and violates the assumption. Acceptable values are between 1 and 5. Degrees of freedom for RQ 1 and 2 is 108, RQ 3 is 108, and RQ 4 is 107.

Final reporting includes N, df, r and r^2, *F* value, significance level (p), B, beta, and SE B, regression equation, power, and Spearman's correlation coefficient (ρ). Coefficient of determination was assessed to determine the percentage of response variation in the criterion variable(s) explained by the predictor variable (Gall et al., 1996). *F* value is used to measure if an independent variable had a significant predictive relationship with the outcome variable (Warner, 2008). Standardized beta (β) measured the strength of the predictor variable to the criterion variable; the closer the value is to 1 or -1, the stronger the relationship (Warner, 2008).

The p-value for each independent variable was set at .05 to test the null hypothesis based on accepted patterns in research. Linear regression line was reported in the form of a regression equation. Bivariate linear regression provides an equation used to predict raw scores from one variable to another using a regression equation (Warner, 2008). The regression equation is used to express how a change in the predictor variable will affect the criterion variable. In this dissertation it was used to predict changes in academic scores from total fitness and muscular fitness scores.

Statistical power measures the probability that a specific test will lead to the rejection of a false null hypothesis. Statistical power is based on the sample size, level of significance, directionality, and effect size (Gall et al., 1996). Unstandardized beta (B) was calculated to find the slope of the line between the predictor variable and the criterion variable (Warner, 2008). The standard error for the unstandardized beta (*SE B*) was calculated to aid in determining significance. Similar to a standard deviation for a mean, the more spread out the numbers are, the less likely that significance will be found (Warner, 2008).

CHAPTER FOUR: FINDINGS

Overview

This study assessed the relationship between physical fitness and academic achievement among officer aircrew. Assessments included the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test along with self-reporting of physical fitness scores. The material in this chapter includes a review of the research questions and null hypotheses, descriptive statistics (study population statistics, dependent variable, and independent variables), and results.

Research Questions

RQ1: How well does the total physical fitness (aerobic and muscular) as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

RQ2: How well does aerobic fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

RQ3: How well does muscular fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

RQ4: Does the age of the subject influence the predictive capability of total physical fitness (aerobic and muscular) and academic skill level as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

Null Hypotheses

$H_0$1: Total physical fitness will not predict academic skill level as measured by the Air Force Physical Fitness Test and Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test.

$H_0$2: Aerobic fitness will not predict academic skill level as measured by the Air Force Physical Fitness Test and Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test.

$H_0$3: Muscular fitness will not predict academic skill level as measured by the Air Force Physical Fitness Test and Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test.

$H_0$4: Subject age will not significantly impact the predictive ability of total physical fitness on academic skill level as measured by the Air Force Physical Fitness Test and Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test.

Descriptive Statistics

Participants

The participants were from a convenience sample of volunteers. Fitness scores were self-reported. A total of 121 potential volunteers were contacted during the summer of 2018 for the study. Survey and assessments were completed by 114 volunteers. A total of 110 complete samples were recorded for the study. The discarded four assessments lacked complete physical fitness score data based on profile limitations.

The gender breakdown for the study was 96.3% male and 3.7% female which represented an under-sampling of females. The aircrew position breakdown was 32.7% pilots, 46.3% weapon system officers, and 21% electronic warfare officers. The typical aircrew breakdown is 40%

pilots, 40% weapon system officers, and 20% electronic warfare officers, so pilots were slightly oversampled and weapon system officers slightly under-sampled. The participants' age group breakdown was 33.63% under 30 years of age, 65.45% age range 30 to 39, and <1% over 40 years of age.

Criterion Variable

The study's criterion variable was the Wechsler Fundamentals: Academic Skills Numerical Operations Test. The frequency distribution is shown in Figure 2. The assessment standard score scale range is 30-170 with single point increments. Skewness for academic scores was 0.12 with a standard error of 0.23. Kolmogorov-Smirnov (p = 0.20) and Shapiro-Wilk (p = 0.34); both tests show normal distribution for the criterion variable in Table 1. No extreme outliers were detected in the data (see Figure 3).

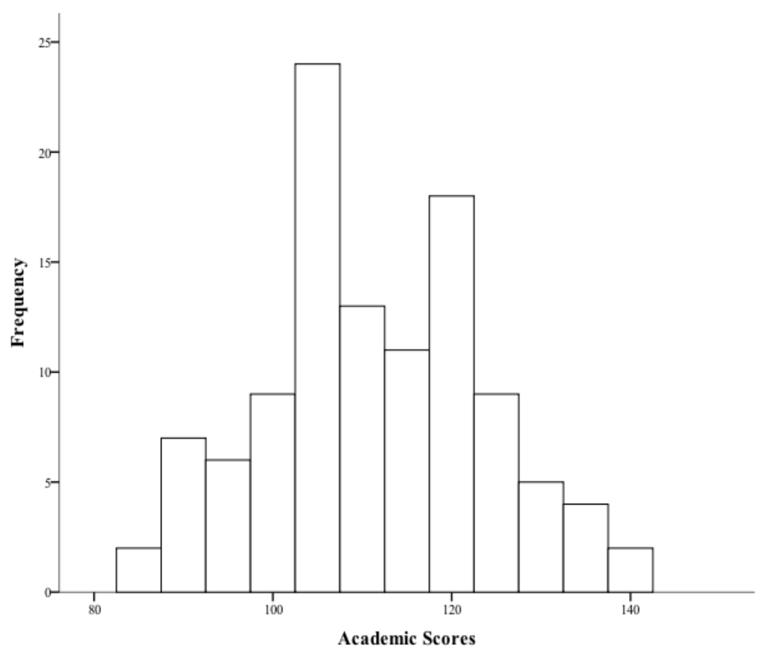

Figure 2. Academic Score frequency distribution. n=110, $\bar{x}$=111.2, s^2 = 157.45, s =12.54

Table 1

Test of Normality: Academic Scores (Age Adjusted Standard Scores)

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Age Adj Standard Score	.068	110	.200*	.987	110	.343

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

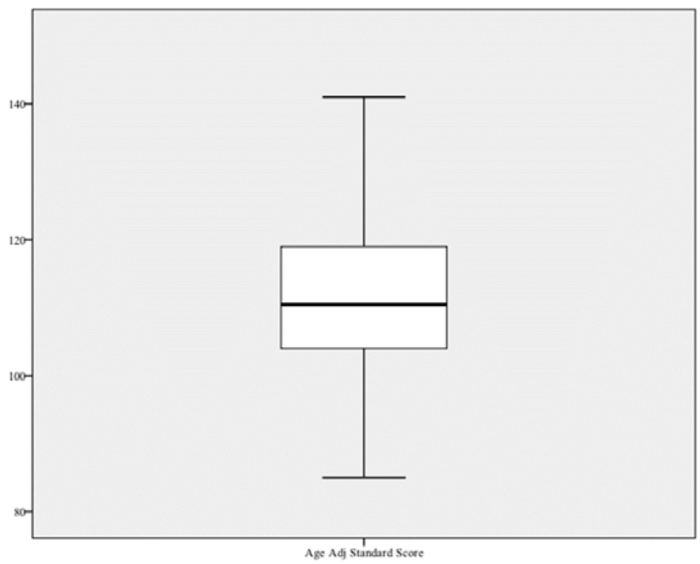

Figure 3. Academic Score Box Plot

Predictor Variables

Total fitness scores were used as the predictor variable for research question one and four. Standard score scale range for the fitness assessment was 0-100 (see Appendix D for scoring increments and breakouts). A square root transformation was accomplished on the dataset to achieve normal distribution. Frequency distribution is shown in Figure 4. Skewness for the square root transformation was 0.05 with a standard error of 0.23. Kolmogorov-Smirnov ($p = 0.16$) and Shapiro-Wilk ($p = 0.28$) both show normal distribution for the data in Table 2. No extreme outliers were detected in the data set (see Figure 5).

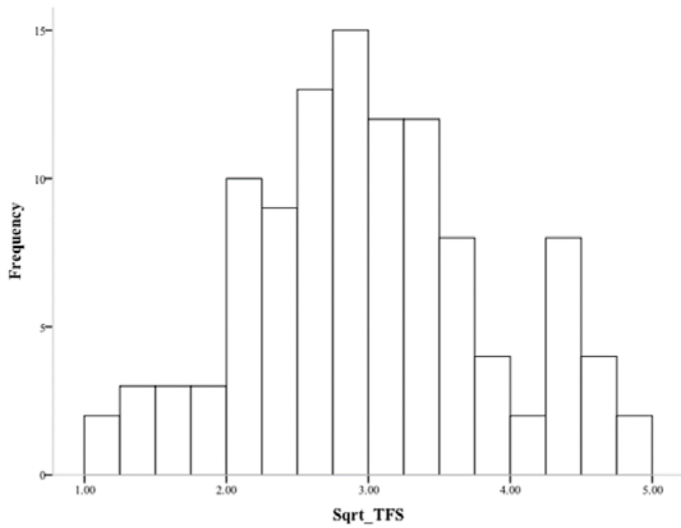

Figure 4. Square Root Transformation Total Fitness Score frequency distribution. *n*=110, $\bar{x}$ =2.9, s^2 = 0.73, s =0.85

Table 2

Test of Normality: Total Fitness Scores

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Sqrt_TFS	.075	110	.166	.986	110	.286

a. Lilliefors Significance Correction

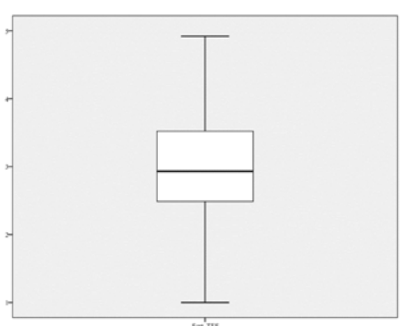

Figure 5. Square Root Transformation Total Fitness Score Box Plot

A 1.5-mile assessment was used to measure aerobic fitness, the predictor variable for research question two. The standard score scale range for the 1.5 mile-run was 0-60 (see

Appendix D for scoring increments and breakouts). A square root transformation was accomplished on the dataset. Frequency distribution is shown in Figure 6. Skewness for the square root transformation was 0.24 with a standard error of 0.23. Kolmogorov-Smirnov (p = 0.02) and Shapiro-Wilk (p = 0.12). The dependent variable shows normal distribution on the Shapiro-Wilk test (see Table 3). Two outliers were detected in the data (see Figure 7).

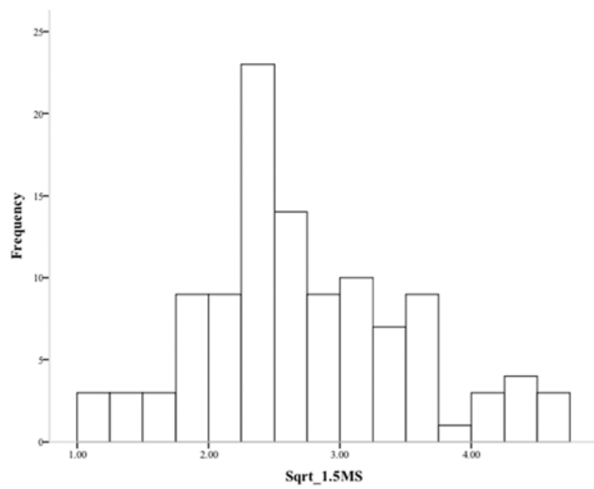

Figure 6. Square Root Transformation 1.5 Mile Aerobic Score frequency distribution. *n*=110, $\bar{x}$ =2.76, s^2 =0.67, s = 0.82

Table 3

Test of Normality: 1.5 Mile Scores (Aerobic Fitness)

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Sqrt_1.5MS	.110	110	.002	.981	110	.127

a. Lilliefors Significance Correction

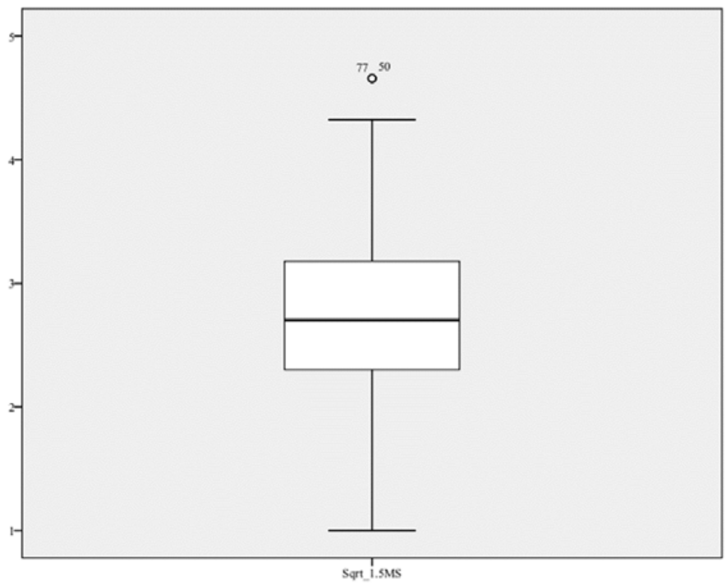

Figure 7. Square Root Transformation 1.5 Mile Aerobic Score Box Plot

Age was used as a predictor variable for research question four (age range 24 to 40). The frequency distribution is shown in Figure 8. Skewness was -0.79 with a standard error of 0.23, Kolmogorov-Smirnov ($p = 0.05$), and Shapiro-Wilk ($p = 0.03$). The dependent variable shows normal distribution on the Kolmogorov-Smirnov (see Table 4). No outliers were detected in the data (see Figure 9).

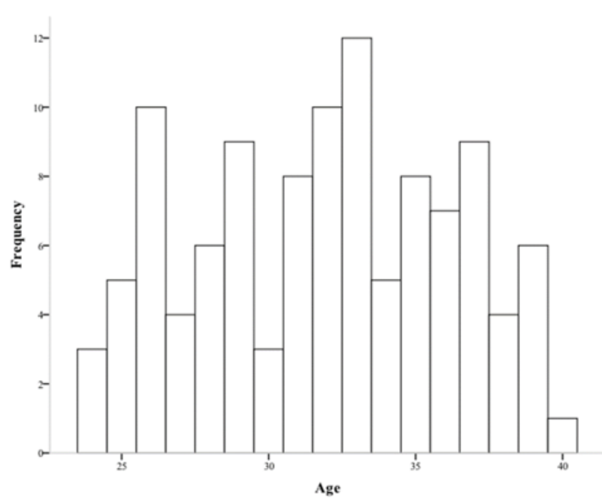

Figure 8. Age frequency distribution. n=110, $\bar{x}$ =31.91, s^2 =18.67, s = 4.32

Table 4

Test of Normality: Age

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Age	.085	110	.048	.961	110	.003

a. Lilliefors Significance Correction

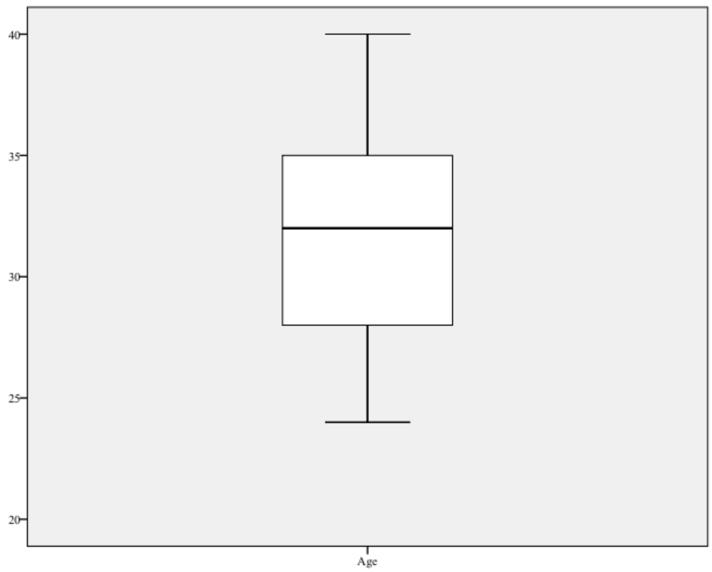

Figure 9. Age Box Plot

The muscular fitness score was used as the independent variable for research question three. Standard score scale range for muscular fitness scores were 0-20 (see Appendix D for scoring increments and breakout example). Linear muscular scores violated the assumption of normality. A Spearman's rank correlation coefficient was used as a non-parametric assessment of the relationship between the predictor and criterion variables.

Results

Assumption Tests

Assumption of bivariate outliers and assumption of multivariate normal distribution were assessed using scatter plots between the criterion variable and predictor variables. Scatterplots revealed weak relationships between the criterion and predictor variables (see Figure 13). Scatter plots between the predictor variables for research question four also revealed weak relationships (see Figure 14). Variance inflation factor (VIF) was used to assess the assumption of non-multicollinearity for research question four. VIF between the predictor variables of age and the square root transformation of total fitness score was 1.0; well within the acceptable VIF range of 1-5.

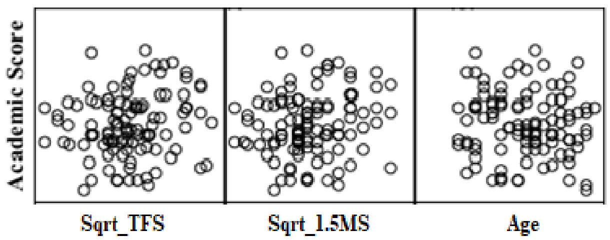

Figure 10. Predictor and Criterion Variables Scatter Plots

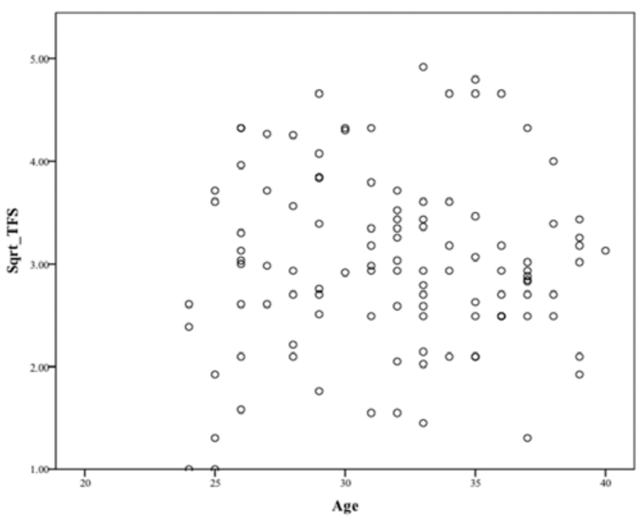

Figure 11. Square Root Transformation Total Fitness Score and Age Scatter Plot

Null Hypothesis One

RQ1: How well does the total physical fitness (aerobic and muscular) as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations test?

H_01: Total physical fitness will not predict academic skill level as measured by the Air Force Physical Fitness and Wechsler Fundamentals: Academic Skills Numerical Operations tests.

The significance level was set at α =.05 with 108 degrees of freedom (n=110) and a medium effect size. The linear correlation coefficient indicates no significant linear relationship (r=.16), with a regression equation of Y = 104.050+2.39 (Sqrt_TFS). The coefficient of determination (R^2= .03) indicates 3% of the variation in academic achievement is associated with total fitness. The P-Value (p = .09) is greater than the alpha level (α =.05) indicating the results are not statistically significant, thus the researcher failed to reject the null hypothesis. Betas are located in Table 6; the F-value (F=2.96) is discarded based on the high P-Value.

Table 5

Beta Table: Academic Scores and Total Fitness Scores

B	*SE B*	*β*
2.39	1.39	0.16

Dependent Variable: Academic Score
Predictors: (Constant), Sqrt_TFS

Null Hypothesis Two

RQ2: How well does aerobic fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations test?

H_02: Aerobic fitness will not predict for academic skill level as measured by the Air Force Physical Fitness and Wechsler Fundamentals: Academic Skills Numerical Operations tests.

The significance level was set at α =.05 with 108 degrees of freedom (*n*=110) and a medium effect size. The linear correlation coefficient indicates no significant linear relationship (*r*=.16*)*, with a regression equation of *Y* = 104.24 + 2.52(Sqrt_1.5MS). Coefficient of determination (R^2= .03) indicates 3% of the variation in academic achievement is associated with aerobic fitness. P-Value (*p* = .08) is greater than the alpha level (α =.05) indicating the results are not statistically significant and the null hypothesis is not rejected. Betas are located in Table 7; the F-value (*F*=3.02) is discarded based on the high P-Value.

Table 6

Beta Table: Academic Scores and 1.5 Mile Run Scores

	B	*SE B*	*β*
	2.52	1.45	0.17

Dependent Variable: Academic Score
Predictors: (Constant), Sqrt_1.5MS

Null Hypothesis Three

RQ3: How well does muscular fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

$H_0$3: Muscular fitness will not predict academic skill level as measured by the Air Force Physical Fitness Test and Wechsler Fundamentals: Academic Skills Numerical Operations Sub-Test.

The predictive relationship between muscular fitness and academic skills could not be assessed using bivariate regression based on the non-parametric nature of the muscular fitness data. A Spearman's correlation coefficient was accomplished in examining the relationship between the predictor variable and the criterion variable.

The significance level was set at α =.05 with 108 degrees of freedom (ρ = -.02). Correlation coefficient located in Table7.The P-Value (p = .80) was greater than the alpha level (α =.05), indicating the results are not statistically significant and the null hypothesis is not rejected.

Table 7

Spearman's Rho Correlation

			Muscular Fitness	Academic Score
Spearman's rho	Muscular Fitness	Correlation Coefficient	1.000	-.024
		Sig. (2-tailed)	.	.800
		N	110	110
	Academic Score	Correlation Coefficient	-.024	1.000
		Sig. (2-tailed)	.800	.
		N	110	110

Null Hypothesis Four

RQ4: Does the age of the subject influence the predictive capability of total physical fitness (aerobic and muscular) and academic skill level as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

$H_0$4: Subject age will not significantly impact the predictive ability of total physical fitness on academic skill level as measured by the Air Force Physical Fitness and Wechsler Fundamentals: Academic Skills Numerical Operations tests.

The significance level was set at α =.05 with 107 degrees of freedom (n=110) with a medium effect size. The linear correlation coefficient indicates a no significant linear relationship (r =.18), with a regression equation of Y = 111.52 -0.24(Age) + 2.43(Sqrt_TFS). The coefficient of determination (R^2= .03) indicates 3% of the variation in academic achievement is associated with total fitness and age. Since the P Value (p = .16) is greater than the alpha level (α

=.05), the results are not statistically significant and the null hypothesis is not rejected. Betas are located in Table 8; the *F* value (*F*=1.85) is discarded based on the high P value.

Table 8

Beta Table: Academic Scores, Total Fitness Scores, and Age

	B	*SE B*	*β*
	2.42/-.24	1.39/-.28	0.17/-.08

Dependent Variable: Academic Score
Predictors: (Constant), Sqrt_TFS, Age

CHAPTER FIVE: CONCLUSIONS

Overview

This study assessed the relationship between academic skills and physical fitness among aircrew flight officers. The study sample was comprised of young to middle aged adults. The conclusions section of the study includes a review of findings comparing this dissertation research to past studies, implications of the findings, limitations, and recommendations for future research.

Discussion

The purpose of this study was to explore the relationship between physical fitness and academic skills among aircrew flight officers who ranged in age from 24–40 years. Prior research in younger populations in the age range 9 to 22 suggested physical fitness levels are related to academic skills (Roberts et al., 2010; Sardinha et al., 2014; Maghosoudi et al., 2014; Wittberg et al., 2012). Prior research on populations of adults over 60 years of age revealed the same benefit, noting an increase in white matter brain health (Burzunksa et al., 2014) and an increase in hippocampus volume (Erickson et al., 2010). However, research among young to middle aged adult populations has been limited.

Ratey and Hagerman (2008) noted that fitness aids in production of IGF-1 and VEGF proteins, both playing critical roles in brain health. Rendiero and Rhodes (2018) reported that physical exercise is critical to brain plasticity through a mechanism of neuro activation of the hippocampus, leading to long–term neuro–adaptations. The hippocampus provides memory, motivation, and spatial navigation (Anand & Dhikav, 2012) and may have a role in the acquisition of physical fitness.

Current research shows hippocampus neurogenesis becomes almost undetectable by adulthood (Sorrels et al., 2018). However, among adults the evidence shows physical fitness delays cognitive decline (Ruiz et al., 2010). Specifically, Erickson et al. (2011) found a 1-2% growth of the hippocampus region, effectively reducing decline by 1-2 years among adults over 60 years of age who exercised regularly.

This dissertation study assessed 110 aircrew flight officers (age range 24 to 40) to better understand the relationship between physical fitness and academic skills in the young–to–middle–aged demographic. The theoretical construct for this study was the theory of brain neuroplasticity. Brain neuroplasticity, the ability of the brain to adapt to various factors such as age and even pathology, has been noted throughout the human lifespan, but the influence of brain neuroplasticity can vary with age (Pascual-Leone et al., 2011).

Research Question One

RQ1: How well does the total physical fitness (aerobic and muscular) as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

The results showed no statistically significant predictive relationship between total physical fitness and academic skills and the null hypothesis was not rejected. The findings are in contrast to the 2015 Uniformed Services University of the Health Sciences (USU) study (Stephens et al., 2015). The authors reported that they studied a similar sample and noted a positive correlation between the average overall fitness score and pre-clerkship GPA ($r = 0.34$) of Army medical students. However, critical differences between the studies are important to note. The USU study used GPA as its dependent variable in contrast to a standardized academic assessment. Furthermore, the aerobic component of the USU study was self-selected by the student (run, swim, or bike), weakening external validity of this study. Research on adolescents in this area has shown positive correlations between total fitness and academic achievement (Bass et al., 2013; Chomitz et al., 2009; Han, 2018). Neurogenesis, a component of brain plasticity, is more prevalent in age range 9 to 22 and may explain the positive relationship between fitness and academic achievement found for youth and in early adulthood.

It is possible that there is truly an absence of relationship between physical fitness and academic skills in the age range 24 to 40. However, Air Force flight officers' overall fitness levels and academic skills were noted to be in the very high and excellent ranges. It is also possible that the measurement instruments possess ceiling effects for this group thus not detecting an actual relationship between fitness and academic skills.

Research Question Two

RQ2: How well does aerobic fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

The results showed no statistically significant predictive relationship between aerobic fitness and academic skills and the null hypothesis was not rejected. This is in contrast to a study from RAK Medical and Health Sciences University in which college students age range 18 to 24 were assessed (Elmagd et al., 2010). That study found a significant positive correlation between physical activity and academic performance. However, several key differences are important to note. The study utilized GPA as its dependent variable in contrast to a standardized academic assessment. Furthermore, the aerobic component of the study was self-reported fitness activity by the student (primarily walking, jogging, running, and dancing), weakening external validity.

Several studies **(**Roberts et al., 2010; Sardinha et al., 2014; Esteban-Cornejo et al., 2014;

and Torrijos et al., 2014) found positive relationships between aerobic fitness and academic achievement among youth age range 6 to 18, noting brain neuroplasticity as a possible reason for the relationship. Based on the literature, aerobic fitness as a predictor of academic achievement among adolescents appears to be significant. However, relationship between aerobic fitness and academic achievement in the age range 24 to 40 was not evident based on use of the Wechsler Fundamentals Numerical Operations sub-test.

Research Question Three

RQ3: How well does muscular fitness as measured by the Air Force physical fitness test, predict academic skills as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

In this dissertation study, the predictive relationship between muscular fitness and academic skills could not be assessed with parametric testing based on the non-parametric nature of the muscular fitness data. In lieu of a multivariate regression analysis, a Spearman's correlation coefficient was accomplished in examining the relationship between the predictor variable and the criterion variable. The results showed no statistically significant predictive relationship between muscular fitness and academic skills and the null hypothesis was not rejected.

Chen et al. (2013) and Esteban-Cornejo et al. (2014) found no association between muscular fitness and academic achievement in the age range of 9 to 22. Esmaeilzadeh et al. (2018) found a negative association between explosive strength and composition information processing among young adult males. Bass et al. (2013) and Coe et al. (2013) noted a positive association between muscular fitness and academic achievement in the age range of 9 to 22. The literature does not report on the relationship between muscular fitness and academic skills for subjects in the age range of 24 to 40. Therefore, the results produced are the first in this area and while they show no relationship, it is possible the muscular fitness measurement tool included a ceiling effect that influenced the study outcomes.

Research Question Four

RQ4: Does the age of the subject influence the predictive capability of total physical fitness (aerobic and muscular) and academic skill level as measured by the Wechsler Fundamentals: Academic Skills Numerical Operations sub-test?

The results showed no statistically significant predictive relationship between total physical fitness and age in relation to academic skills and the null hypothesis was not rejected. Abt et al., (2016) noted a decline in fitness by older soldiers, specifically higher body fat, lower aerobic capacity, and lactate threshold. The findings of the present study did not agree with these findings given the absence of a relationship between subject age and testing results.

Implications

Several findings from this study add to the existing body of literature: (a) the academic mean score of officer aircrew in this study were one standard deviation above the general population mean score; (b) the mean score of officer aircrew in this study were in the excellent fitness category; and (c) no detectible predictive relationship was noted between fitness and academic skills in the age range 24 to 40 for the officer aircrew sampled in this study. Findings one, two, and three can be explained by a possible ceiling effect of the measurement instruments given the very high achievement scores in the study sample of age range 24 to 40 years (Gall et al., 1996). Another possible explanation for finding (c) is a brain neuroplasticity that is different for the age range of 24 to 40 years.

While brain neuroplasticity has been suggested as a mechanism for a positive predictive relationship between fitness and academic skills in the age range of 9 to 22 and adults over 60 years of age, it was not evident in the present study. Therefore, it is possible that brain neuroplasticity is different for the age range of 24 to 40 years.

Gow et al. (2012), Benedict et al. (2013), and Burzunksa et al. (2014) demonstrated that adults over 60 years of age benefit from aerobic fitness through increased brain white matter health, specifically the maintaining of microstructural integrity. The maintenance of brain white matter is critical in sustaining cognitive functions such as academic achievement (Rohde &Thompson, 2007). Pereira et al. (2000) noted BDNF protein increases in the brain with aerobic exercise and Cotman and Berchold. (2002) related this to better functioning brain synapses and glutamatergic neuron expansion, leading to better white matter function.

The lack of consistent research demonstrating a predictive relationship between physical fitness and academic achievement among the age range of 24 to 40 years leaves open the possibility of different brain neuroplasticity development during this stage.

Future studies may consider alternate constructs as possible explanations for the relationship between physical fitness and academic skills. Davenport (2010) asserted student motivation as a possible driver for both cognitive and psycho-motor domains. Tremblay et al. (2000) asserted fitness plays a critical role in self-esteem, which is believed to indirectly contribute to academic achievement. Joëls (2008) asserted emotional stress as a possible factor in hippocampus atrophy and as a suppressant in neurogenesis.

Limitations

Several limitations were present in the study. Possible sampling bias could have occurred based on limiting participants to one geographical location. Although limited to one location, a diverse sample (i.e., age, rank, and air crew positions) was present for the study with the exception of the ratio of males to females. Self-reporting of physical fitness test scores was also a limitation. Using a self-reporting instrument did not allow the researcher to verify the accuracy of the data provided for the fitness assessment portion of the study; although self-reporting of fitness scores was conducted anonymously to encourage honesty in responses. A lack of measuring fitness intensity and frequency was a limitation in gathering broader fitness data. An assessment of fitness intensity and frequency could potentially provide a more accurate measure of constant physiological changes. Although not as robust as using a combination of fitness intensity and frequency measures, the Air Force physical fitness test is a professionally administered valid and reliable instrument used to assess total physical fitness.

The study also did not differentiate officers based on undergraduate college majors. Officers with mathematical and technical degrees could potentially have had an advantage on the Wechsler Fundamental Academic Skills Numerical Operations Test. Using volunteer participants could have limited motivation to exude maximum effort on the academic assessment. To overcome this limitation the researcher emphasized the anonymity and the importance of the research. To better assess the effects of age on the predictive relationship, future assessment instruments should have no age adjustments in either the predictor or criterion variable.

Academic assessments were conducted in group and individual settings on random days and times based on participant availability. The non-standardized assessment times could have affected participants' performance based on the day and time of the assessments. The muscular fitness measurement upper bounds was a limiting factor in providing parametric data for a linear model. Lastly, the study used a cross-sectional analysis to assess relationships and not causality.

Recommendations for Future Research

Recommendations for future research in the field of physical fitness and academic achievement are numerous: (a) Increase geographic locations; (b) Increase the scope of population demographics to other specialties to include enlisted career fields and other military branches; (c) Increase the sample size; (d) Compare military males and females; (e) Compare relationships by subject military rank; (f) Target military cadets (typical age range 18 to 22); (g) Incorporate variables such as self-esteem and diet; (h) Incorporate a pretest and posttest experimental design with a control group and experimental group of military officers; and (i) Conduct a longitudinal analysis on the effects of fitness on academic achievement as noted in London and Castrechini (2011).

Conclusion

Although no relationship was found between physical fitness and academic achievement among officer aircrew, it is important to note the lifelong benefits from engaging in regular fitness such as reduced risk of chronic diseases such as cardiovascular diseases, colon and breast cancer, arthritis, and diabetes (Stroth et al., 2010). The current body of literature on the relationship of fitness to academic performance among adults, along with the findings of this study are inconclusive; the most promising areas for further research are aerobic fitness in relation to academic achievement and cognitive performance among adolescents and adults over 60 years of age. Lastly, research beyond correlational and predictive studies is needed to better assess the relationship between physical fitness and academic achievement.

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APPENDICES

APPENDIX A: IRB Letter

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

July 17, 2018

Michael Lopez
IRB Exemption 3268.071718: The Effects of Physical Fitness on Academic Achievement among Bomber Aircrew

Dear Michael Lopez,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under exemption category 46.101(b)(2), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:101(b):

> (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
> (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Please note that this exemption only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

[redacted]

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
The Graduate School

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APPENDIX B: Recruitment Letter

THE RELATIONSHIP BETWEEN PHYSICAL FITNESS FACTORS AND ACADEMIC SKILLS IN FLIGHT OFFICERS IN THE UNITED STATES AIR FORCE

20 June 18

Recruitment Letter:

Dear Potential Aircrew Study Participant;

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree in education. The purpose of my research is to generate knowledge regarding the relationship of personal fitness and academic skills among military personnel, especially flight officers. I am writing to invite you to participate in my study.

If you are 22-50 years old, a current Air Force Aircrew member with a current physical fitness score and are willing to participate; you are eligible to participate in this study.

You will be asked to complete both Wechsler Fundamentals: Academic Skills Numerical Operations Assessment and the data collection during the same test period. Estimated time of completion for the entire process will be less than 35 minutes. Your participation will be anonymous, no personal, identifying information will be collected.

To participate, complete the attached data collection form and the Wechsler Fundamentals: Academic Skills Numerical Operations Assessment, and physically place them in the bin located in the front of the room labeled “return forms”. The researcher will be serving as the proctor.

A consent document will be attached to the assessment, and contains additional information about my research. Please read the consent document before completing the assessment. You do not need to sign and return the consent document to me.

Sincerely,

Michael Lopez,

APPENDIX C: Consent Form

The Liberty University Institutional
Review Board has approved
this document for use from
7/17/2018 to --
Protocol # 3268.071718

CONSENT FORM

THE EFFECTS OF PHYSICAL FITNESS ON ACADEMIC ACHIEVEMENT AMONG BOMBER AIRCREW

Michael Lopez
Liberty University
School of Education

You are invited to be in a research study of how physical fitness effects academic achievement among bomber aircrew. You were selected as a possible participant because of your aircrew qualification, current physical fitness score and age (22-50 years of age). Please read this form and ask any questions you may have before agreeing to be in the study.

Michael Lopez, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is research, how well does physical fitness measures (cardiovascular, muscular, and body composition) predict academic achievement for bomber aircrew?

Procedures: If you agree to be in this study, I would ask you to do the following things:

1. Fill out the written data collection form. It will take approximately 5 minutes.
2. Take the Wechsler Fundamentals: Academic Skills Numerical Operations Assessment. It will take approximately 30 minutes to complete.

Risks and Benefits of being in the Study: The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Participants should not expect to receive a direct benefit from taking part in this study.

Benefits to society include having a better understanding of the relationship between physical fitness and academic achievement among adults.

Compensation: Participants will not be compensated for participating in this study.

Confidentiality: The records of this study will be kept private. Research records will be stored securely, and only the researcher will have access to the records.

- Participant responses will remain anonymous.
- All research data will be kept under lock and key in a filing cabinet. After three years, all data will be destroyed or erased.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University or USAF. If you decide to participate, you are free to not answer any question or withdraw at any time, prior to submitting your assessments, without affecting those relationships.

APPENDIX D: Air Force Physical Fitness Scoring Chart Example

https://static.e-publishing.af.mil/production/1/af_a1/publication/afi36-2905/afi36-2905.pdf

APPENDIX E: Data Collection Form

1. Please choose the answer that best describes you.

A. _Male _Female

B. _ Pilot _ WSO _EWO

2. What is your current age? ___

3. What was your undergraduate cumulative grade point average? ___

4. Fill in your Air Force Physical Fitness Scores & Raw data from your last exam.

___ Push Ups

___ Sit Ups

___ Waste Measurement

___ 1.5 Mile Run

__ Total