A WOMEN-ONLY COMPARISON OF THE U.S. AIR FORCE FITNESS TEST AND THE MARINE COMBAT FITNESS TEST

THESIS

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Abstract

In 2009, Captain Thomas Worden determined the Air Force Physical Fitness Test (AFPFT) poorly predicted combat capability for his 86 study participants. With only 5 of these 86 volunteers being women, this limited Worden's findings to primarily men. This follow-on research investigated whether these results carried over to women.

We recruited 61 female volunteers and compared their performance on the AFPFT to the Marine Combat Fitness Test, the proxy for combat capability. Like Worden's research, we discovered little association between the two (R^2 of 0.161). However, this association significantly increased (adj R^2 of 0.572) when utilizing the raw scores of the AFPFT instead of using the scoring tables.

Improving upon these associations, we built multiple regression models using Ordinary Least Squares. Similar to Capt Worden's mostly male-study we arrived at comparable conclusions. The best two-event model for combat fitness capability incorporates a half-mile run and 30-lb ammunition-can lifts (adj R^2 of 0.864) and the best three event model adds a Maneuver Under Fire (adj R^2 of 0.91). By adopting either model, we greatly improve the Air Force's ability to assess combat capability for women.

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Tarah D. Mitchell

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A WOMEN-ONLY COMPARISON OF THE U.S. AIR FORCE FITNESS TEST AND THE MARINE COMBAT FITNESS TEST

I. Introduction

Problem Statement

The objective of this research is to identify the fitness components necessary for performance in a combat environment and determine whether the Air Force Physical Fitness Test (PFT) evaluates Airmen sufficiently enough in these areas. The current Air Force PFT sets the baseline standard of fitness for airman and evaluates member's state of physical health. What is unknown, however, is whether the test satisfactorily evaluates member's physical combat readiness in the battlefield.

Both the U.S. Army and U.S. Marines modified their existing physical training programs and incorporated, or are in the process of incorporating, additional physical fitness tests, which assess member's physical combat readiness. The revamped programs emphasize speed, agility, and plyometric exercises and incorporate combat tests to assess member's strength in these components. Troops returning from the war zone who faced combat situations first hand provided feedback, which led to the creation of these assessments. They serve to evaluate troops' readiness for ground combat and complement the service's existing baseline fitness tests.

In March 2009, USAF Captain Thomas E. Worden published a thesis titled *A Comparison of the US Air Force Fitness Test and Sister Services' Combat-Oriented Fitness Tests*, which served to determine whether the Air Force PFT could evaluate combat readiness in Air Force personnel. From his research, he concluded "AFPFT scores had minimal predictability (R^2 of 0.215)"and a "higher body mass index (BMI) predicts higher combat capability (p-value of 0.021)" (Worden, 2009). Out of the 86 USAF members participating in this research, only 5 of these members were female highlighting a disparity in the number of women participants. As a result, he could not infer back to the general Air Force population with respect to women's performance. In addition, the 5 females had higher average USAF PT scores (96.8) compared to the men (90.1). Not having a more representative spread of AFPFT scores within the female sample prevented further deducible statistical analysis for combat capability. This follow-on research serves to engage a larger sample of the USAF female population with a wider range of PT scores allowing for a better analysis of the combat fitness of women in the Air Force.

The research in this study consists of performance data on each event in the Air Force PFT as well as each event in the Marine Combat Fitness Test (MCFT). Additional data variables include age, height, and weight. Using this data, we perform simple linear and multiple regression analyses to determine the likelihood of Air Force PFT event scores predicting combat readiness using the MCFT scores as our combat diagnostic. We also perform Analysis of Variance (ANOVA), and contingency table testing analysis on subject's scores on each test and determine if dependencies exist. Using this analysis, one can determine if modifications to the current Air Force physical fitness test would improve the evaluation of combat readiness within Air Force personnel.

Background

The fitness culture of the Air Force ever-evolves with the most recent modernization being the "Fit to Fight" program. Each fitness evolution responds to the changing wartime environment. Today the wartime environment consists of airmen deploying to locations and in capacities never encountered before in combat. "In-Lieu-Of" (ILO) taskings or Joint Expeditionary Taskings (JET) permit Airmen to serve alongside and even augment sister service members in front line combat roles. All career fields within the Air Force remain susceptible to these taskings. Because these deployments often require personnel at short notice, all Airmen should receive physical training for a combat environment; members not adequately prepared can put themselves and their unit members in danger.

As a result of the shifting combat environment, both the Army and Marine Corps adapted their fitness conditioning programs to better prepare their personnel for ground combat. The Army implemented a Physical Readiness Training (PRT) program in 2010 incorporating more robust and combat-ability workouts into the Army fitness program. Within the PRT program are two new assessments - the semi-annual Army Physical Readiness Test (APRT) and the semi-annual Army Combat Readiness Test (ACRT) – which will replace the current Army physical fitness test. The Army began pilot testing in 2011 for both tests and works to establish gender and age specific standards. The Marine Corps employed the annual Combat Fitness Test in 2008 in response to fitness leadership requesting an assessment more depictive of a combat environment. This 3-event test evaluates anaerobic ability and endurance components necessary while in a war zone.

The goal of this research includes determining if the Air Force PFT can predict combat capability in our troops and whether the alteration of the PFT is necessary in the evolving state of war. In pursuing this goal, we compare the fitness programs of the Air Force and Marine Corps, evaluate what components of fitness each assessment seeks to test, and determine whether the performance of these components is enough to achieve combat readiness. We also determine what fitness testing events best correlate with combat performance-based fitness in attempts to better train and equip our troops for the changing demands of warfare.

Scope of the Study

The scope of this study involves testing Air Force women stationed at Wright-Patterson Air Force Base (WPAFB) on the MCFT. The associate investigator obtained recent Air Force fitness test results from the members including height, weight, and age data. Using these results, the author performed an analysis of fitness performance events within each test, along with the variable data. We test the research hypothesis below to determine the AFPFT's predictability with regards to combat performance-based fitness.

Research Hypothesis

Null Hypothesis (H_O): The Air Force Physical Fitness Test is not predictive of combat capability within Air Force personnel

Alternate Hypothesis (H_A): At least one event within the Air Force Physical Fitness Test is predictive of combat capability within Air Force personnel

Investigative Questions

1. Does performance among peers on the Air Force PFT indicate how one will perform relative to peers on the Marine Combat Fitness Test?
2. Can modification to the AFPFT scoring mechanism result in better prediction of combat readiness in Air Force personnel? Will completely removing any of the PFT components provide a better assessment of combat capability?
3. Are any of the events within the Air Force PFT and MCFT, better than others with regard to predicting combat performance-based fitness?

> Are there significantly predictive events volunteers took during the … Marine Combat Fitness Test that when included in our Air Force test, or used to replace a less predictive event on the Air Force test, can push that predictability mark even higher? (Worden, 2009:48)

4. Do variable dependencies exist between events within the Air Force PFT or MCFT and combat readiness?
5. Does Abdominal Circumference or BMI suggest predictability of combat capability? Do any similarities exist in this predictability?

Chapter Summary

The primary objective in this research involves determining the Air Force fitness test's predictability of combat fitness and whether measures within the Air Force PFT require modification to increase this predictability further. This research builds on the thesis, *A Comparison of the US Air Force Fitness Test and Sister Services' Combat-Oriented Fitness Tests*, by Captain Worden (2009) and serves to incorporate similar ideology and comparable methodologies. The next chapter reviews applicable literature on the components of physical fitness, the concept of total force fitness, general fitness versus combat fitness programs within the military environment, and how these programs changed in response to an evolving war environment.

II. Literature Review

Chapter Overview

This chapter begins with an evaluation of literature explaining physical preparedness and fitness of military members and how this relates to the concept of total force fitness. The review details how the ever changing mission within the military impacts physical conditioning of service members. The chapter goes on to discuss general fitness and combat fitness programs within the military environment and the physical capabilities thought to characterize each type of fitness. This review concludes with an evaluation of the Air Force physical fitness test and whether the test needs modification to better prepare Airman for the combat environment.

Components of Physical Preparedness and Fitness of Military Members

Members of the Armed Forces play a significant role in the safety and well being of U.S. citizens. This level of defense requires the military to have a high degree of physical preparedness in order to successfully support this nation. Previous war engagements remind military leadership how vital physical readiness is to the security of our nation. Army Field Manual (FM) 21-20 reads:

> On 5 July 1950, U.S. troops, who were unprepared for the physical demands of war, were sent to battle. The early days of the Korean war were nothing short of disastrous, as U.S. soldiers were routed by a poorly equipped, but well-trained, North Korean People's Army. As American soldiers withdrew, they left behind wounded comrades and valuable equipment (because) their training had not adequately prepared them to carry heavy loads. (Department of the Army, 1998:iii)

The lessons from the Korean War are as important today as they were then. Military members must adapt to different situations, environments, and enemies. As a result, military branches create physical training programs, which prepare troops for the rigors of a war environment. The guidance of the physical training program differs depending on the mission of each individual branch, however, the objective of all focuses on the components of physical fitness.

Components of Physical Fitness

The components of physical fitness include muscular strength, cardiovascular fitness, muscular endurance, flexibility, and body composition. Muscular strength characterizes a muscle's ability to exert force against a resistance. High weight, low repetition dumbbell training and barbell lifting are examples of muscular strength exercises. Cardiovascular fitness or endurance develops through aerobic training and depends on the body's ability to deliver and utilize oxygen and nutrients by the tissues and to remove wastes (ABC of Fitness, 2011:n. pag.). Basketball, running, and swimming are all examples of cardiovascular activity.

Muscular endurance involves a muscle's ability to accomplish a task multiple times (Roy, Springer, McNulty, and Butler, 2010:15). An example of an endurance training exercise includes low weight, high repetition dumbbell training. Flexibility training enables a military member to increase their range of motion about a joint and may allow them to perform physical tasks with decreased likelihood of injury. Static or motionless stretches held for 10-30 seconds after a workout session serve as effective flexibility exercises. Body composition is the lean body mass to fat ratio in the body (ABC of Fitness, 2011:n. pag.). The National Heart Lung and Blood Institute, within the National Institutes of Health, classifies an underweight BMI as less than 18.5, a normal

BMI between 18.5 and 24.9, an overweight BMI between 25 and 29.9, and an obese BMI as greater than 30 (National Heart Lung and Blood Institute, 2011:n. pag.). Tools physicians use to measure one's body composition include calipers, bioelectrical impedance analysis, and water displacement plethysmography (Halls, 2003:n. pag.). These tools prove more accurate than bodyweight alone or body mass indices (ratio of height and weight), because they better estimate the contribution of fat to the total body mass.

While fitness specialists consider muscular strength, cardiovascular fitness, muscular endurance, flexibility, and body composition as the primary components of physical fitness, the journal *Military Medicine* references mobility as an additional component necessary for service members. "Mobility is the ability to move the body in space with the precision necessary to negotiate an obstacle" (Roy, Springer, McNulty, and Butler, 2010:15). Mobility training includes anaerobic exercises targeting one's speed, agility, and balance. Plyometric, jumping and directional change drills, and sprint training exercises are examples of mobility training. Military members should implement all of these components of fitness within their respective physical training programs in order to accomplish mission tasks. Including all of these elements in a fitness program better prepares a service member for the physical and psychological stresses of war. Deficiency in any of these areas can put a military member's life, and ultimately his unit members' lives, in jeopardy.

Standardized Tests

Standardized physical tests measure a member's capability in select components of physical fitness. "The results of physical tests constitute the main criteria of the positive annual evaluation of the military" (Plavina, 2007:237). While these military tests do not test all fitness components, the tests do measure to some degree muscular endurance and to a lesser degree strength and power with push-ups, pull-ups, a flexed arm hang, sit-ups and cardiovascular endurance with a distance run. The Air Force semi-annual physical fitness test (PFT) consists of the following: 1 minute timed push-ups, 1 minute timed sit-ups, a 1.5 mile timed run, and a waist measurement. The Army semi-annual test consists of 2 minute timed push-ups, 2 minute timed sit-ups, and a 2 mile timed run. The Navy semi-annual PFT consists of the following: 2 minute timed push-ups, 2 minute timed curl-ups, and a 1.5 mile timed run. The Marine Corps is currently the only branch with two fitness evaluations, the PFT and the Combat Fitness Test. The semi-annual physical fitness test consists of a 2 minute timed abdominal crunch, pulls-ups (for men), a flexed arm hang (for women), and a 3 mile timed run. The annual MCFT consists of three events – 880 yard run, 2 minute timed ammo can lift, and a 300 yard timed obstacle course. The combat test serves to complement the branch's existing physical fitness test and measures members' ability to complete tasks similar to those in a combat environment (Roy, Springer, McNulty, and Butler, 2010:15).

Because military leadership are to "ensure that physical fitness testing does not form the foundation of unit physical…testing (training) programs", an effective standardized test would include all components of physical fitness (Department of the Army, 2010:A-1). Testers could evaluate components individually or in an obstacle course format similar to the MCFT. With no military branch exempt from the ground combat environment, all members of the armed forces should require evaluation of combat environment readiness. This will enable the U.S. to have not only a physically stellar force, but also the most adaptable military in the world.

Total Force Fitness

Having an above average level of physical fitness is an important part of a service member's total well-being, but physical fitness is not the only component of health requiring attention. The components of psychological, behavioral, medical, nutritional, spiritual, social, and physical health make up total force fitness (Rounds, 2010:124). Each category depends on the others and together affects the total health of a service member. Poor nutritional health influences one's medical and physical components. Unstable psychological health affects behavioral and social skills. Military leadership use force fitness as a measurement tool in evaluating total combat readiness in troops.

As the military continues to engage in conflicts overseas, leadership gives more attention to psychological and behavioral health issues such as post-traumatic stress disorder and anxiety. These issues are often harder to diagnose and treat relative to obvious physical injuries. As a result, the Department of Defense (DoD) provides guidance under the DoD Directive (DoDD) 6200.04 titled *Force Health Protection*, which addresses many components within total force fitness. The directive states, "Commanders, supervisors, individual Service members, and the Military Health System shall promote, improve, conserve, and restore the physical and mental well being of members of the Armed Forces…" (Department of Defense, 2004:2).

In addition, the DoDD 1010.10 titled *Health Promotion and Disease/Injury Prevention* establishes guidelines for the DoD to implement health promotion, disease and injury prevention programs, and improve military readiness including the health, fitness, and quality of life for military personnel (Land, 2010:4). With directives such as DoDD 6200.04 and DoDD 101.10, the government works to improve total force fitness among service members, but challenges remain.

> Leadership at all levels of the military recognize the challenge of total force fitness, to identify its key elements, to describe how they interact, and to select validated and relevant outcome measures to assess achievement in each domain and in totality. (Walter, Coulter, Hilton, Adler, Bliese, and Nicholas, 2010:104)

Only when DoD leadership works to address total force fitness among service members can they address these challenges. Our service members must be mentally, psychologically, and physically ready for the war zone. Only through total force fitness initiatives can we ensure this preparation occurs.

The Evolving Mission's Impact on Service Members

In 2004, Air Force Chief of Staff General John P. Jumper stated "The amount of energy we devote to our fitness program is not consistent with the growing demand of our warrior culture. It's time to change that" (Callander, 2004:70). As a result, Air Force leadership built the Fit to Fight program, rejuvenating the Air Force fitness program into what the program is today. Currently, the Air Force PFT consists of push-ups, sit-ups, a 1.5 mile run, and a waist circumference measurement. While this test is a significant change from the sub-maximal cycle ergometry test from years ago, the test does not correlate with the warrior culture General Jumper mentions in his speech.

Today our military fights a type of war never encountered before in any previous combat engagements. Our armed forces should be total force fit to adapt to the evolving DoD wartime mission.

> In Vietnam, the Communists waged a classic, peasant based, centrally directed, three-stage, Maoist model insurgency, culminating in a conventional military victory. In Iraq, small, scattered, and disparate groups wage a much smaller-scale war of ambushes, assassinations, car bombings, and sabotage against U.S. and other coalition forces and reconstruction targets. (Record and Terrill, 2004:2)

While the U.S. military aim of global supremacy remains the same in both theaters, the strategic and physical demands are different.

Because every combat environment differs and the enemy is changing, our military must adapt. The roles once thought to characterize each military branch do not apply anymore. Air Force personnel are not the only service members flying planes. The Army and Marine Corps are not the only troops serving on the ground. “In-Lieu-Of” (ILO) or Joint Expeditionary Taskings (JET) bring more Air Force personnel to the front lines of combat.

> The sustained asymmetrical warfare against an elusive insurgency, which characterizes Operations Iraqi Freedom and Enduring Freedom has changed much of the way the Air Force experiences warfare and widened the pool of airmen who experience direct combat conditions. (Walter, Coulter, Hilton, Adler, Bliese, Nicholas, 2010: 104)

The changing combat landscape requires a different approach and readiness culture in order to defeat our opponents.

Today, more Airmen serve on the battlefield than ever before and no career field is exempt. Finance servicemen must be ready to fight while transporting cash outside the wire. Medical members stand equipped to administer care to wounded troops in hostile territory. “With the war in Afghanistan continuing for at least the next three years…there will be little letup for the Air Force's mission overseas" (Fontaine, 2011:2). The DoD consistently tasks Air Force men and women to serve alongside their Army and Marine brothers in arms via ILO taskings. According to the Officer-In-Charge at the WPAFB Installation Personnel Readiness unit:

> Since 1-Feb-2010, there have been 55 JET taskings from WPAFB (out of 1,415 total). There were 19 JET taskings in all of 2010, 30 in 2011, and so far there are 6 scheduled for 2012. Out of the 55, 6 were from the Communications Sq, 17 from the Med Group, and 21 from (National Air and Space Intelligence Center) NASIC. The rest were various units from around base, I would say not particularly combat specific. (Griffin, 2012:n. pag.)

With the prevalence of these combat-focused deployments, Air Force members must go beyond traditional roles of the past and concede to a "warrior culture" mentality.

Given the war of today differs from previous engagements, we must change how we physically prepare our troops. Military fitness programs should be more performance and mission-task based. *Military Medicine* refers to this mission-oriented philosophy as the specificity of training (Roy, Springer, McNulty, and Butler, 2010:14).

> …to march long distances with full pack, weapons, and ammunition through rugged country and to fight effectively upon arriving at the area of combat…to make assaults and to run and crawl for long distances; to jump in and out of foxholes, craters, and trenches, and over obstacles; to lift and carry heavy objects; to keep going for many hours without sleep or rest – all these activities of warfare and many others require superbly conditioned troops. (Roy, Springer, McNulty, and Butler, 2010:15)

These tasks require the following fitness components: mobility, muscular strength and endurance, flexibility, and cardiovascular endurance. In addition to these direct combat requirements, troops should expect to move equipment, set-up base camps, and operate mission essential equipment. This requires the physical fitness components of muscular strength and endurance. As a result, physical conditioning programs and tests should evaluate member's abilities on these fitness components.

We must learn to train as we fight and embrace the "Fit to Fight" mentality completely. Because no career field is exempt from the rigors of war and short notice deployments are not out of the ordinary, all must prepare for the stresses of combat. In the June 9th, 2008 issue of the *Air Force Times*, physical training leaders discuss the need for combat fitness components within Air Force PT testing. The March 7th, 2010 is of the *Air Force Times* discusses how the momentum for the Air Force to add a combat element in testing has come mostly from Airmen returning from deployments whom directly experienced the combat environment. "The performance measurements of yesteryear are outdated and irrelevant for modern warfare" (Fontaine, 2011:3).

Readiness Training Initiatives

The primary battlefield careers in the Air Force include the following: combat rescue officer, special tactics officer, air liaison officer, para-rescue jumper, combat controller, Tactical Air Control Party (TACP), explosive ordinance disposal, and enlisted and officer special operations weather technician (Tan, 2011:n. pag.). Because of the high demand and stress level for these airmen, many of these positions are vacant; thus, directly jeopardizing the mission. As a result, other career field personnel must step in to fill these roles. While many initiatives have come about to prepare career-specific airmen for the combat environment, this does not allow all airmen to embrace the warrior culture.

The TACP preparatory course is one initiative preparing battlefield service members for the war zone. Students attending this course push their limits in a 5 day grueling course, helping to prepare them for further technical training.

> Since the first class in March (2010), the TACP Preparatory Course has already contributed to a significant decrease in attrition when students get to technical training at Hurlburt Field. The schoolhouse attrition has dropped from about 50 percent to about 30 percent, said Master Sgt. Dave Clark, the course chief for the TACP Preparatory Course. (Tan, 2011:n. pag.)

Threat Management Group (TMG) training is an initiative serving to train members outside of the primary battlefield careers. Former explosive ordinance device expert Brandon Cox began the program in 2004 in hopes to prepare personnel "whose respective branch of service didn't have the resources or time to train in explosives recognition, hand-to-hand defensive combat and close-quarter combat" (Walker, 2010:n. pag.). Cox states "Prior to the wars in Iraq and Afghanistan, non-combat personnel didn't see combat. But now, even a bus driver may be put on the front lines" (Walker, 2010:n. pag.). TMG trains the troops to a standard, not a time; therefore, only personnel mastering the material pass the course. TMG training provides non-battlefield career personnel with the skills necessary to fight in a combat environment effectively and return home safely.

Another initiative the Air Force uses to prepare Airmen for battle is the Battlefield Airmen Technical Training Liaison Element (BATTLE). This course brings together airmen from each battlefield career along with a medic, athletic coach, and swim coach to mentor and train Basic Military Training (BMT) trainees on what they can experience in a combat environment. BATTLE training involves all career fields and assists in mentally and physically preparing airmen for the war zone.

While this initiative benefits new airmen, BATTLE training does not continue past BMT. As a result, airmen forget lessons learned and neglect combat-focused physical training upon entering the normal duty environment. This can put our airmen at risk if they receive a short notice tasker in a combat role post BATTLE training. Continued hands on education and physical training would assist in keeping airmen ready. Because the Air Force does not mandate this type of physical and mental training for non career-specific airmen, some troops volunteer for the training on their own.

Each year, more and more Airmen volunteer to take Army-taught classes with their sister services. “Since 2009, the total has increased from roughly 9,200 to more than 10,700. For Airborne School alone, the Air Force has requested 1,950 slots in the past three years — 750 in 2009, 600 in 2010 and 600 in 2011” (Ricks, 2011:1). Ranger, airborne, sniper, and air assault school are just a few of the programs offered through volunteer inter-service training. These programs allow service members to learn beyond their core career and earn battlefield career badges.

Staff Sergeant Brett Lafreniere sums up the value of the training -“There is a leadership value in working alongside the Army, earning a badge that the Army earns…they see us stepping out of our role — it shows that we’re willing to work right alongside them and that we’re able to be more effective in the mission” (Ricks, 2011:1). This training allows airmen to learn and compete with soldiers. This type of inter-service training allows members to work more effectively together in future joint assignments. Inter-service training also allows military members to dispel stereotypes typically associated with individual branches.

General Fitness and Combat Fitness Programs in the Military

> The U.S. Department of Health and Human Services separates physical fitness into two categories: health-related fitness and performance-related fitness…health-related fitness is the amount of physical training required to reduce the risk of disease, while performance fitness is the amount of physical training required to achieve a performance goal. (Roy, Springer, McNulty, and Butler, 2010:14)

Physical goals such as sprinting into a bunker or carrying an injured comrade out of harm's way are a few tasks military members expect to perform. Tax payers insist on military members being in stellar physical shape because service member's jobs involve protecting the lives of American citizens, therefore, service men and women should implement performance-related training into their regular physical fitness program.

The physical fitness tests within the Air Force, Army, Navy, and Marines serve as fitness baseline and health-related fitness tests:

> "The Fitness Assessment provides commanders with a tool to assist in the determination of overall fitness of their military personnel…overall fitness is directly related to health risk, including risk of disease and death" (Department of the Air Force, 2010:6-18).

> "Physical fitness testing is designed to ensure the maintenance of a base level of physical fitness essential for every Soldier, regardless of Army MOS or duty assignment" (Department of the Army, 2010:A-1).

> "All Navy AC and RC personnel shall meet minimum physical fitness standards for continued naval service" (Department of the Navy, 2011:2).

> "The PFT is a collective measure of general fitness Marine Corps-wide" (Department of the Navy, 2008:2-1).

Members in shape for these tests are at a lower risk for health problems and injuries versus out of shape members. These tests assist in not only keeping members healthy, but also are thought to reduce health and medical costs to the DoD. If these members are unhealthy, they will be unfit to perform their military duties.

Air Force

The Air Force Instruction (AFI) 36-2905 serves as the fitness program guidance for all members of the U.S. Air Force. This AFI details the fitness test procedures, elements of a physical training program, and exemption procedures. Under the Commander's Intent heading of the Air Force AFI36-2905 states:

> Being physically fit allows you to properly support the Air Force mission. The goal of the Fitness Program (FP) is to motivate all members to participate in a year-round physical conditioning program that emphasizes total fitness, to include proper aerobic conditioning, strength/flexibility training, and healthy eating. Health benefits from an active lifestyle will increase productivity, optimize health, and decrease absenteeism while maintaining a higher level of readiness. (Department of the Air Force, 2010:6)

This intent mentions the purpose of the Air Force fitness program as one to promote year round wellness and health. What the impact statement does not acknowledge, however, is the FP's role in regards to training airmen for the current global engagement. While health-related fitness is vital in the overall well-being of our troops, a solid performance based fitness program will ensure our troops achieve success in the war zone.

The components of the Air Force physical fitness test serve to determine one's aerobic fitness, body composition, and to some degree muscular fitness levels for chosen muscle groups, but do not evaluate absolute muscular strength, flexibility, or mobility. "Health and readiness benefits increase as aerobic fitness and body composition and muscular fitness improve with increases in physical activity" (Department of the Air Force, 2010:18). The Air Force PFT 1.5 mile timed run correlates with aerobic fitness. Members exempt from performing this component, due to medical injury, perform a 1 mile timed walk instead. The waist measurement component correlates with body composition; however, the event correlates more accurately with visceral adiposity (internal fat) as opposed to over all body fat. The 1 minute timed push-ups and 1 minute timed sit-ups correlate with muscular fitness or endurance. The standards for each component vary based on gender and age. In 2010, the Department of the Air Force established the Fitness Assessment Cell to conduct fitness assessments for all Air Force members and to encourage standardization in testing. All Airmen complete the PFT with the exception of deployed, pregnant, or medically exempt personnel.

While the Air Force physical fitness test evaluates members' muscular endurance, body composition, and cardiovascular endurance, the test only tangentially measures muscular strength and does not measure flexibility, or mobility at all. There is currently no fitness test or evaluation in place to measure members aptitude in these components within the Air Force for all personnel. Currently, Air Force leadership expects the physical training leaders (PTLs) to implement these components within their unit fitness programs, but not all PTLs do so. As a result, members not engaging in an effective conditioning regiment will be deficient in these fitness areas.

Army

The Army FM 21-20 details the fitness guidance for members of the U.S. Army. This manual devotes chapters solely to nutrition, the components of physical fitness, the fitness test procedures, and sample exercise programs. The Army FM 21-20, states the following as the objective of the Army Physical Fitness Test (APFT): "… the APFT is a three-event physical performance test used to assess muscular endurance and cardio respiratory fitness…Performance on the APFT is strongly linked to the soldier's fitness level and his ability to do fitness-related tasks" (Department of the Army, 1998:14-1).

The APFT consists of 2 minute timed push-ups, 2 minute timed sit-ups, and a 2 mile timed run. While these test elements support health-related benefits of their physical training program, they do not evaluate all components of physical fitness.

The manual goes on to state:

> While the APFT testing is an important tool in determining the physical readiness of individual soldiers and units, it should not be the sole basis for the unit's physical fitness training. Commanders at every level must ensure that fitness training is designed to develop physical abilities in a balanced way, not just to help soldiers do well on the APFT. (Department of the Army, 1998:14-1)

This statement further supports the need for performance-related fitness. Because Army troops support ground combat, they should perform above average, in comparison to a member of the general population, in all components of physical fitness. A soldier lacking strength in one of the components can put his unit member's lives in danger. As a result, Army fitness leadership advocates combat-related fitness training within unit-level fitness programs.

Since 1999, the Army started looking at ways to modify the existing Army Physical Fitness Test (APFT) to include more combat-preparation components. Effective March 2010, the Army implemented a Physical Readiness Training (PRT) program which incorporates more total body and combat-based workouts into the Army fitness program. In February 2011, the Army publicized the proposal of two new fitness tests, the Army Physical Readiness Test (APRT) and the Army Combat Readiness Test (ACRT) to replace the current Army physical fitness test.

The APRT "expands from three to five events, eliminates sit-ups, increases the pace of push-ups, and replaces the long-distance run with shorter faster runs. The five events include: 60 yard shuttle run, one-minute rower (variation of sit-ups), standing long jump, one-minute push-up, 1.5 mile run" (Army PRT, 2011:2). The ACRT serves to "provide a more accurate picture of a Soldier's ability to perform Warrior Tasks and Battle Drills" (Army PRT, 2011:2). The members will perform the ACRT wearing Army battle gear including helmet and uniform and carry a weapon. The test includes the following events: 400 meter run, hurdles, high crawl, casualty drag, sprints, and several other movement drills. All members, regardless of career specialty, will take this fitness test.

Lieutenant General Mark Hertling, deputy commanding general for initial military training briefed the components of the new tests to Army Chief of Staff General George Casey in February 2011. In the briefing he states:

> The current (Army physical fitness) test is not a strong predictor of successful physical performance on the battlefield or in full-spectrum operations because it does not adequately measure components of strength, endurance or mobility. It instead provides 'only a snapshot' assessment of upper- and lower-body muscular endurance and fails to identify anaerobic capacity." (Bacon, 2011:n. pag.)

Because of this deficiency in the Army's PFT, the APRT and ACRT serve to evaluate soldiers on strength, endurance, and mobility components. The Army began pilot testing last year for both tests and is currently establishing gender and age specific standards. "The new tests could be adopted Army-wide as early as October (2011)" states Lt. Gen. Hertling (McIlvainel, 2011:27).

Navy

Under the Discussion heading of the U.S. Navy Naval Operations (OPNAV) Instruction 6110.1J Fitness Program document reads the following:

> It has become increasingly important for all Navy personnel to maintain a minimum prescribed level of physical fitness necessary for world-wide deployment, whenever or wherever needed…the Navy utilizes a holistic approach

> to overall wellness via exercise, nutrition, weight control, tobacco cessation, prevention of alcohol abuse, and health and wellness education. (Department of the Navy, 2011:2)

While this minimum level of physical fitness may be satisfactory for general fitness, the minimum is unsatisfactory for combat or performance-related fitness. The OPNAV 6110.1J directs Navy personnel to participate in moderate activity at least 150 minutes a week and perform strength training exercises twice a week with all major muscle groups. Seamen participate in a semi-annual physical fitness assessment including a medical screening and body composition assessment held in conjunction with the semi-annual PFT.

The Navy semi-annual physical fitness test consists of the following: 2 minute timed push-ups, 2 minute timed curl-ups, and a 1.5 mile timed run. Consistent with the Air Force and Army physical fitness documents, the OPNAV 6110.1J advocates consistent physical training, not just in preparation for the annual fitness evaluation. Exemption procedures are in place for those members unable to perform any, or all, of the test components due to medical injury, pregnancy, or deployment status. Procedures are not in place, however, detailing how Navy members can better prepare for mission-related duties.

Marine Corps

Marine Corps Order (MCO) P6100.12 outlines the Marine Corps fitness training program:

> Every Marine must be physically fit, regardless of age, grade, or duty assignment. Fitness is essential to the day-to-day effectiveness and combat readiness of the Marine Corps…The habits of self-discipline required to gain and maintain a high level of physical fitness are inherent to the Marine Corps way of life and must be a part of the character of every Marine. Marines who are not physically fit can be

> a detriment to the readiness and combat efficiency of their unit. (Department of the Navy, 2002:1-3)

This manual details the administering procedures for the Marine Physical Fitness test, body composition program policies, and remedial program policies. The document outlines specific components necessary in Commander's physical training programs: general strength training, performance-specific strength training, aerobic endurance, anaerobic endurance, and mobility. The Marine Corps semi-annual physical fitness test consists of a 2 minute timed abdominal crunch, pulls-ups (for men), a flexed arm hang (for women), and a 3 mile timed run.

The Marine Corps is currently the only branch to evaluate the mobility and muscular strength of Marines with the Combat Fitness Test. The MCFT is a response to fitness leadership requesting a test more accurately depicting the stressors of a war zone. In 2008, the Marine Corps created the MCFT which serves to accomplish this objective. "The MCFT was specifically designed to evaluate strength, stamina, agility and coordination as well as overall anaerobic capacity" (Department of the Navy, 2008:3-1).

The Marine Combat Fitness Test has three events. The first is an 880 yard run (1/2 mile) known as Movement to Contact (MTC). The goal is to complete the ½ mile run in the shortest time possible. The second event is the 30 lb. lift, known as the Ammunition Can Lift (AL), where members lift an ammo can from chest height to above head level with arms extended. Members repeat this action for as many repetitions as possible within a 2 minute time span. The final event is a 300 yard obstacle course, known as Maneuver Under Fire (MANUF) course.

The MANUF includes running, high crawling, running with ammunition cans, throwing a mock-grenade, and moving a mock casualty. The mock casualty is another Marine weighing “within 10 lbs.” of the testing member and “within 6 inches” of the testing member’s height (Department of the Navy, 2008:3-4). The MANUF begins with a Marine completing the first four legs: a sprint ending with a forward facing clockwise turn (J hook) around a cone, a high crawl, a modified high-crawl on hands and knees, and a zigzag run through pre-positioned cones. The member then picks up the mock casualty into an underarm carry, drags the casualty through two cones covering about 10 yards, lifting the casualty into a fireman’s carry, and running back to the start line before placing the casualty back onto the ground.

Afterwards, the Marine lifts two 30 lb. ammo cans and runs in zigzag fashion through pre-positioned cones while still carrying the cans. Then the member places the weights down and picks up a mock-grenade, throws the grenade toward a target space about 22.5 yards away, and drops to the ground to perform 3 push-ups. “Five seconds will be deducted from the overall MANUF time for (grenade) hits and five seconds will be added to the overall MANUF time for (grenade) misses” (Department of the Navy, 2008:3-6). After getting back up from push-up position and re-lifting the two 30 lb. cans, participants run another zigzag leg with the weights, and the final 2 legs straight to the finish line.

“‘It’s looking at burst speed and anaerobic ability,’ said Lt. Col. John Armellino, one of the Marines helping to develop the new CFT for Training and Education Command in Quantico, Va. ‘The commandant wanted to develop a better measure of overall fitness, to better prepare the Marines for combat’” (Tilghman, 2008:1). All members, regardless of career specialty take this fitness test. The Marines Corps performs this test as a result of the evolving wartime mission requiring a new method of physical fitness preparation.

While baseline fitness testing is important in keeping our troops healthy, performance-related fitness keeps our troops alive in combat. Variations in the mission and demands of war require us to adjust physical training accordingly. Only with specificity of training are members of the armed forces prepared to encounter the changing enemy. Besides baseline fitness, we need to implement other fitness training characterizing special military physical preparedness: speed, force, adroitness, flexibility, and the characteristics of physical tolerance (Plavina, 2007:237). Without this incorporation, the lives of our armed forces and the DoD mission remain vulnerable.

Combat Fitness Testing Across the Air Force

Currently, no official test exists within the Air Force to evaluate performance-based combat readiness. While much debate takes place amongst the ranks, a war-environment based evaluation has yet to surface. One side of the argument is airmen are not ground forces and should not train as such. The PFT is enough to evaluate member's physical fitness level and members deploying with sister services receive all the combat training they need in preparation for deployment. The other side of the argument is with more airmen filling ground combat roles, airmen must be as physically fit as the Army and Marine Corps. The conventional role held by Air Force members does not apply anymore. Short notice just-in-time deployments, without career field exemption, make it unlikely for an Air Force member to get in combat readiness shape in time for war. "The

Air Force has embraced a doctrinal concept, the air and space expeditionary force, that calls for units to deploy within a very short timeframe to support joint or combines operations" (Alexander, 2003:38). Members not mentally and physically prepared generate weaknesses in the battlefield. Consequently, all Air Force members should have a performance-based fitness evaluation.

Sister-services lead the way in the implementation of more combat-focused fitness tests, allowing the Air Force to evaluate what works and what does not work with regards to these types of tests. With the evident DoD mission shift toward joint service combat, the Air Force fitness program remains susceptible to further fitness changes. One change suggested by an Air Force member is to eliminate the body composition component from the semi-annual fitness test and instead implement the measurement in the annual physical health assessment (PHA). The abdominal measurement component measures health risk and does not correlate with combat-related fitness performance. In the thesis titled *Fit-to-Fight: Waist vs. Waist/Height Measurements to Determine an Individual's Fitness Level – a Study in Statistical Regression and Analysis*, Steven Swiderski recommends the following: "Base an individual's fitness score on their fitness level and not on their cardiovascular risk level. Rely on the proven BMI tests to determine an individual's cardiovascular risk" (Swiderski, 2005:63). Because of the affect height and weight displacement has on the abdominal area, the author suggests a one size fits all approach to waist measurement is not a reliable fitness standard. Instead, he proves a member's waist to height ratio (adj R^2 of 0.072 and p-value of <0.0001) is a better predictor of one's fitness level versus a waist measurement (adj R^2 of 0.0078 and p-value of 0.0178), when completed along with a distance run, push-ups, and sit-ups

(Swiderski, 2005:44). Another change encouraged within the Air Force suggests modifying the fitness test completely.

In 2009, Air Force Captain Thomas Worden published a thesis titled *A Comparison of the US Air Force Fitness Test and Sister Services' Combat-Oriented Fitness Tests* where he evaluates whether the Air Force PFT is a good measure of combat-related fitness. In this thesis, Worden analyzes the components of each branch's fitness test and the physical capabilities necessary to perform each component. He goes on to assess whether the Air Force test measures the same fitness components troops require in a combat environment. The result of his simple regression analysis with the dependent variable as the Combat Composite, using both the MCFT and pilot Army CRT volunteer results, and the independent variable as the Air Force Composite, using the Air Force PFT volunteer scores, is an R^2 value of 0.215. Worden's hypothesis that the current Air Force Physical Fitness Test "has a poor capability of predicting combat capability is strongly supported due to the low adjusted R^2 value" associated with this analysis (Worden, 2009:40).

The thesis summarizes the Air Force's need to modify the physical fitness test in order to more accurately measure combat readiness in Airmen. "Utilizing a proxy for combat capability in future updates to Air Force fitness testing is most likely a wise decision. This research found…the two (1/2 mile run and 30 lb. lifts) or three event (1/2 mile run, 30 lb. lifts, Army push-ups) models" as the best in predicting battlefield readiness (Worden, 2009:75). The two event model results in an adjusted R^2 value of 0.86 with an overall model p-value of <0.0001 and the three event model results in an adjusted R^2 of 0.89 with an overall model p-value of <0.0001. Both of these test models enable time effective testing, without jeopardizing the day to day mission, and incorporate both baseline health-related and performance-related fitness. A complete overhaul of the test would allow all airmen to be combat ready without having to isolate and prep career-specific troops, saving additional training time.

Out of the 86 USAF members participating in the research for Worden's thesis, only 5 of these members were female indicating a significant disparity in the number of women participants versus men. This disparity prevents a thorough analysis of the combat capability of all airmen, men and women. In addition, the group of 5 females had a significantly higher average USAF PT score (96.8) when compared to the men (90.1), so this small sample of women can be considered an overly fit selection of women and not necessarily a good representation of the women in the Air Force. A more thorough analysis would incorporate a larger spread of fitness levels, with PT scores ranging from failing (less than 75) to the maximum (100). This follow-on research serves to engage a larger sample of the USAF female population with a wider range of PT scores (75-100) using similar investigative questions and methodology techniques used in Worden's thesis. This will allow for a better analysis of the combat readiness of women in the Air Force.

Chapter Summary

This literature review discusses physical preparedness and fitness of military members and how this relates to the concept of total force fitness. We explain how the changing military mission initiates an evolution in how we approach physical fitness. The review summarizes general fitness and combat fitness and current programs in place across all military branches. From here, we conclude with an evaluation of the Air Force physical fitness test and whether the test needs modification to better prepare Airman for combat.

The next chapter details the methodology behind evaluating the Air Force physical fitness test with respect to combat fitness. Using the volunteer Air Force Physical Fitness Test results and performance results on the MCFT, we perform statistical analysis in determining whether the Air Force PFT adequately prepares our Airmen for combat. Using this methodology, research questions introduced in Chapter One are put to the test in attempts to discover whether alteration to the existing test is necessary in building a more combat ready Air and Space Force.

III. Analysis

Chapter Overview

This chapter begins with a brief summary of the protocol approved for this research along with the amendments, the collected data, and the methodology used to analyze the data. Statistical testing of research questions ensues using the assessment information and appropriate model diagnostics. The chapter details regression analysis, Analysis of Variance (ANOVA), and contingency table testing on the data using JMP® software (2010). The objective of the analysis involves determining what statistical differences, if any, exist between the Air Force Physical Fitness Test and the Marine Combat Fitness test, the proxy for combat readiness. We seek to determine what variations of the tests offer improved predictability of combat fitness for Air Force personnel and the likelihood of a performance event inferring a member's level of combat readiness.

Protocol Discussion and Data Collection

The protocol used in this study, F-WR-2011-0059-H, received Institutional Review Board (IRB) approval on 5 May 2011 (see Appendix A for approval letter and Appendix B for approved protocol). Within this protocol are the details of the data collection process, methodology, and possible risks involved. Two amendments were made to the protocol for this research, with the first amendment receiving approval on 16 Jun 11 (Appendix C) and the second receiving approval on 27 Sep 11 (Appendix D). The first amendment incorporates the following changes to the protocol: (1) using 30 lb. ammunition cans instead of 30 lb. dumbbells, (2) allowing Reservists and National Guard females to participate in the research study in addition to Active Duty females, and (3) implementing MCFT Maneuver Under Fire (MANUF) course dimension changes. The MANUF course has the same components as indicated in the initial protocol, however, because the associate investigator conducted all of the study sessions outdoors instead of indoors, the dimensions of the testing area changed. The second amendment involves replacing the study reader from Lt Col Unger to Major Ritschel, due to Lt Col Unger's retirement midway through the study.

Data collection began on 6 Jun 11 and ended on 31 Oct 11 with 61 total volunteers. The subjects for the research consist of female Air Force active duty, guard, and reserve personnel assigned to the Wright-Patterson AFB (WPAFB) area, medically cleared to participate in USAF fitness testing. The associate investigator published research advertisements throughout the installation including all of the WPAFB gyms, the base newspaper, airmen dormitories, the Air Force Institute of Technology (AFIT) Intranet web server, the Company Grade Officer's Council, and through several e-mail distribution lists specific to base fitness leadership.

The ideal volunteer performed her last AFPFT no more than 6 months before taking the MCFT to prevent possible changes in physical fitness between the two tests, but member's not meeting this criterion still participated. Out of the 61 total volunteers, 10 completed their AFPFT more than 6 months prior to completing the MCFT. Fortunately, 25 members volunteered from the USAF School of Aerospace Medicine and these members took their Air Force PFT as part of Basic Military Training (BMT) a week or two prior to participating in the research preventing significant fitness changes. The data collected in this research consists of 33 variables (reference Appendix E), including volunteer descriptive variables, Air Force PFT event variables, both raw and score based, MCFT event variables, both raw and score based, volunteer stratification variables for each event in each respective fitness test, and success-failure (dummy) variables. The referenced variables in this chapter, however, include only the ones found significant with regards to the combat capability. The research investigator also collected data such as clothing worn, test date and weather, and notes on test performance during the research sessions.

Because the Marine Combat Fitness Test is the only official combat performance-based evaluation in the U.S. military, this test serves as the proxy for combat capability. The total scores for the MCFT range from 0 to 300 and serve as the Combat Composite measure for the volunteers. Table 1 shows the event minimums for female participants.

Table 1: Marine Combat Fitness Test Minimum Requirements for Movement to Contact (MTC), Ammunition Can Lift (AL), and Maneuver Under Fire (MANUF) events

Female				
Age	**17-26**	**27-39**	**40-45**	**46+**
Movement To Contact (MTC)	5:27	5:28	5:35	5:50
Ammunition Can Lift (AL)	17	13	7	6
Maneuver Under Fire (MANUF)	5:59	6:04	6:25	6:30

Members may exceed the AL values for a higher score, but members not meeting MTC and MANUF event values will fail the respective test component and earn an automatic score of 60. Reference Appendix F for the Marine Combat Fitness Test score charts.

> Maximum and minimum performance criteria were established utilizing specific performance percentiles, by age group. Marines must achieve the minimum performance requirement for all three events to successfully pass the CFT. Failure to meet the minimum requirement in any one event constitutes a failure of the entire test. (Department of the Navy, 2008:3-8)

Table 2 displays the score classification the Marine Corps uses for this test.

Table 2: MCFT Classifications

MCFT Classifications	
1st Class	270-300
2d Class	225-269
3rd Class	190-224
Fail	189 and below

Any member earning a score less than 189 fails the test. Both the raw and score performance values are variables used in the analysis.

Each volunteer provided Air Force Physical Fitness Test results via Air Force Fitness Management System (AFFMS) score print-outs. Included in these print-outs are both the raw and score results for each performance event on the AFPFT (1.5 mile run, waist circumference, push-ups, and sit-ups) and additional data such as age, height, weight, and BMI. Members earn scores for each event using the female scoring charts in Appendix G. With these charts, one can determine the applicability of the fitness scoring mechanism with regard to predicting combat readiness or if a different scoring scale is ideal. Using the scoring charts, we can also analyze the scored data versus the raw data to further evaluate the scoring mechanism and determine if raw event data yields a more predictive combat capability model. Using fitness data from both tests, we analyze the primary research objectives in determining the Air Force fitness test's predictability of combat performance-based fitness and if measures within the test require modification to increase this predictability further.

The Air Force Physical Fitness Test and its Relationship to Combat Capability

In order to address the research questions annotated in the Introduction, the author analyzes the AFPFT's possible statistical association with combat capability utilizing JMP® software. Using the volunteer AFPFT and MCFT score data, a simple linear regression tests the Air Force fitness assessment's predictability with regards to combat fitness capability. In this analysis, Combat Composite is the dependent variable, using the MCFT volunteer data scores, and the Air Force Fitness Composite is the independent variable, using the AFPFT volunteer data scores. Figure 1 displays the resulting output, with an R^2 value of 0.161.

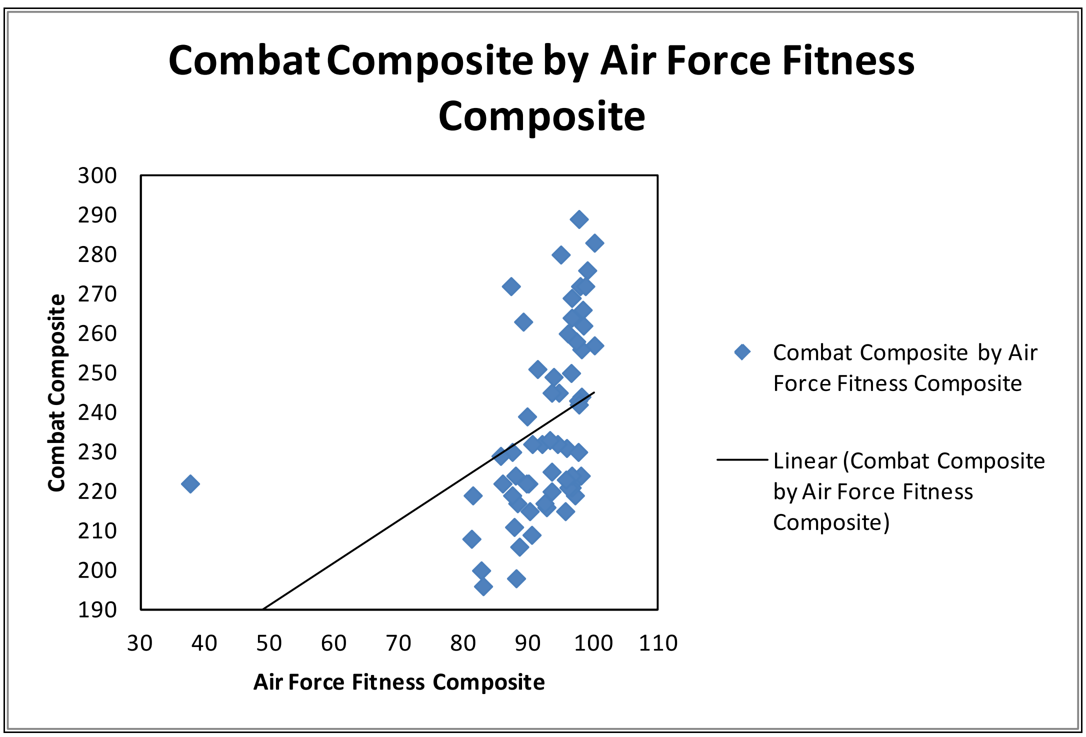

Figure 1: Simple Linear Regression of Combat Composite by Air Force Fitness Composite

The R^2 value relays the percent of variation in the dependent variable explained by the independent variable. The closer the R^2 value is to 1, the better the correlation. The low R^2 value present in this analysis statistically supports the hypothesis of the Air Force PFT having a poor correlation with combat fitness and ultimately having a poor chance of predicting combat readiness.

In Figure 1, an outlier volunteer is present in the output. The point could potentially influence the results of our analysis. The corresponding volunteer did not complete the cardio components of her most recent Air Force PFT, resulting in an automatic failure. She is the only volunteer from our sample failing her PFT, which indicates why she highlights in this simple regression. When running the regression with the outlier excluded, the R^2 value increases to 0.347. If the outlier shows up in continued analyses, we will decide whether the value should stay excluded.

The next simple linear regression involves the comparison of Air Force fitness score stratification results to Marine Combat Fitness Test score stratification results amongst the volunteers. The dependent variable is the volunteer stratification based on Combat Composite and the independent variable is the volunteer stratification based on the Air Force Fitness Composite. With this analysis, we can determine how well the Air Force Composite stratification can predict the Combat Composite stratification. Figure 2 displays the results of this analysis, with an R^2 value of 0.368. Using this result, not even 37% of a volunteer's Combat Composite stratification correlates with her Air Force Composite stratification.

Applying the results from each simple linear regression, the next step involves evaluating whether modification to the AFPFT scoring mechanism results in better prediction of combat readiness in Air Force personnel. In order to test this research question, we perform a multiple regression with the volunteer Combat Composite data, the dependent variable, against the volunteer AFPFT raw data, the explanatory variables. Table 3 displays the parameter estimates for the model with an adjusted R^2 value of 0.572.

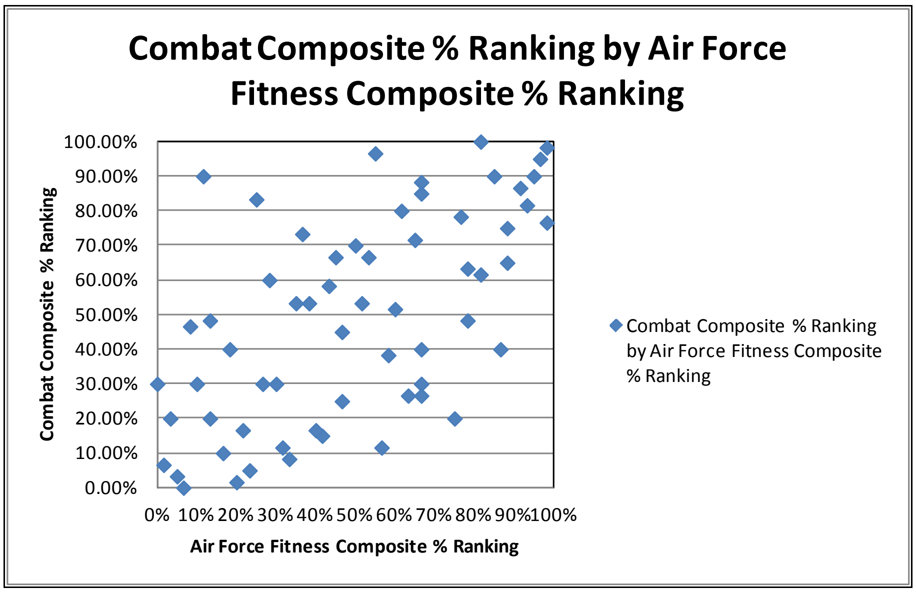

Figure 2: Simple Linear Regression of Combat Composite Stratification by Air Force Composite Stratification

Table 3: Combat Composite by Air Force PFT Variables Multiple Regression Model Parameter Estimates

The adjusted R^2 value is similar to R^2, but applies when using more than one independent variable for analysis. The adjusted R^2 value accounts for correlation inflation, which results from adding non-predictive independent variables to a model (Neter, Kuter, Nachtsheim, and Wasserman, 1996:230-231). One can write the multiple regression model mathematically using the following equation, representing the population:

$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p + \varepsilon \tag{1}$$

where

y = *Combat Composite dependent variable*

β_0 = *intercept*

ε = *error*

β_i = *parameter values for each independent variable*

We apply the parameter estimates from Table 3 to this equation, generating the following estimated regression model:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \cdots + \hat{\beta}_p x_p \tag{2}$$

We will apply the estimated regression model in further analysis.

Table 3 displays the output from individual Student's T-tests based off the hypothesis introduced in Chapter One, the Air Force Physical Fitness Test is not predictive of combat capability within Air Force personnel. This output includes the following: Estimate, Std error, t Ratio, Prob > [t], and Std Beta. Estimate refers to the estimated parameter values or coefficients for each explanatory variable in the model. Std error represents the estimated standard deviation of the coefficient estimate. T Ratio is the ratio of a parameter's estimate to its standard error. Prob > [t], the p-value based on a t-test, is the measure of significance each independent variable provides. Each model's F-test has a Type I error rate of 0.05. P-values below 0.05 are significantly predictive. Std Beta refers to the estimate values resulting from a mean of 0 and a variance of 1 (JMP® 9.0.1, 2010:n. pag.).

We apply the Bonferroni method when determining the companionwise error rate for a multiple regression model. This method incorporates a multiple comparison of means by applying the experiment wise error rate, Type I error, for the overall model, per the F-Test, and dividing by the total number of independent variables, per Equation 3 below:

$$\alpha_c = \frac{\alpha_e}{p} \tag{3}$$

where α_c is the *companionwise error rate*, α_e is the *overall Type I error significance level* or *experiment wise error rate* and p is the *number of variables* (Neter, Kuter, Nachtsheim, and Wasserman, 1996:154-155). Explanatory variables within a multiple regression model are considered significant if their p-values are less than or equal to the respective companionwise error rate for the model.

The "VIF" or Variance Inflation Factor, see Equation 4, measures multicollinearity or linear dependency between two independent variables.

$$\frac{1}{1-R_i^2} \tag{4}$$

This dependence results in an inflation of the standard errors within a multiple regression model. For example, if two explanatory variables have high individual p-values, and high VIF scores, it likely means that the inclusion of both variables inflates the estimated standard error of each. We will reference these diagnostics again in future parameter estimate tables.

AFPFT Cardio and AFPFT Push-Ups in Table 3 show strong significance (p-values below 0.0083 (0.0083 = $\frac{0.05}{6} = \frac{\alpha_e}{\# tests(p)}$) while AFPFT Waist shows weak insignificance (p-value below 0.05, but above 0.0083). The similar VIF scores for BMI and AFPFT Waist suggest possible dependence between these variables that we shall investigate. The estimate value for the AFPFT Cardio component is negative (-0.14), AFPFT Waist component is positive (3.28), and AFPFT Push-Ups component is positive (1.04) which implies running a shorter 1.5 mile run time, having a larger waist circumference, and performing a higher number of push-ups predicts some combat capability (adjusted R^2 value of 0.572). The Age and Sit-up variables suggest insignificance with respect to our Combat Composite in Table 3, therefore, we remove the variables in future multiple regression models.

While the AFPFT Waist and BMI variables are different measures of physical health for the human body, the current Air Force fitness program suggests they are both useful in estimating one's health risk (Department of the Air Force, 2010:50-51). The next step in the analysis involves testing whether the components are interchangeable with regards to predicting combat capability. Comparing one multiple regression model with the following variables: BMI, AFPFT Cardio (raw), and AFPFT Push-Ups (raw) to another model with the following variables: AFPFT Waist, AFPFT Cardio (raw), and AFPFT Push-Ups (raw) allows us to test this interchangeability. Figure 3 displays the resulting output for the initial regression model.

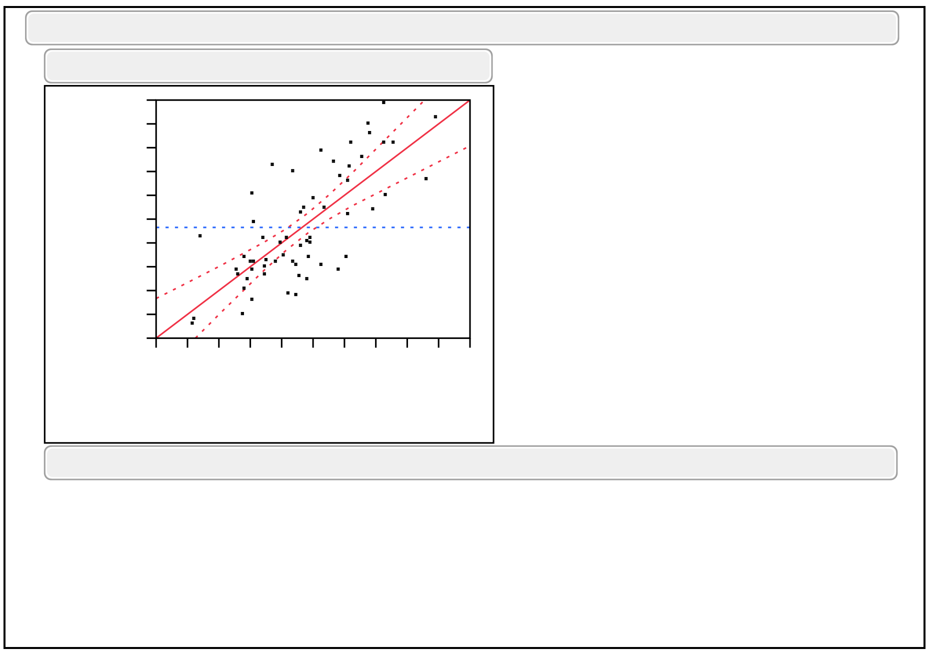

Figure 3: Combat Composite by Air Force PFT Multiple Regression Model Without Waist Component

While the adjusted R^2 value decreases (0.53) in comparison to the previous model (0.57), BMI now shows as significant in the model (p-value < 0.0167). This result implies running a shorter 1.5 mile run time, having a larger BMI, and performing a higher number of push-ups predicts some combat capability. This suggests BMI and AFPFT

Waist show significance when the other is not in the model. The AFPFT Cardio and AFPFT Push-Ups variables still show as significant (p-values < 0.05/3 = 0.0167).

To test this further, we perform another multiple regression with the same independent variables in Figure 3, but replace the BMI variable with AFPFT Waist variable. Figure 4 shows the adjusted R^2 value is relatively similar (0.567) in comparison to the initial model in Figure 3 (0.572) and AFPFT Waist shows as significant.

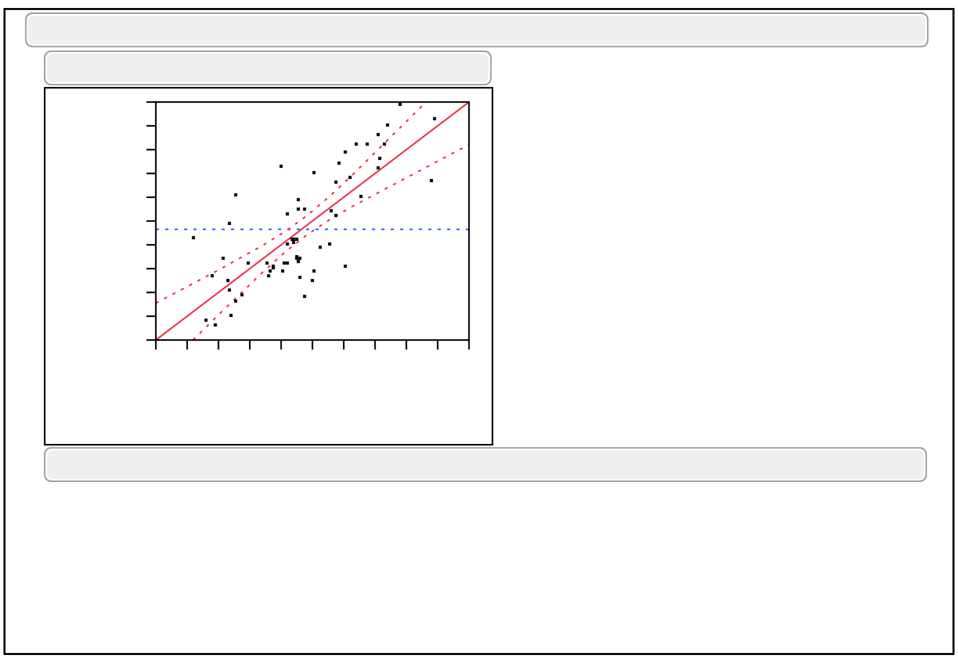

Figure 4: Combat Composite by Air Force PFT Multiple Regression Model Without BMI Component

This regression model confirms BMI and AFPFT Waist show significance when the other is absent from the model, implying interchangeability between the two variables. The AFPFT Cardio and AFPFT Push-Ups variables still show as significant (p-values < 0.05) in this regression.

While this model indicates increased predictability with regards to combat fitness, the model is far from perfect due to scoring bias. Pre-existing maximum scores for push-up and sit-up components in the Air Force fitness test incentivize members to stop at the maximum event if they are capable of performing more repetitions, see scoring charts in Appendix G, limiting the output range. This in turn affects the raw and scored variables for the push-up and sit-up events in our analysis. Figures 5 and 6 display distributions for raw and scored push-up results, respectively.

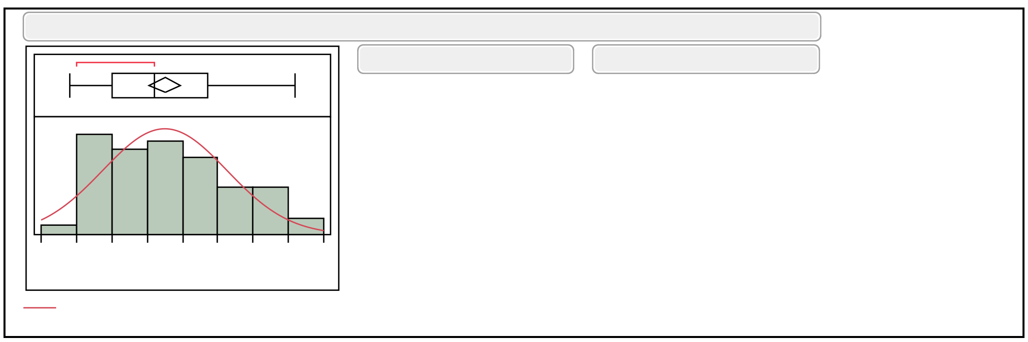

Figure 5: Air Force Push-Up Raw Data Distribution

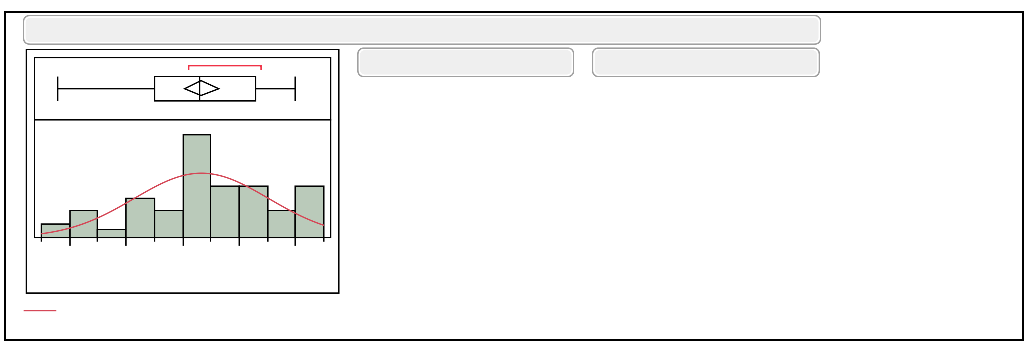

Figure 6: Air Force Push-Up Scored Data Distribution

From the raw data in Figure 5, we notice a wide range of push-up repetitions. The scored push-up data in Figure 6 suggests volunteer's earning an average of 8.3 points on this event. The sit-up distributions, however, yield completely different results. Figures 7 and 8 display distributions for raw and scored sit-up results, respectively.

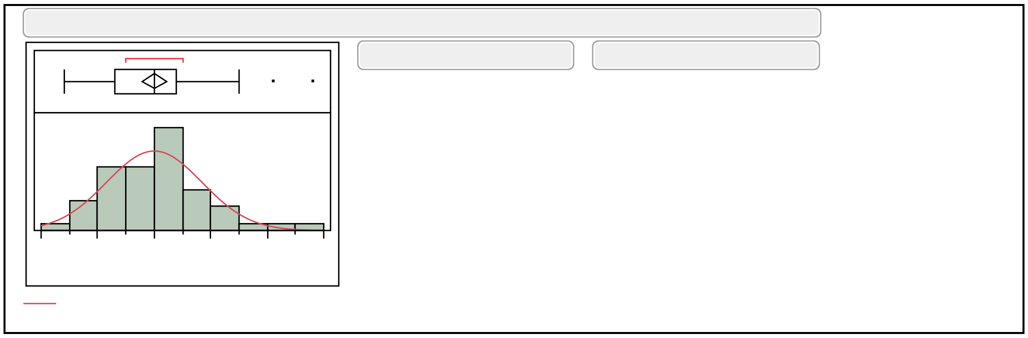

Figure 7: Air Force Sit-Up Raw Data Distribution

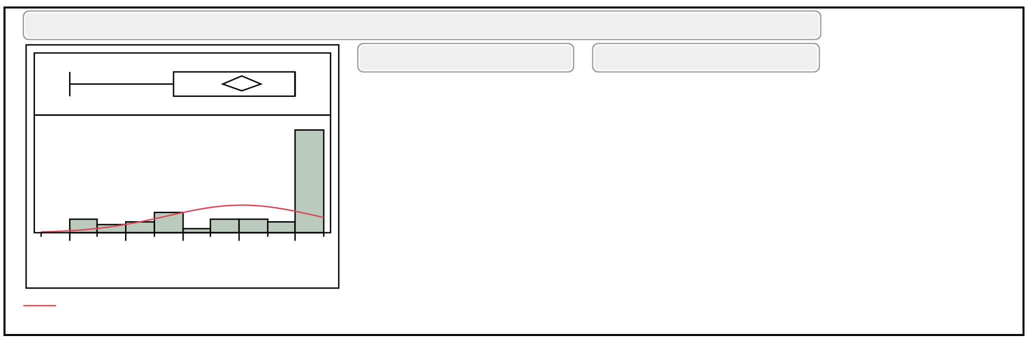

Figure 8: Air Force Sit-Up Scored Data Distribution

In both figures, we observe a distribution peak where the volunteer's perform the necessary repetitions in order to earn the maximum event score. As a result, one can hypothesize the scoring charts for the sit-ups are too simplistic, since over 75% of subjects exceed this score value. The author will discuss the implications of this result further in Chapter Four. The decrease in volunteer sample size, from 61 to 60 for the sit-up distributions is due to one volunteer not completing the sit-up component of the AFPFT for medical reasons.

Potential Modifications to the Air Force Physical Fitness Test

Per the initial analysis, the Air Force PFT is less than 17% predictive of combat readiness, with the MCFT as the indicator for combat readiness. This same test, with the removal of scoring chart data and application of raw data, improves to over 57% with regards to predicting combat capability (relatively a 335% improvement). This result proposes the following research question, "are there significantly predictive events that volunteers took during the … MCFT that when included in our Air Force test, or used to replace a less predictive event on the Air Force test, can push that predictability mark even higher?" (Worden, 2009:48).

The initial step in this analysis involves checking the predictability of each applicable variable with combat performance-based fitness. Using a subsets regression technique (StatSoft Inc., 2011:n. pag.), we can run individual models of Combat Composite by each variable. Table 4 summarizes the R^2 and p-value for each variable run individually against the Combat Composite variable.

A categorization column for the variables based on the R^2 value and where the value falls in relation to the level of significance categories helps in stratifying the variables from most predictive to least. From this, one can determine the predictability of each event with regards to the Combat Composite and build plausible event models better correlating with combat capability.

Table 4: Subsets Regression Summary of Combat Composite by Fitness Component Variables and Significance Levels

Continuous Variables	R^2	P-value	Cat. Number
Age	0.047	0.0933	-
Height	0.15	0.002*	-
Weight	0.066	0.0464*	-
Body Mass Index (BMI)	3.36E-05	0.9646	-
Air Force Physical Fitness Test (AFPFT) Cardio (raw) – seconds; 1.5 mi. run	0.29	<.0001*	1
Air Force Physical Fitness Test (AFPFT) Abdominal Circumference (raw)	0.014	0.3712	0
Air Force Physical Fitness Test (AFPFT) Push-Ups (raw)	0.305	<.0001*	2
Air Force Physical Fitness Test (AFPFT) Sit-Ups (raw)	0.286	<.0001*	1
Marine Combat Fitness Test (MCFT) Movement to Contact (MTC) (raw) – seconds; 1/2 mi. run	0.333	<.0001*	2
Marine Combat Fitness Test (MCFT) Ammunition Can Lift (AL) (raw)	0.764	<.0001*	4
Marine Combat Fitness Test (MCFT) Maneuver Under Fire (MANUF) (raw) – seconds	0.516	<.0001*	3
Level of Significance of each event			
Category	**R^2 Range**	**Cat. Number**	
non-predictive	<0.15	0	
low-predictive	0.15-0.3	1	
moderate-predictive	0.3-0.45	2	
high-predictive	0.45-0.6	3	
most-predictive	> 0.6	4	

Per Table 4, the most predictive event is the Marine Combat Fitness Test Ammunition Can Lift (AL). This one event is more predictive of combat capability (R^2 of 0.76) than our best AFPFT scoring raw data model referenced in Table 3 (adjusted R^2

value of 0.572). The Marine Combat Fitness Test Maneuver Under Fire (MCFT MANUF) event falls in the highly predictive category, with the MCFT Movement to Contact Event (MCFT MTC) falling into the moderately predictive category. All but one of the remaining events are either low predictive or non-predictive per our significance categories. Because the R^2 value for the Air Force PFT Push-Up event is close to the moderately predictive category range and the previous multiple regression analyses indicate push-ups as significant (see Figures 3 and 4), we categorize this event as moderately predictive along with the MCFT MTC event. Using these results, we build several “best” models using events falling into category 2 (moderate predictive) through 4 (most predictive). Construction of these models involves only the number of events and the models reiterate as necessary until the application of all possible event combinations. Table 5 shows the event model iterations and the associated R^2 or adjusted R^2 values for with and without distance models.

According to Table 5, the MCFT AL event is the most predictive one event model with an R^2 of 0.76. The most predictive two event model with a distance run includes the MCFT MTC and MCFT AL events and the most predictive two-event model without a distance includes the MCFT MANUF and MCFT AL events. Because the distance run model yields a higher adjusted R^2 value of 0.864, the model is chosen as the best two event model overall. This is a 10.43% increase over the best one event model. The most significant three event model with a distance run includes all events within the Marine Combat Fitness Test--the MCFT MTC, MCFT AL, and the MCFT MANUF. The most predictive three-event model without a distance run incorporates the MCFT MANUF, MCFT AL, and the AFPFT Push-Ups. The with distance model is appropriate as the best three-event model as it produces a higher adjusted R^2 value of 0.906. This is a 4.15% increase in comparison to the best two-event model.

Table 5: Event Model Iterations

One Event Model	
MCFT ACL (raw)	x
R^2	**0.764**

Two Event Model Iterations	W/ distance run			w/o distance run		
	1	2	3	4	5	6
MCFT MTC (raw) – seconds; 1/2 mi. run	X	X	X			
MCFT MANUF (raw) – seconds	X			X	X	
MCFT ACL (raw)		X		X		X
AFPFT Push-Ups (raw)			X		X	X
Adj R^2	0.610	**0.864**	0.445	**0.842**	0.622	0.775

Three Event Model Iterations	W/ distance run			w/o distance run
	1	2	3	4
MCFT MTC (raw) – 1/2 mi. run	x	x	x	
MCFT MANUF (raw) – seconds	x	x		x
MCFT ACL (raw)	x		x	x
AFPFT Push-Ups (raw)		x	x	x
Adj R^2	**0.906**	0.674	0.865	**0.857**

Four Event Model Iterations	
MCFT MTC (raw) – 1/2 mi. run	x
MCFT MANUF (raw) – seconds	x
MCFT ACL (raw)	x
AFPFT Push-Ups (raw)	x
Adj R^2	**0.908**

If we exclude the MCFT MANUF event from the three event model, due to the event incorporating elements not often experienced in an Air Force environment (i.e. fireman's carry), the next best distance model incorporates the MCFT MTC, MCFT AL, and AFPFT Push-Ups. Because exactly four events fall into category 2 (moderate predictive) through 4 (most predictive), only one four event model is possible. This model yields an adjusted R^2 value of 0.908, the highest of all the event models. Table 6 summarizes the most predictive models. These models only apply to Air Force members meeting the fitness variable ranges annotated in Appendix H.

Table 6: Summary of Predictive Models

Model	**Event(s)**	**R^2 or Adj R^2**
One Event	MCFT ACL (raw)	0.764
Two Event	MCFT MTC (raw) – seconds; 1/2 mi. run, MCFT ACL (raw)	0.864
Three Event	MCFT MTC (raw) – seconds; 1/2 mi. run, MCFT ACL (raw), MCFT MANUF (raw) – seconds	0.906
Four Event	MCFT MTC (raw) – seconds; 1/2 mi. run, MCFT ACL (raw), MCFT MANUF (raw) – seconds, AFPFT Push-Ups (raw)	0.908

To prevent a possible endogenous effect, with the dependent variable (Combat Proxy) demonstrating a high correlation with the events within the proxy itself, we perform another subsets regression. In this regression, the same explanatory fitness variables are the our independent variables and the Air Force Fitness Composite is the dependent variable instead of the MCFT proxy to evaluate if the AFPFT events show significance. Table 7 displays the results of this regression.

Table 7: Subsets Regression Summary of Air Force Fitness Composite by Fitness Component Variables

Continuous Variables	R^2	P-value	Cat. Number
Age	0.0156	0.338	-
Height	0.0182	0.299	-
Weight	0.0361	0.1427	-
Body Mass Index (BMI)	0.098	0.0141	-
Air Force Physical Fitness Test (AFPFT) Cardio (raw) – seconds; 1.5 mi. run	0.701	<0.0001*	4
Air Force Physical Fitness Test (AFPFT) Abdominal Circumference (raw)	0.1	0.0122*	0
Air Force Physical Fitness Test (AFPFT) Push-Ups (raw)	0.111	0.0086*	0
Air Force Physical Fitness Test (AFPFT) Sit-Ups (raw)	0.07	0.0406*	0
Marine Combat Fitness Test (MCFT) Movement to Contact (MTC) (raw) – seconds; 1/2 mi. run	0.43	<0.0001*	2
Marine Combat Fitness Test (MCFT) Ammunition Can Lift (AL) (raw)	0.05	0.0898	0
Marine Combat Fitness Test (MCFT) Maneuver Under Fire (MANUF) (raw) – seconds	0.028	0.199	0

The subsets regression results show significance between the Air Force Fitness Composite and each event within the Air Force Fitness Test (p-value <0.05). The author discusses the implications of this result in Chapter Four.

Inferential and Descriptive Model Assumption Diagnostics

We decide to examine all four of the event models for further diagnostics. Figure 9 displays the most predictive one event model along with parameter estimates. A decrease in sample size for this output, 61 to 60, is due to volunteer #27 not completing the MCFT AL event in the allotted time.

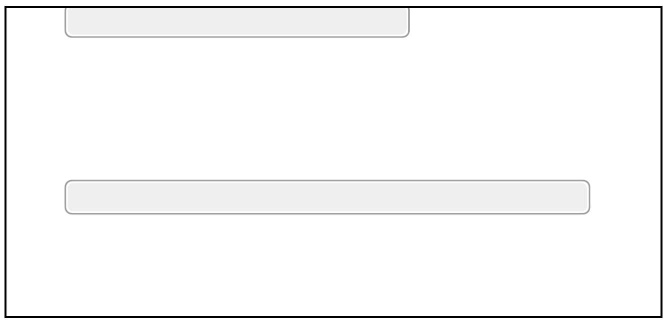

Figure 9: Simple Regression Output of Best One Event Model

Figure 10 displays the most predictive two event model along with parameter estimates. The decrease in sample size for this output is due to the same volunteer in Figure 9 that did not complete the MCFT AL event. Figure 11 displays the most predictive three event model along with parameter estimates. The decrease in sample size for this output is due to volunteer #27, not completing the MCFT AL event, and also volunteer #3 not completing the MCFT MANUF event. Figure 12 displays the four event model along with parameter estimates. Both the three and four event models include the same fitness events with the exception of the AFPFT Push-Ups. The adjusted R^2 values are comparable with the three event model yielding an adjusted R^2 value of 0.906 and the four event model yielding an adjusted R^2 value of 0.908.

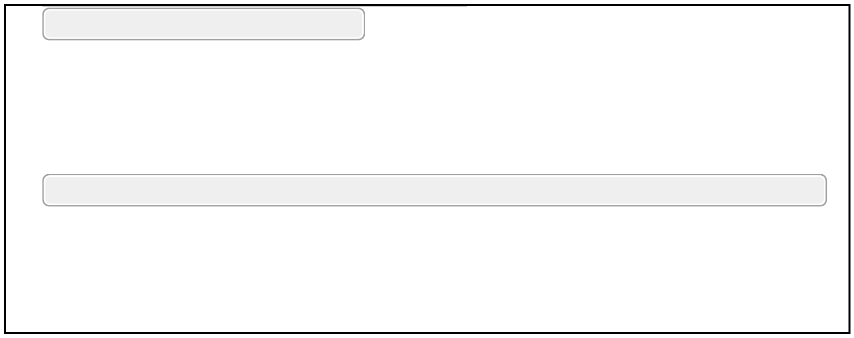

Figure 10: Multiple Regression Output of Best Two Event Model

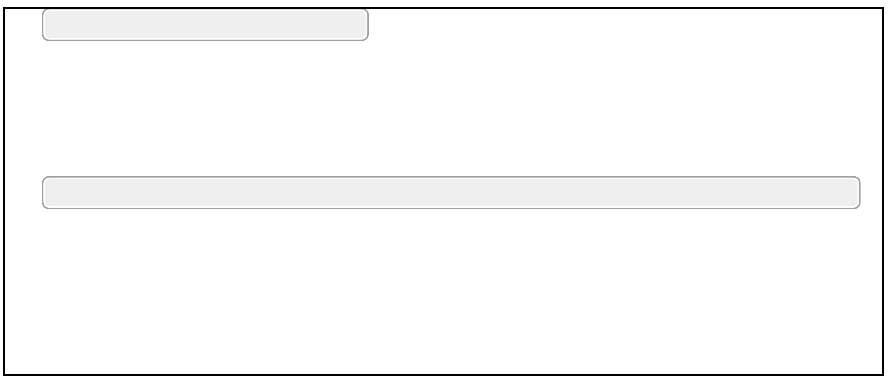

Figure 11: Multiple Regression Output of Best Three Event Model

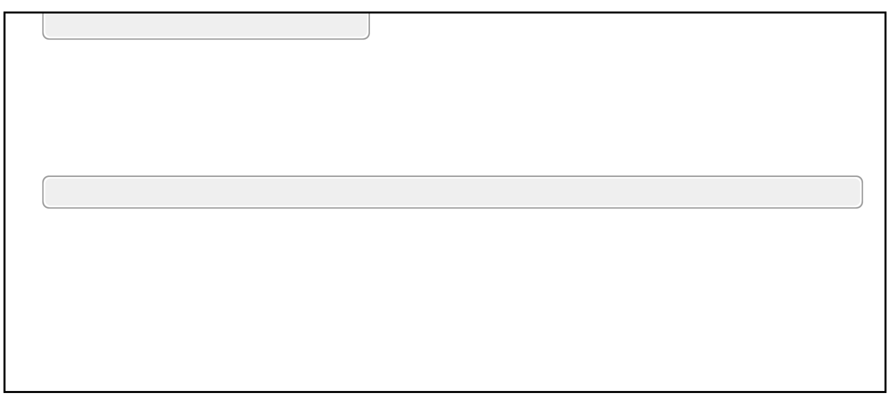

Figure 12: Multiple Regression Output of Four Event Model

Because the only difference between the two events is the Push-Up component and this variable shows insignificance (p-value > 0.05/4 = 0.0125), we decide to exclude the four event model from further analysis.

The statistical diagnostics checked include several inferential and descriptive tests applicable in statistical analysis. The tests evaluate the following model assumptions with respect to the residuals in the models: Normality, Independence, and Constant Variance. Table 8 summarizes the diagnostics used in evaluating these assumptions.

Table 8: Inferential and Descriptive Diagnostics for Best Models

Models - using best of w/ and w/o distance	**Adj R^2**	**Shapiro-Wilk (> 0.05)**	**Breusch Pagan (> 0.05)**
One (MCFT AL)	0.76	0.435	0.523
Two (MCFT MTC (raw) – seconds; 1/2 mi. run and MCFT AL)	0.864	0.103	0.766
Three (MCFT MTC (raw) – seconds; 1/2 mi. run, MCFT MANUF, and MCFT AL)	0.91	0.521	0.287

We explain and apply the criteria for each assumption in the following sub-sections. If necessary, removal of influential data points from the models is appropriate since the points affect the passing of one or more diagnostic tests. The results of these diagnostics will reflect on the validity of our models.

Normality

The Shapiro-Wilk test is useful in testing the assumption of normality of model residuals. Residuals will meet this model assumption if the Shapiro-Wilk p-value is greater than 0.05. The null and alternate hypotheses include the following:

> Null Hypothesis (H_O): The residuals associated with the predictive models exhibit a normal distribution
>
> Alternate Hypothesis (H_A): The residuals associated with the predictive models do not exhibit a normal distribution

Analysis of this diagnostic involves visually checking a studentized residual distribution for any outliers and the appearance of a normal distribution. While a plot may appear to visually meet the model assumption, the Shapiro-Wilk test provides the mathematical proof. Figures 13 through 15 display the studentized residual plots and Shapiro-Wilk results for the one, two, and three event models, respectively.

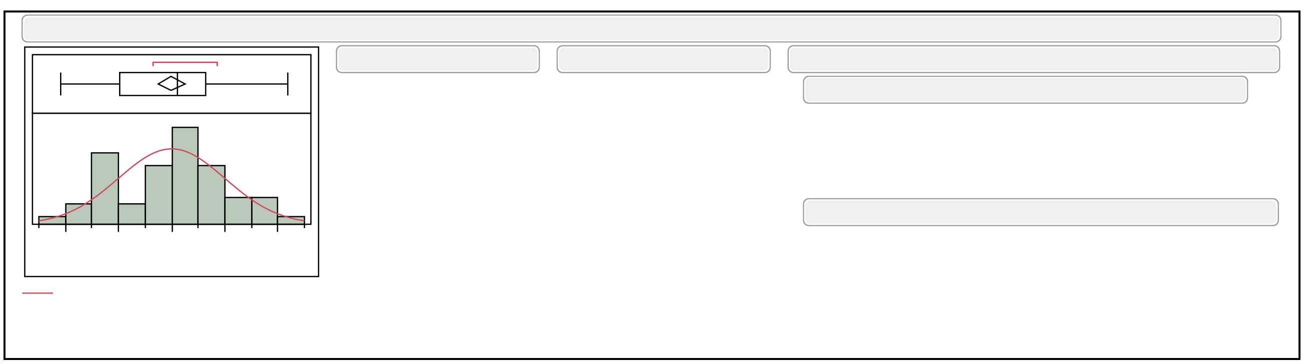

Figure 13: One Event Model Normality Output

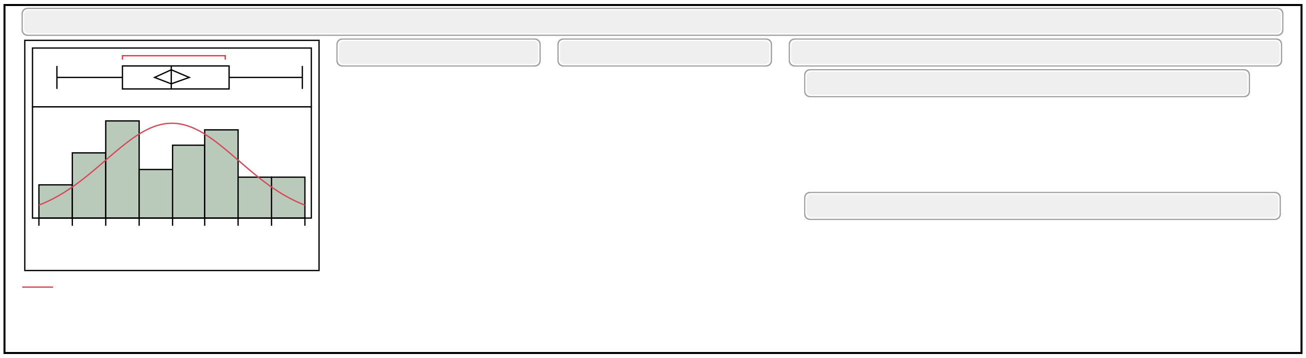

Figure 14: Two Event Model Normality Output

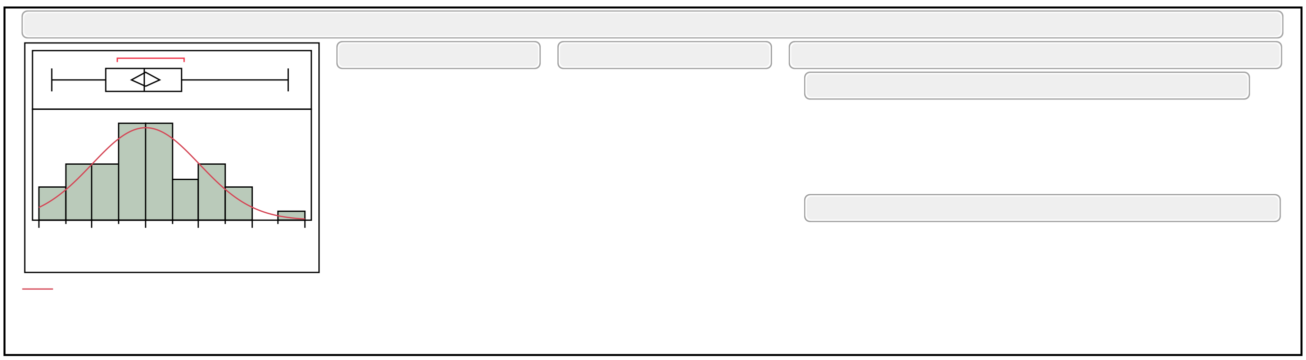

Figure 15: Three Event Model Normality Output

All of the figures appear normally distributed and pass the statistical test (p-value > 0.05), so we proceed to our next diagnostic test for Independence.

Independence

In order for the models to assume Independence, they must undergo a visual test using runs charts. A runs chart is a graph of model residuals over a span of time. When graphing the studentized residual data, there should not be any visible trend in the data. A trend suggests dependency between variables. The null and alternate hypotheses for this model assumption include the following:

Null Hypothesis (H_O): The residuals associated with the predictive models exhibit independence

Alternate Hypothesis (H_A): The residuals associated with the predictive models do not exhibit independence

Figures 16 through 18 displays the studentized residual run charts for the one, two, and three event models, respectively.

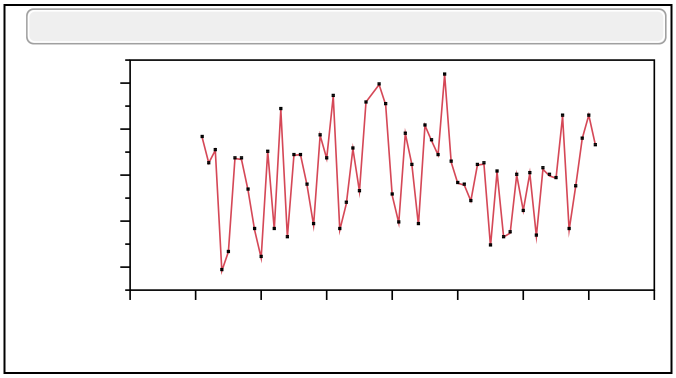

Figure 16: Studentized Residual Run Chart of One Event Model

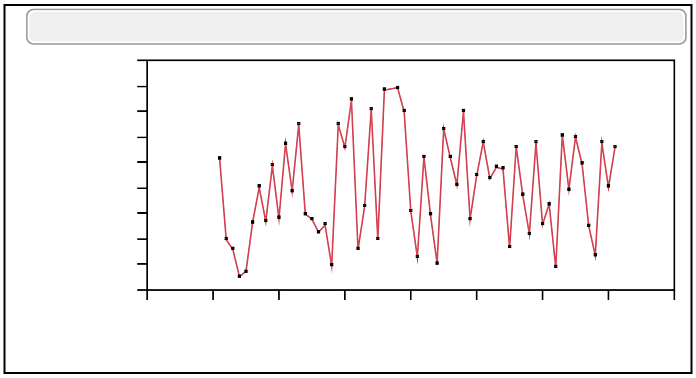

Figure 17: Studentized Residual Run Chart of Two Event Model

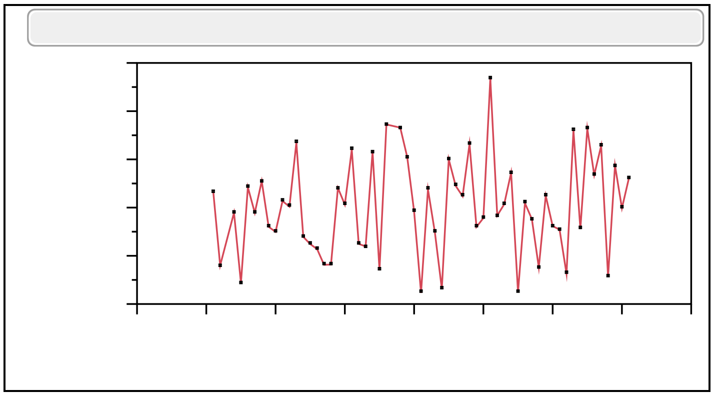

Figure 18: Studentized Residual Run Chart of Three Event Model

From these charts no noticeable trends are observable in the data; therefore, we assume independence in the models.

Constant Variance

The residuals model assumption of Constant Variance incorporates another set of visual and statistical tests. The null and alternate hypotheses include the following:

Null Hypothesis (H_O): The residuals associated with the predictive models exhibit constant variance

Alternate Hypothesis (H_A): The residuals associated with the predictive models do not exhibit constant variance

The visual test includes a residual by predicted scatter plot. One should not observe any trends in the plot. Figures 19 through 21 display the studentized residual scatter plots for the one, two, and three event models, in our analysis. The Breusch-Pagan test is the statistical check for Constant Variance.

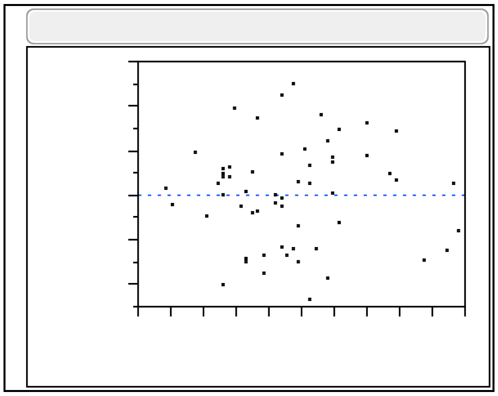

Figure 19: Constant Variance Scatter Plot, One Event Model

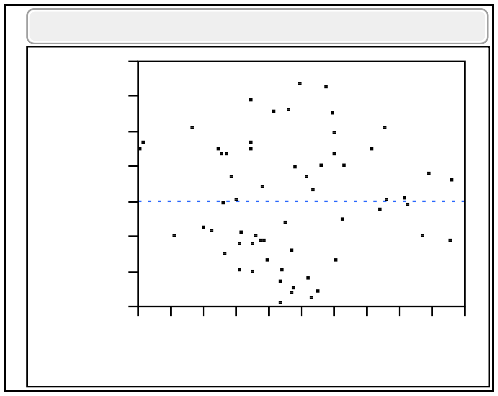

Figure 20: Constant Variance Scatter Plot, Two Event Model

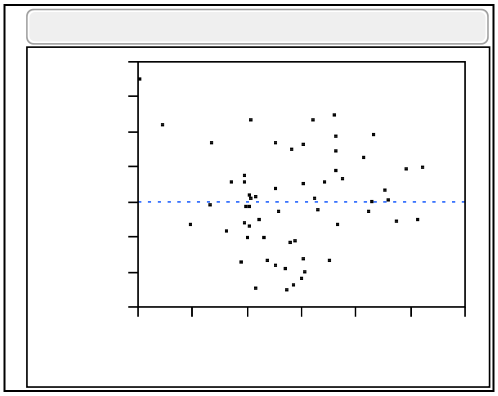

Figure 21: Constant Variance Scatter Plot, Three Event Model

An ideal model results in a Breusch-Pagan p-value of greater than 0.05. Meeting this model diagnostic assumes there is constant variance in a model. Table 9 displays the Breusch-Pagan results for the one, two, and three event models, respectively. All Breusch-Pagan test results are greater than 0.05; therefore, we assume constant variance in the models.

Table 9: Breusch-Pagan Test Results for Event Models

Breusch-Pagan Test Results						
Model	**SSR**	**SSE**	**N**	**df(reg)**	**Test Stat**	**P-value**
One (MCFT AL)	13389	7552.4	59	1	0.409	0.523
Two (MCFT MTC (raw) – seconds; 1/2 mi. run and MCFT AL)	5407.37	4197.70	59	2	0.534	0.766
Three (MCFT MTC (raw) – seconds; 1/2 mi. run, MCFT MANUF, and MCFT AL)	18175.77	2846.12	58	3	3.774	0.287

Application of Other Diagnostics

Additional diagnostics prove useful in validating accuracy of the predictive models. These diagnostics assess the presence of influential data points, test for multicollinearity, and calculate the mean absolute percent error within each model. Table 10 summarizes the output for these diagnostics. The diagnostic used in the detection of influential data points is Cook's Distance. This diagnostic measures the influence of individual points on the total model. No one point should have too much of an effect on the model (percent effect). An ideal model will have a Cook's Distance value of less than

0.25 for all data points. A data point within the 0.25-0.5 range suggests minor influence and any point greater than 0.5 suggests major influence on the data (Neter, Kuter, Nachtsheim, and Wasserman, 1996:380-381).

Table 10: Summary Output of Additional Diagnostics

Models - using best of w/ and w/o distance	**VIF (< 5)**	**Cook's Distance (<0.25)**	**Mean Absolute Percent Error (MAPE)**
One (MCFT AL)	<5	< .09	3.86
Two (MCFT MTC (raw) – seconds; 1/2 mi. run and MCFT AL)	<5	< .06	3.081
Three (MCFT MTC (raw) – seconds; 1/2 mi. run, MCFT MANUF, and MCFT AL)	< 5	<.4	2.416

Detection of Influential Data Points

If a data point falls in the minor influential category, further research determines the appropriate reasons why and we decide whether to exclude this data point from our analysis or not. Figures 22 though 24 display the Cook's Distance plots for the one, two, and three event models, respectively. Using these plots, one can visually check for any influential data points. The three event model yields an outlier value. This point corresponds to volunteer #41. This member is the only volunteer failing two components of the MCFT, suggesting why she highlights in the plot. While this influential point is not major, we annotate the point for possible exclusion.

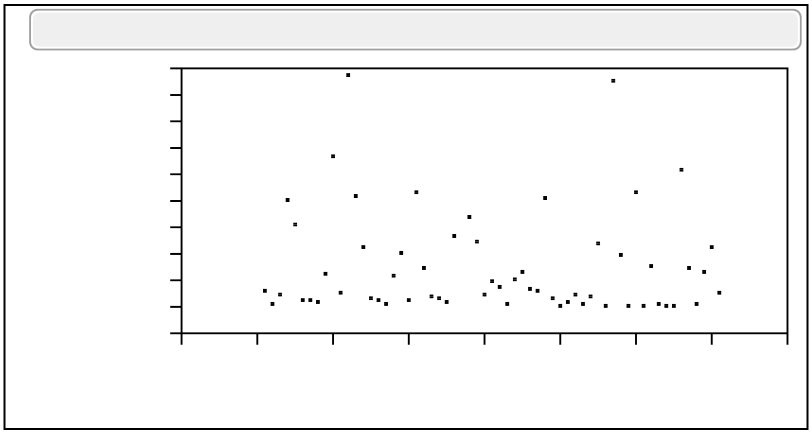

Figure 22: One Event Model Cook's Distance Plot

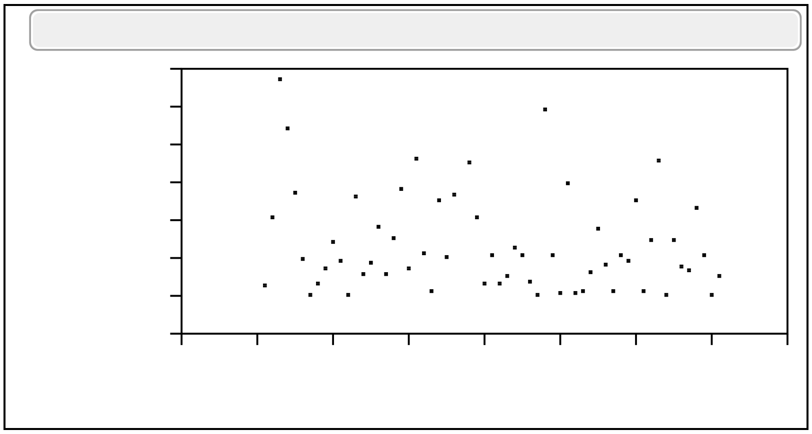

Figure 23: Two Event Model Cook's Distance Plot

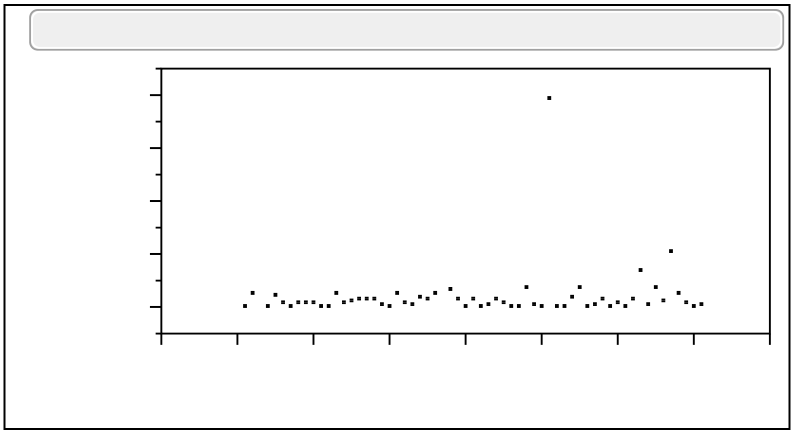

Figure 24: Three Event Model Cook's Distance Plot

Multicollinearity

The VIF score, referenced earlier in the chapter, is the measure for multicollinearity, or linear dependence between variables. An ideal model needs a VIF score of less than 5 to show lack of linear dependence between variables. The Table 10 summary, as well as the regression output in Figures 9-12, displays the VIF scores for the models and no parameter displays a VIF greater than 5, therefore, we assume no linear dependency between variables.

Mean Absolute Percent Error (MAPE)

While not one of the model assumptions used in testing models validity, MAPE is useful in testing a model's accuracy. The following equation represents the Mean Absolute Percent Error:

$$\mathrm{M} = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right| \tag{5}$$

where A_t refers to the actual Combat Composite scores earned by the volunteers and F_t term refers to the predicted Combat Composite scores based off our significant models. The MAPE calculates the absolute percent error within a model. Because a low MAPE associates with minimal error in this analysis, we prefer a small MAPE value. Upon analyzing the MAPE distributions from all three of our models, Figures 25 through 27, one observes all low values suggesting minimal error in the analysis.

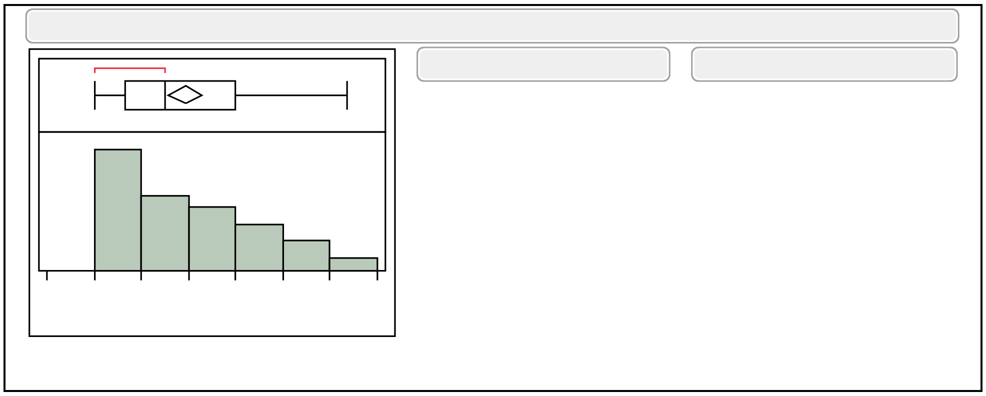

Figure 25: MAPE Distribution, One Event Model

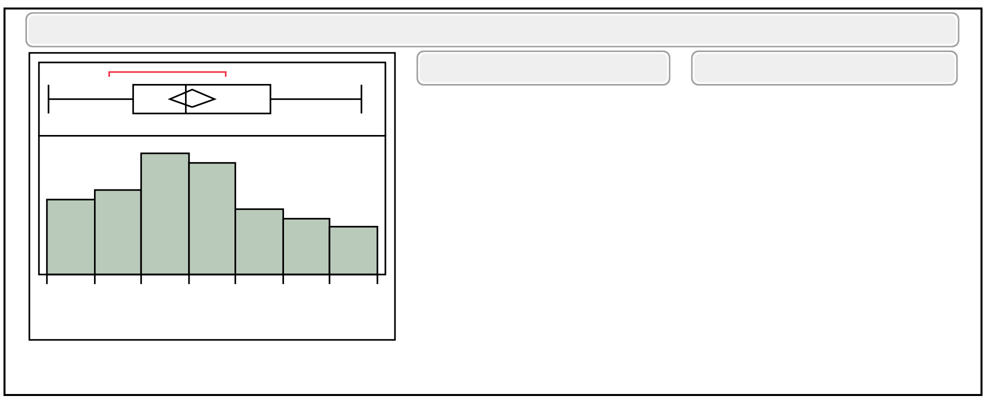

Figure 26: MAPE Distribution, Two Event Model

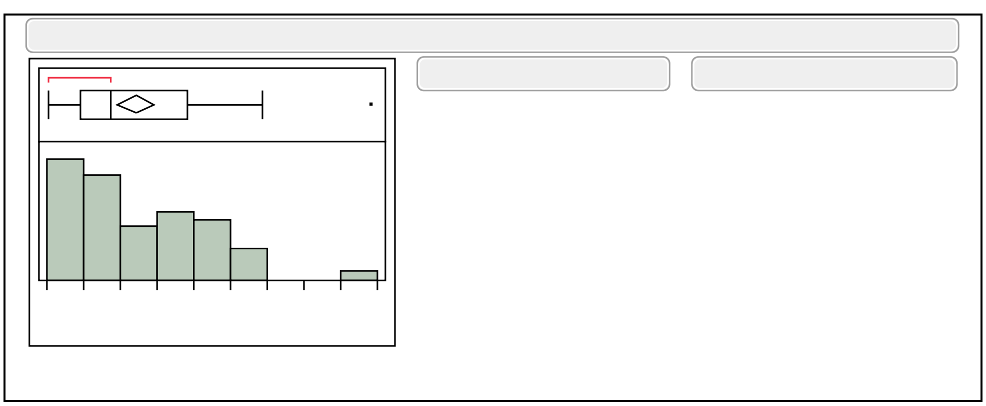

Figure 27: MAPE Distribution, Three Event Model

A small outlier value shows in our three event MAPE distribution. This point corresponds to volunteer #41, the same member observed in the Cook's Distance plot for the three event model. Because this point flags in two of the diagnostic tests, we excluded the point, re-ran our diagnostic tests, and checked to see if the significance (p-values) changed. Figure 28 displays the three event models regression output with volunteer #41 excluded. From this output, the adjusted R^2 value increases slightly (0.906 to 0.914) in comparison to the original output in Figure 11, but not significantly and the p-values maintain significance.

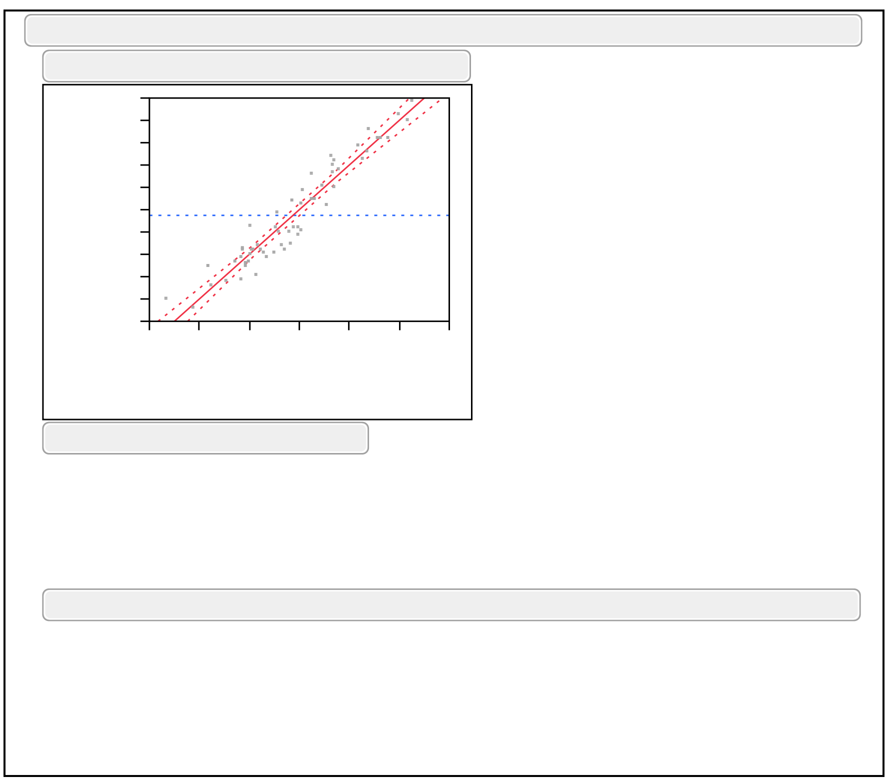

Figure 28: Multiple Regression Output of Best Three Event Model with Volunteer 41 Excluded

Figures 29 and 30 display the Cook's Distance and MAPE output for the three event model, respectively, with volunteer #41 excluded. The points within the Cook's Distance plot still show minor influence and the MAPE output indicates a slight decrease in the MAPE value (2.42 to 2.26), but not a significant one. When comparing the original three model output to the output with the excluded point, the results do not change much, therefore, we keep this value in our model for further analysis.

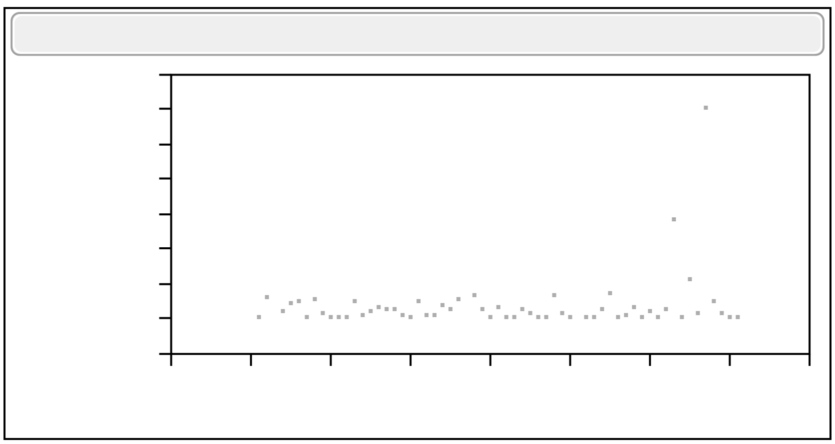

Figure 29: Three Event Model Cook's Distance Plot with Volunteer 41 Excluded

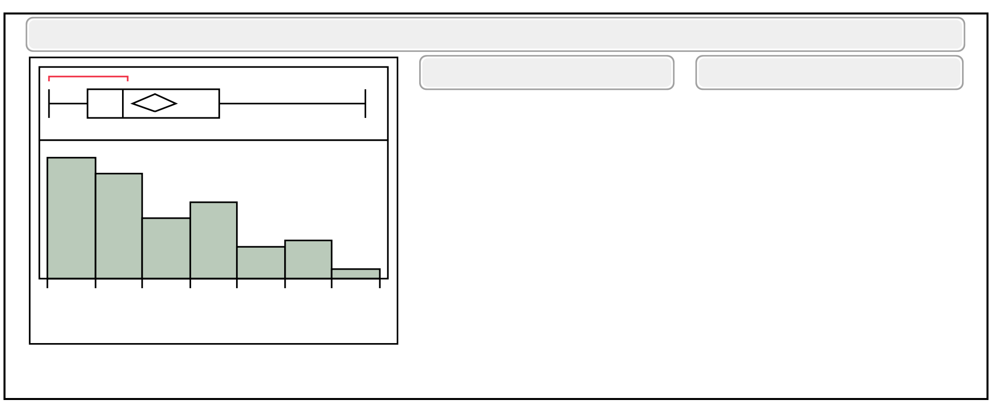

Figure 30: MAPE Distribution, Three Event Model with Volunteer 41 Excluded

χ^2 Contingency Table Testing

Of all events in the Combat Composite, the MCFT Maneuver Under Fire event is the only one incorporating the most components of physical fitness (muscular strength, muscular endurance, cardio respiratory endurance, flexibility, and body composition). Because this event proves significant with regards to combat fitness capability, per earlier simple linear and multiple regression analyses, one test the statistical dependency with other variables. Using a χ^2 contingency table hypothesis test, we test the null hypothesis of whether dependency exists between the MANUF variable and the other events. Using this testing tool can determine if variables such as waist circumference, BMI, or AFPFT score demonstrate dependence with the MCFT MANUF event, and ultimately, if the variables together increase combat capability for Air Force personnel.

The first χ^2 test incorporates dummy variables for the Air Force waist circumference max standard for women, 31.5," and MCFT MANUF event failure. Members having a smaller or equivalent to 31.5" waist value were a 1 and all others a 0. For the MCFT MANUF event, members failing any component were 1 and all others were a 0. Table 11 displays the results of this test.

Table 11: Contingency Table Test Results: Waist of 31.5" (cut-off for female max) vs. MANUF Completion

MANUF	Waist<=31.5" (1)	Waist>31.5" (0)	TOTAL
Passed (0)	29	2	31
Failed (1)	23	7	30
TOTAL	52	9	61

The χ^2 p-value value of > 0.05 implies we do not reject the null hypothesis. However, similarity between the Likelihood Ratio (0.057) and Pearson (0.063) χ^2 p-values suggest perhaps there may be a weak association between the MANUF and waist circumference. This indicates the probability of a member failing the MANUF event decreases if their waist is less than 31.5”. This seemingly contradicts prior results, per Table 3, that a member with a larger waist circumference is relatively more combat capable. However, the prior multiple regression models take into account the other fitness variables as well, making these results more conclusive.

We perform another χ^2 contingency table hypothesis test with the volunteer average BMI, 22.86, and MCFT MANUF event failure to analyze possible dependency between BMI and combat performance-based fitness. Table 12 displays the results. The p-values suggest independence (Likelihood Ratio p-value of 0.368 and Pearson’s p-value of .369) between the two factors.

Table 12: Contingency Table Test Results: BMI of 22.86 (volunteer avg) vs. MANUF Completion

MANUF	BMI<=22.86" (1)	BMI>22.86" (0)	TOTAL
Passed (0)	14	17	31
Failed (1)	17	13	30
TOTAL	31	30	61

The last χ^2 contingency table hypothesis test incorporates the average AFPFT score for the volunteers and MCFT MANUF event failure. Our results, shown in Table

13, indicate a borderline dependency exists. The Likelihood Ratio (0.053) and Pearson (0.055) p-values are close to the significance value of 0.05, therefore, we do not outright reject the null hypothesis. However, this borderline p-value suggests a member earning a lower than average AFPFT score may have a greater probability of failing the MCFT MANUF. This indicates that member's not in shape for the Air Force fitness test will more than likely fail the Marine fitness test. With a higher Type I error value (>0.05), we could conclude independence between the BMI and MANUF event failure.

Table 13: Contingency Table Test Results: AFPFT score (avg) vs. MANUF Completion

MANUF	AFPFT score <=92.01 (volunteer avg) (1)	AFPFT score>92.01 (volunteer avg) (0)	TOTAL
Passed (0)	17	20	37
Failed (1)	13	11	24
TOTAL	30	31	61

Chapter Summary

This chapter detailed the significant findings present in our research. Using the collected fitness assessment data for the Air Force Physical Fitness Test and Marine Combat Fitness Test, we applied several mathematical tests to determine the possible statistical differences between both fitness assessments. The next chapter discusses the results of these tests and summarizes the predictability of the Air Force Fitness Program with regards to combat performance-based fitness.

IV. Conclusions and Recommendations

Chapter Overview

This chapter culminates the research presented in prior chapters regarding Air Force members and combat-based fitness. The discussion begins with a detailed look at the key findings from the Analysis chapter, explains the relevance of these findings, and reviews significant events within the Air Force Physical Fitness Test and Marine Combat Fitness Test best correlating with combat readiness. Following this discussion, the research concludes with recommendations to Air Force leadership, research limitations, and opportunities for future research.

Key Findings from the Analysis Chapter

With the findings detailed in the Analysis chapter, the author addresses research questions and hypotheses, introduced in Chapter One, on the relevance of the Air Force PFT with respect to combat capability. In addition, we compare methodologies used in this research to those used in Captain Worden's research to observe any similarities or differences in results. In the initial simple linear regression model with the dependent variable as the Combat Composite and the independent variable as the Air Force Fitness Composite (Figure 1 of the Analysis chapter), the low R^2 value of 0.161 clearly shows the minimal correlation the Air Force fitness test has with respect to combat performance-based fitness. This value also displays what possible correlation the scoring mechanism for the Air Force fitness composite has with the scoring mechanism for the MCFT. The same model in Worden's thesis supports this hypothesis further by yielding an R^2 value of 0.215 (Worden, 2009:154).

The next simple linear regression in the Analysis chapter compares the Air Force fitness stratification results for the volunteers to the combat fitness stratification results to observe any relationship between the stratification results in both tests. If a volunteer scores in the top 10% for the Air Force fitness test, does this necessarily mean she will score in the top 10% for a combat fitness based test? The R^2 value of 0.368 (Figure 2 of the Analysis chapter) indicates this probability of equal stratification is quite low. Because the two tests evaluate a different combination of fitness components, a volunteer will not earn parallel scores on both tests, and ultimately will achieve different stratification results among their peers. The same model in Worden's thesis yields an R^2 value of 0.23 (Worden, 2009:39).

Further analysis tests the plausibility of altering the current AFPFT scoring system to better predict combat capability in Air Force personnel. The explanatory variables Worden uses in his model for the same analysis include: Age, BMI, AFPFT Cardio (raw), AFPFT Waist (raw), AFPFT Push-Ups (raw), and AFPFT Sit-Ups (raw). In this multiple regression model, the resulting adjusted R^2 value of 0.572 is a significant increase in comparison to the R^2 value from the first simple linear regression (0.161). This result questions the validity of the scoring mechanism for the Air Force PFT. Worden's same model yields an adjusted R^2 value of 0.737 (Worden, 2009:41). If the scoring system is truly representative of how a person performs on the assessment, the R^2 value for the simple linear regression, with the scored Air Force Fitness Composite, should resemble the R^2 value for the multiple regression with the raw Air Force PFT variables. Because the values are not similar, we question the accuracy of the fitness assessment scoring, via tables. The pre-existing maximum scores for the push-up and sit-up components further supports this thought process.

These pre-set values give Air Force personnel a goal to reach for, but provide no incentive for members to exceed. “In some cases, a subject may stop at the maximum even though they have the ability to continue since they already received the maximum score, and they are likely considering saving that remaining energy for their next event” (Worden, 2009:43). Members may be physically able to exceed the maximum values, but the score remains a value of 10. This lack of incentive decreases member’s motivation to go beyond the predetermined requirement to earn a maximum score. A peak in the sit-up distributions (Figures 5 and 6) supports this thought process and suggests the scoring mechanism used for this event is too simplistic. In the push-up distributions (Figures 7 and 8), however, we notice a wide range of values. In the author’s opinion, this is likely due to the lower upper body strength in women relative to men and women must work harder to earn a maximum score for this event. As a result, we expect a wider range of raw data for the push-up event. In Capt Worden’s mostly male study, both the sit-up and push-up distributions yielded a peak right where the participants reached the maximum for the respective event.

> It is clear that the scoring charts for the sit-ups are too easy when 85.366% of subjects got to or exceeded the maximum for sit-ups…The pushup raw data and points distributions…respectively, show the vast majority of test takers stopping in the 50-60 pushups range, which on the charts, is the range where the maximum of 10 points is received. Like the sit-ups scoring charts, this high number implies that the pushup scoring charts are likely set too easy to achieve that maximum as well. (Worden: 2009:43-44)

These combined results suggest that a modification in the scoring mechanism for the sit-up event, for both genders, and in the push-up event, for males, would allow for a better predictability of combat fitness and better assess members in their upper body muscular endurance.

The multiple regression models highlighting BMI and the Air Force Waist component prove significant (Figures 3 and 4 in the Analysis chapter). While each measures different elements of the human body, they also suggest predictability with regards to combat capability when the other is absent from a model. In all of the models, however, the estimate for both components is positive, indicating a person with a larger waist circumference or a larger BMI is more combat fit versus someone possessing opposite characteristics. With the Air Force fitness test putting such emphasis on having a small waist (20% of the PT score comes from the waist circumference measurement), this demand can hinder personnel from being ready for combat. “Abdominal circumference may be a good measure for general health but has no predictability in terms for combat capability” (Worden, 2009:76).

Subsets regression analysis assists in determining the predictability of each event within the Air Force PFT and MCFT with combat capability. From this, one can evaluate each individual event, as well as several significant models with respect to combat capability. To prevent a possible endogenous effect, we performed another subsets regression with the Air Force Fitness Composite as the proxy and analyzed whether the events within the AFPFT showed significance. Results indicate that the events were in fact significant, suggesting that the Air Force Fitness Test and Marine Combat Fitness Test are in fact assessing two different things, or in this case two different levels of fitness. This proves the initial hypothesis of the Air Force Physical Fitness Test not being predictive of combat capability within Air Force personnel.

The most significant models found in the initial subsets regression include the following: one event model - MCFT Ammunition Can Lift (AL); two event model – MCFT Movement to Contact (MTC) 1/2 mile run and MCFT AL; three event model – MCFT MTC, MCFT AL, and MCFT Maneuver Under Fire (MANUF). The author recommends implementing the two event model due to ease of assessment administering and Air Force leadership will likely not incorporate a robust event like the MANUF in fitness testing (included in the three event model).

In comparison, Worden's thesis yields the following best event results: one event model - Army Shuttle run; two event model – MCFT MTC (1/2 mile run) and MCFT AL (30 lb lifts); three event model - MCFT MTC, MCFT AL, and the Army Push-Ups; and four event model - MCFT MTC, MCFT AL, Army Push-Up, and Army shuttle run. Because Capt Worden uses additional testing events in his analysis, one should expect some differences in the model results. One highlighted similarity, however, is Worden's best two-event model result, which is the exact same result found in our analysis.

All of the models meet the residuals model assumptions of Constant Variance, Independence, and Normality. None of them contain any major influential data points (Cook's Distance), display any multicollinearity (VIF), or have a high percentage of error (MAPE). All of the p-values in the models show significance as well per the Bonferroni multiple means comparison, except for the four event model. Recalling Figure 12 of the Analysis chapter, all of the values under the Prob> {t} column are less than the Bonferroni value of .0125 (0.05/4) except for the Air Force push-ups. This result suggests the component is not predictive in this model and ultimately we excluded the model for further analysis.

While the simple linear and multiple regression models prove conclusive in analysis of the Air Force PFT and MCFT, the χ^2 contingency tables are not as reliable. One of the χ^2 contingency tables indicate insignificance (p-value>0.05), and the remaining two border the significance p-value. The first contingency table (reference Table 11 of the Analysis chapter) suggests a member with a smaller waist having a higher relative level of combat capability (p-value 0.057). Capt Worden's analysis yielded similar results – "a p-value of 0.0052129 which equates to a variable dependency" (Worden, 2009:71). The last contingency table test with average AFPFT score versus MCFT MANUF Completion borders significance (p-value 0.053) with the hypothesis of a member earning a lower than average AFPFT score having a greater probability of failing the MCFT MANUF event. Because these contingency tests do not take into consideration the other fitness variables, like the multiple regression analyses, we cannot infer any significant conclusions.

Significant Events in Both Fitness Tests

Using the predictive event models within the Analysis chapter, one can determine the most significant events with respect to combat readiness. Looking back at our top three models, the significant events are the MCFT MTC, AL, and MANUF.

Marine Combat Fitness Test (MCFT) Movement to Contact (MTC)

This event is the only distance specific event in the Combat Fitness Test. The event is a test of anaerobic endurance covering a ½ mile distance. The goal of the MTC is for participants to complete the course in the shortest time possible. Because this distance event shows more predictability in terms of combat capability (R^2 of 0.33) versus the Air Force cardio 1.5 mile run event (R^2 of 0.29), the event suggests shorter distances correlate more with a combat environment as opposed to longer ones. This result supports the notion of troops in combat running short distances to close the proximity for contact with the enemy.

Marine Combat Fitness Test (MCFT) Ammunition Can Lift (AL)

The AL is a test of muscular endurance. In this event, members lift the ammunition can from chest level to above head level with arms extended. Afterwards, the member brings the can back down to chest level. This counts as one repetition. The member repeats this action in as many repetitions as possible within a 2 minute time span. This event requires use of several muscles including the deltoids, triceps, and trapezius (back muscle directly below the neck). Combat-related tasks such as rapid movement of equipment (ammo, water, chow, and supplies) required to sustain direct combat actions with the enemy require muscular endurance from similar muscle groups.

Marine Combat Fitness Test (MCFT) Maneuver Under Fire (MANUF)

The MANUF incorporates anaerobic endurance, muscular strength, muscular endurance, mobility, and flexibility. The MANUF includes sprinting, low crawling, modified low crawling, running with ammunition cans, throwing a mock-grenade, and carrying a mock-casualty in the fireman carry position. The goal of the MANUF is for participants to complete the course in the shortest time possible. The initial sprint and crawl drills require burst speeds of energy and agility found in combat situations such as crawling under cover. The fireman’s carry simulates carrying a comrade to an area of safety. The fireman’s carry is a significant event within the MANUF, because the carry incorporates both anaerobic endurance and muscular strength. Of the 32 volunteers failing the MCFT, 30 failed the MANUF as a result of not completing the fireman's carry portion. Comparably to Worden's results, "Eleven subjects (7 men and 4 women) could not lift the adult-sized dummy into the fireman's carry, accounting for a 14.103% overall failure rate…" (Worden, 2009:97). Rarely do Air Force personnel perform this carry unless in a field training environment and even then do they ever carry a person within 10 lbs. of their own body weight. When a member arrives in a combat environment, he or she cannot anticipate the size of the person needing assistance, so building this muscular strength component is important in ensuring he or she can help a fellow comrade. The running with ammunition cans action in this event simulates having to carry equipment around and the dummy grenade simulates throwing an explosive ordinance at an enemy. This event not only incorporates the most fitness components of all the events, but also incorporates the most combat-related activities as well. The event is a likely combination of all feedback received from troops serving in or returning from a combat environment regarding physical tasks performed.

Recommendations to Air Force Leadership

There is no question the combat landscape is changing. With every war brings a new environment, new tactics, and new ways to train and equip the military force. This evolving platform requires an adaptable military, one able to react and fight in a multitude of war scenarios. One key reason the U.S. has the largest military power in the world, is the capability to fight and win regardless of the enemy. This requires evolving modifications to the training and assessment programs used in preparing soldiers, troops, airmen, and marines. The foundation for this preparation is physical fitness. Without quality fitness and testing programs in the military branches, armed forces will be ill prepared to perform tasks necessary within a war zone.

The Army and Marine Corps have taken great initiative to train their personnel for the rigors of war. While the Marine Corps is the only branch with an authorized combat performance-based assessment, the Army will soon implement their own combat based evaluation as well, as detailed in the Literature Review chapter. These two services serve as a prime example for the Air Force to follow in future efforts to revamp the physical training program. Physical training program modifications in the past resulted from a number of issues, including physical performance relative to sister services and health risks.

> The Air Force has had over 15 fitness policy changes in its short existence, generally prompted by poor performance or some sort of research study findings…leadership is showing a willingness to accept policy and training changes that are more contingency-focused (as evidenced by the recent addition of 'Beast' to the Air Force basic training). (Worden, 2009:75-76)

If leadership can implement changes such as this to support the evolving contingency mission, why is there such hesitation to revise the physical training program as well? Just-in-Time (JIT) deployment trainings, sporadic unit contingency trainings, and combat scenarios during Professional Military Education and basic training are not going to maintain a satisfactory level of combat readiness. Unless an airman is in a contingency-specific career field and engages in combat-based training on a regular basis, rarely will he or she have the opportunity to put on a ruck sack and get dirty.

Per DoD Directive 1308.1, "Service members must possess stamina and strength to perform, successfully, any mission," and that "…each service develops a quality fitness program that improves readiness and increases combat effectiveness of their personnel" (Worden, 2009:79). In-lieu-of (ILO) taskings and Joint Expeditionary Taskings (JET) put all airmen at risk for short notice deployments and require airmen to backfill Army and Marine personnel roles. The prior role of airmen providing support from a distance or by plane during combat no longer applies. A different enemy and an evolving war environment require a different way to train personnel. Short JIT trainings over a one or two month period do not prepare airmen to the same standard as Army or Marine personnel who continually train for combat. This limited training puts the lives of our airmen at risk. To better prepare them for the demands of a combat environment, the author suggests training airmen how we fight. If no career position is exempt from going on an ILO or JET deployment, leadership should prepare the entire Air Force accordingly. Because combat-specific personnel are no longer the only members vulnerable to fill these roles, all airmen should receive war-based physical training. Having a fit-to-fight force means being physically in shape not only for health reasons, but for the defense of this nation. Our men and women volunteer their lives to serve and protect this nation, therefore, leadership should train them to excel.

Getting personnel more combat ready does not require a drastic overhaul in the assessing and physically preparation of Air Force members. Per the Analysis chapter, increasing predictability 335% (R^2 value increases from 0.161 to over 0.57) is possible by simply changing the PFT scoring system alone and removing maximum values. Within this analysis, the raw scores of personnel indicate more predictability of combat capability versus the biased pre-set maximum scoring charts. As a result of implementing this minor change, many of the events within the Air Force PFT remain intact, while at the same time modernizing how leadership assesses airmen, and giving airmen motivation to strive for better event performance. Another minor change could involve removing the waist circumference as an event on the PFT and instead applying this component to the annual physical health assessment (PHA). Analysis suggests the measurement negatively correlates with health risk and positively with combat-related fitness performance (the higher the circumference is for a member, the more combat ready the member is). “For this reason, it is important for military leadership to acknowledge that a low (value) may be even more of a negative characteristic than a very high (value)” (Worden, 2009:77).

Another change could involve modifying the current fitness assessment, using one of the most predictive models described in the Analysis chapter. The author recommends use of the two event model in future assessments as the model shows predictability not only in this study (adj R^2 value of 0.864), but in Captain Worden’s as well (adj R^2 0.8514). Use of this model not only increases combat capability among airmen, but also requires less time and space than the current Air Force fitness test. This means less testing time and more time back at the unit, increasing productivity. A more significant change could be to implement two separate assessments, similar to the Army and Marine Corps. The semi-annual Air Force PFT would remain in place as a health-based evaluation and an additional annual combat performance-based test could supplement. While this avenue would require more testing time, the change would best prepare airmen for the strenuous demands of war.

Regardless of what avenue chosen, leadership should prepare airmen as necessary to defend this country. Inadequate physical preparation part puts sister-service member’s lives in jeopardy when deploying airmen to backfill in ILO and JET positions. The findings present in this research, along with the initial research by Captain Worden, suggest change takes place to increase the combat effectiveness and total force fitness of our airmen.

Research Limitations

Several limitations impact this research in one way or another. Because of restrictions imposed with human-based research as well as safety concerns, many of these were unavoidable, while others serve as a function of studies incorporating physical involvement. The key limitations present in the execution of this research included: lack of prior knowledge of combat fitness events, weather, time, safety limitations, and varying incentives and motivation among volunteers.

Lack of Prior Knowledge of Combat Fitness Events

Because members had little to no knowledge of the fitness events other than what was included in the Institutional Review Board (IRB) Informed Consent Document, this served as a definite limitation. If members were able to practice or observe an actual MCFT in advance of the study session, this could impact each volunteer's performance and result in higher performance levels. Because only one of the volunteers reported having previous experience with the assessment, via Marine members in her unit, the limitation of prior knowledge was relatively consistent across all volunteers.

Weather and Time

All of the study sessions took place outdoors at an open field location with a ½ or ¼ mile track. This location proved to be ideal because the area simulated an environment the Marine Corps would use when conducting their own MCFT, but the location was also susceptible to weather changes. During the data collection period, the associate investigator cancelled and rescheduled 6 sessions due to excessive rain or heat. If the Wet Bulb Globe Temperature (WBGT) indicated a black flag advisory based on humidity and heat temperature or the Health and Wellness Center (HAWC) leadership believed performing fitness assessments outdoors would be unsafe due to weather restrictions outlined in AFI 36-2905, the investigator rescheduled the study session accordingly. Changing times and dates of sessions inconvenienced not only the associate investigator, but the volunteers as well. Fortunately, many of the volunteers had flexible schedules and were able to adjust, but few were not.

The restricted data collection time frame, June 2011 to October 2011, served as a limitation as well because the investigator had to encourage as many participants as possible in order to get a satisfactory sample size for research. This resulted in accepting participants that may have taken their last PFT more than 6 months prior to the MCFT, enabling possible changes in fitness levels (reference beginning of the Analysis chapter). Many potential volunteers expressed interest in the study, but for one reason or another such as Temporary Duty (TDY) assignments or physical profiles, could not participate during the collection time period. Other volunteers scheduled to participate cancelled at the last minute due to reported short notice deployment taskings or other demands with their jobs. These limitations likely exist during actual MCFT testing as well, however, because the assessment is a requirement for all Marine’s, they are likely more motivated to complete the assessment in a timely manner.

Safety Limitations

In an attempt to minimize the risk to gain ratio for this research, the associate investigator altered certain higher difficulty test events to minimize safety risks for volunteers. For example, the Marine Corps use actual people during the fireman's drag and carry within the MANUF event. Prior to the start of the event, "the primary monitor will partner Marines by weight (within 10 lbs.) and approximate height (within 6 inches)," so partners can use each other as a "live" casualty during the event (Department of the Navy, 2008:3-4). Since Air Force personnel receive little training on a proper fireman's drag and/or carry, a standard female-weight (120 lbs.) dummy served as the casualty instead. Subjects also received instruction on the proper way to execute these casualty transport procedures prior to the start of the MANUF.

Additionally, during official PT sessions Air Force members must wear the official PT uniform. While performing the Marine Combat Fitness Test, the only authorized uniform for Marines is the Marine Pattern utility uniform similar to the Air Force Battle Uniform (ABU) (Department of the Navy, 2008:3-2). Because the Air Force does not routinely perform physical activity in this type of uniform, for safety purposes the test subjects had the option to wear their usual PT uniforms instead of ABUs during the MCFT. The associate investigator injected these safety limitations into the research for the sole purpose of minimizing potential injuries during testing.

Varying Incentives and Motivation among Volunteers

There are multiple reasons behind why the volunteers decided to participate in this research. Unit leadership motivated several members with the study counting as a Physical Training (PT) session, while others reported encouragement by co-workers or friends. For many, a physical fitness challenge or change to their workout routine was a driving factor. A few mentioned wanting to see change to the physical fitness program and expressed wanting to be a part of the change. With these varying incentives, there is opportunity to end up with a sample size not truly representative of the fitness levels of women in the Air Force. This self selection process can result in overly fit and enthusiastic sample of volunteers. The research investigator made great effort to prevent this issue including encouraging some less eager members to participate. The resulting AFPFT scores for the volunteers ranged from failing (scoring less than 75) to 100, covering a wide area of fitness levels.

As highlighted in the IRB Informed Consent Document in Appendix A, members could stop study participation at any time they wanted to with no questions asked. The investigator encouraged members to do the best they can, but did not overly push the volunteers, and reminded them the study was on a strict volunteer basis. Because this encouragement left members with little to no incentive to perform their physical best during the study sessions, this resulted in varying motivation among volunteers. Membes may not have exerted as much energy as they would during an Air Force fitness assessment, because there were no consequences associated with the MCFT in the study session. Some participants felt the other volunteers present at the study motivated them to their personal best, while others openly expressed they had little motivation to perform the session to the best of their ability. Out of the 61 total volunteers, one did not complete the MCFT AL event and another did not complete the MCFT MANUF event due to reported fatigue.

Members not having direct access to the scoring standards of the MCFT influenced their motivation as well. In the case of the Air Force PFT, the scoring charts as well as event minimums and maximums are readily available to the Air Force populace. The MCFT scoring charts, however, are not as openly accessible. During the study sessions, the investigator even mentioned lack of knowledge of the assessment scoring standards to prevent possible bias in the performance of the volunteers. If members wanted to know how they performed on the assessment, they were able to take a copy of their scores with them after the session and research online for the MCFT scoring standards. With a copy of their scores, they could get an idea of how they performed and whether they passed or failed the assessment. This lack of knowledge of the scoring standards for the assessment, served as a motivational influence on the volunteers. If they had this information readily available during the session, many of the volunteers would have likely performed better or had a score to work toward earning.

Opportunities for Future Research

This follow-on research, along with the initial research conducted by Captain Worden, serves as one of many research studies performed analyzing the evolving physical fitness demands and combat capability of our military personnel. Opportunities for variations to research questions, methodology, data collection, and discussion points suggest a multitude of areas for future research. Some plausible future research topics are as follows:

1) Implement a similar research study, but instead test Marine Corps females on the AFPFT to evaluate performance.

2) Complete an identical research study, but increase the data collection time allowing for more female participants and in turn a larger sample size.
3) Perform a similar research methodology with women only, but include the new Army Combat Readiness Test (ACRT) events in the data collection process, once authorized by the Army.
4) Research possible combat incidents having taken place as a result of inefficient combat readiness training prior to deployment for Air Force personnel.
5) Instead of using the volunteers' Air Force Physical Fitness Test results, have them take another PFT without the pre-set maximum values and use these raw data scores in analysis to further determine the accuracy of the scoring system.
6) Interview Air Force personnel having performed deployments with Army and Marine members to get feedback on what events would best fit in a combat assessment for the Air Force.

Appendix A. Institutional Review Board Approval Letter

DEPARTMENT OF THE AIR FORCE
AIR FORCE RESEARCH LABORATORY
WRIGHT-PATTERSON AIR FORCE BASE OHIO 45433

05 MAY 2011

MEMORANDUM FOR AFIT/ENV (DR. EDWARD D. WHITE)

FROM: 711 HPW/IR (AFRL IRB)

SUBJECT: IRB approval for the use of human volunteers in research

1. Protocol title: A Women-Only Comparison of the US Air Force Fitness Test and the Marine Combat-Fitness Test

2. Protocol number: FWR20110059H

3. Protocol version: 1.00

4. Risk: Minimal

5. Approval date: 5 May 2011

6. Expiration date: 4 May 2012

7. Scheduled renewal date: 4 April 2012

8. Type of review: Initial – Expedited

9. Assurance Number and Expiration Date:
   - AFRL MPA50002: 14 March 2014
   - AFIT DoD F50301: 30 November 2011

10. CITI Training: Completed

11. The above protocol has been reviewed and approved by the AFRL IRB via expedited review procedures. All requirements, as set by the IRB and its legal counsel, have been fully complied with. The study involves a comparison of the current Air Force Physical Fitness Test with the Marines Combat Fitness Test with the goal of determining if general fitness is a good predictor of combat fitness. This study involves minimal risk to the subjects. This protocol therefore meets the criteria for expedited review in accordance with 32 CFR 219.110 (b)(1) and U.S. Department of Health and Human Services category (7): Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

12. HIPAA authorization is not required, since no HIPAA protected information will be recorded in the execution of this protocol.

13. FDA regulations do not apply since no drugs, supplements, or unapproved medical devices will be used in this research.

14. This approval applies to human use research (as defined in 32 CFR 219 and AFI 40-402) portions of this project only. Attitude and opinion surveys associated with this research must be conducted IAW AFI 38-501, AF Survey Program. If the study is being conducted under an IDE or IND, a copy of the FDA IDE or IND approval letter must be submitted by the Principal Investigator to the IRB.

15. Any serious adverse event or issues resulting from this study should be reported immediately to the IRB. Amendments to protocols and/or revisions to informed consent documents must have IRB approval prior to implementation. Please retain both hard copy and electronic copy of the final approved protocol and informed consent document.

16. All inquiries and correspondence concerning this protocol should include the protocol number and name of the primary investigator. Please ensure the timely submission of all required progress and final reports and use the templates provided on the AFRL IRB web site http://www.wpafb.af.mil/library/factsheets/factsheet.asp?id=7496 .

17. For questions or concerns, please contact the IRB administrator, Lt Patricia Brennan at patricia.brennan@wpafb.af.mil or (937) 904-8100. All inquiries and correspondence concerning this protocol should include the protocol number and name of the primary investigator.

WILLIAM P. BUTLER, Col, USAF, MC, CFS
Director, AFRL IRB

cc:
AFMSA/SGE-C

1st Indorsement to AFIT/ENV (DR. EDWARD D. WHITE) Memo, 5 May 2011, Initial expedited approval FWR20110059H

MEMORANDUM FOR 711 HPW/IR (COL BUTLER)

I have reviewed the hardcopy and electronic records and found them to be complete and accurate.

Patricia C. Brennan

PATRICIA C. BRENNAN, 1 Lt, USAF
Lead Administrator, AFRL IRB

2nd Indorsement to AFIT/ENV (DR. EDWARD D. WHITE) Memo, 5 May 2011, Initial expedited approval FWR20110059H

MEMORANDUM FOR AFMSA/SGE-C

This protocol has been reviewed and approved by the AFRL IRB. I concur with the recommendation of the IRB and approve this research.

06 MAY 2011

RICHARD E. BACHMANN, JR.
Colonel, USAF, MC, CFS
Vice Director
711th Human Performance Wing

Appendix B. Institutional Review Board Research Protocol

A Women-Only Comparison of the US Air Force Fitness Test and the Marine Combat Fitness Test

FWR20110059H

1. Principal Investigator

Dr. Edward D. White, AFIT/ENC, 937-255-3636x4540, edward.white@afit.edu

2. Associate Investigators

a. Capt Tarah D. Mitchell, AFIT/ENV, 314-602-7807, tarah.mitchell@afit.edu

b. Lt Col Eric Unger, AFIT/ENV, 937-255-3636x7402, eric.unger@afit.edu

3. Medical Consultant or Monitor

Col William P. Butler
711 HPW/IR
Phone: 937-656-5436
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One of the investigators, Capt Tarah D. Mitchell, is a trained Physical Training Leader (PTL) and will be present at all testing sessions to not only conduct research, but also serve as a medical observer.

4. Facility/Contractor

No special facilities will be required. The WPAFB Area B gymnasium (Wright Field Fitness Center - WFFC) and outside track (weather pending) will be sufficient. Three session times per week will be established by an investigator and published to study participants.

To allow for a maximum number of USAF women available to participate in this research, study advertisements will be published throughout Wright-Patterson AFB, including but not limited to the base newspaper (pending PA approval and IRB review prior), Area B gymnasium female locker rooms (pending HAWC staff approval and IRB review prior), WPAFB Medical Center female restrooms (pending WPAFB Medical Center staff approval and IRB review prior), and the Air Force Institute of Technology (AFIT) Intranet web server (pending AFIT approval and IRB review prior).

5. Objective

The current Air Force fitness test is used to evaluate service-members' general health. However, it is inconclusive whether or not this test is a good predictor of *combat* fitness. If someone is deemed healthy according to the USAF PT standards, does this mean the person is adequately prepared to perform physical tasks in a combat environment? Does very high or very poor performance on the general fitness test predict very high or very poor performance on a combat fitness test? How much influence does each USAF PT test component have on the predictability of combat fitness? Are there better ways to weigh the event scoring, or to add, subtract, or alter events in order to maximize the predictability of combat fitness? In March 2009, USAF Captain

Thomas E. Worden published a thesis titled *A Comparison of the US Air Force Fitness Test and Sister Services' Combat-Oriented Fitness Tests* which served to answer these questions (reference Protocol F-WR-2008-0041-H). Out of the 86 USAF members that participated in the research for this thesis, only 5 of these members were female indicating a significant disparity in the number of women participants versus men. In addition, the group of 5 females had a significantly higher average USAF PT score (96.8) when compared to the men (90.1), so this small sample of women can be considered an "overly fit" selection of women and not necessarily a good representation of the women in the Air Force. This follow-on research serves to engage a larger sample of the USAF female population with a wider range of PT scores (75-100). This will allow for a better analysis of the combat fitness of women in the Air Force.

This research will be used to compile multiple variable-dependent personnel stratifications from a sample population and compare them to similar stratifications of the same personnel whom will take a newly developed combat fitness test. Regression, Analysis of Variance (ANOVA), and contingency table hypothesis testing analysis will be performed on individual personnel's event scores in order to determine if statistical differences, if any, exist between the general health fitness test and the combat fitness tests, or if variations of the tests offer improved predictability of combat fitness. Results will determine what ramifications this research will have on the Air Force and its evolving mission.

6. Background

The combat of today is ever-evolving and the Air Force mission abroad is getting closer and closer to the Army and Marines role. Past conflicts involved Air Force members located at airfields far from combat and rarely were there instances of these airfields being attacked. In comparison, today's war environment includes Airmen (men and women) deploying to where they are in close proximity to potential enemy forces making them vulnerable to direct and indirect attacks. Air Force members are even augmenting the Army and serving alongside them in long-term outside-the-wire deployment roles, called "In-Lieu-Of" (ILO) or Joint Expeditionary Taskings (JET). Both the Army and the Marines have questioned if a fitness program simply measuring general fitness may not be sufficient at maintaining or measuring combat readiness in their personnel. Both of these sister sisters have explored additional or alternative tests to better measure *combat* fitness, or the ability to handle the strains, stress, and demands required in combat situations. In October 2009, the Marines added a bi-annual Combat Fitness Test (CFT), focusing on burst speed and anaerobic ability. Since 1999, the Army has begun looking at ways to modify its existing Army Physical Fitness Test (APFT) to include more combat-preparation components. Effective March 2010, the Army implemented a Physical Readiness Training (PRT) program which incorporates more total-body and combat-ability workouts into the Army fitness program. An official combat fitness test for the Army is still being discussed by Army leadership. In the June 9th, 2008 Air Force Times cover story titled, "Fix the Fitness Test Now," PT leaders discuss the need for tougher tests and combat fitness components included in USAF PT testing. The March 7th, 2010 Air Force Times article titled “More Want Combat Element in Fitness Test,” discusses how the momentum for the Air Force to add a combat fitness test has come mostly from airmen returning from deployments whom have experienced the combat environment first hand. The goal of this follow-on research is to collect data that when analyzed can provide statistical evidence useful in gaining insight into the recent emphasis toward combat fitness in the US Armed Forces.

7. Impact

Results from this study will be analyzed with those of the initial study by Captain Thomas E. Worden to determine what ramifications this research will have on the Air Force and its mission. Exploratory analysis of the different testing events could lead to numerous implications about our current test and/or the USMC Combat Fitness Test (CFT). This research through statistical analysis can determine whether there is a significant correlation between general fitness and combat fitness, and whether the Air Force current PT program is sufficient for the Air Force’s evolving combat mission. If this research indicates general fitness and combat fitness have little to no correlation with each other, the USAF PT program may require alteration and/or addition of combat fitness components to its current fitness program in order to better keep up with combat requirements.

8. Experimental Plan

a. Equipment:

The research testing will require use of the WFFC gymnasium and outdoor track (weather pending). The equipment needed for the Marine CFT is a track to run on, cones for marking obstacles, two 30 lb dumbbells, a 120 pound “mock casualty” dummy, and a simulated grenade.

b. Subjects:

The subjects for this study will be active duty Air Force women ages 18 or higher, who are medically cleared to participate in USAF fitness testing. All potential subjects must complete and pass the Air Force Fitness Screening Questionnaire (included as an attachment to this proposal) which the AF currently uses prior to allowing a member to complete the USAF fitness test. Self-reporting pregnant women will be excluded from the study. There will be no further compensation for subjects beyond their normal duty pay. According to the Cohen test for power, there will be a minimum of 34 subjects required for significant statistical hypothesis to take place, although it is the goal of the investigators to test as many subjects as possible during the 5-month testing period because the more subjects tested the better statistical conclusions can be drawn from the data. Due to the time constraints of this research, it is estimated that there will be approximately 100 subjects in this study.

Recruiting will occur as follows:

1) Research advertisements will be published throughout Wright-Patterson AFB, including but not limited to the base newspaper (pending PA approval and IRB review prior), Area B gymnasium female locker rooms (pending HAWC staff approval and IRB review prior), WPAFB Medical Center female restrooms (pending WPAFB Medical Center staff approval and IRB review prior), and the

Air Force Institute of Technology (AFIT) Intranet web server (pending AFIT approval and IRB review prior). An investigator will also attend monthly Unit Fitness Program Manager (UFPM) meetings to generate interest among fitness leadership in units.

A. Interested participants will contact an investigator directly and schedule a time to take the Marine CFT during one of the pre-established session days/times.

B. Attend combat testing day. Capt Mitchell, a certified PTL and research investigator, will perform warm-up exercises with participants. Conduct Marine CFT.

C. Data collection with unit completed. Capt Mitchell will perform cool-down exercises with participants.

c. Duration:

Data will be collected from May 2011- September 2011. Each volunteer will be tested in one pre-established time period, roughly one to two hours in duration.

d. Description of experiment, data collection, and analysis:

Members wishing to participate will contact an investigator directly to sign-up for a pre-designated testing session. Potential subjects will read and sign the Informed Consent Document (attached to this protocol), and complete the Fitness Screening Questionnaire prior to testing. The investigators will ask those who have volunteered to bring their Air Force Portal fitness print-outs to the testing site. The test will be comprised of events that count either repetitions or time until completion in seconds. The CFT, events within the CFT, and the measures of performance are included as an attachment to this protocol.

The quantitative values will be the data collected from each volunteer by using "spotters," and stop-watches. The intention for testing is to have at least two participants per session. This allows the investigator to break the volunteers into groups of two, so that when one is testing the other is "spotting," which allows watching for safety in addition to recording the performance for a specific event. There will be a demonstration of the proper technique by an investigator in accomplishing each event of that day's test. Any necessary questions by volunteers on event components will be answered by the present investigator.

This protocol builds upon research protocol F-WR-2008-0041-H. In the previous protocol the same purpose, data collection, and analysis measures were used with three exceptions: 1) both men and women were able to participate in the study, 2) volunteers performed research study during their unit PT time (duty time), and 3)the Army Physical Readiness Test was still being discussed and finalized in the Army environment. Effective March 2010, the Army finalized a Physical Readiness Training (PRT) program which incorporates more total-body and combat-ability workouts into the Army fitness program, while still maintaining their existent Physical Fitness Test. Effective April 2011, the Army announced the roll out of a new fitness test that will replace the old PFT and incorporate exercises from the current PRT (Shaughnessy, 2011). Because the previous Army PFT is still in use and the new standards test are still being finalized, the data collection for this research protocol will not include an Army combat-fitness component. The previous research protocol included the 6-part Army Physical Readiness Test which was still being finalized among Army leadership at the time the research was conducted.

The collected data allows for stratifications among peer-groups which can be assigned by age, career field, or other variables. Subjects will be asked (as requested in the Informed Consent Document) to bring their Air Force Portal fitness score print-outs, providing the critical Air Force fitness test event scored plus additional data including age, height, and weight, which will also be added as variables to the analysis. JMP® will be the program used to analyze this data by altering independent variables and tracking how the peer stratifications are altered among each peer group. Regression, ANOVA, and contingency table hypothesis testing will be used to compare mean performance measures and overall performance for the different tests.

e. Safety monitoring:

Because testing will be done with volunteers in groups of two, the investigator can lead the testing and monitor for safety without being distracted by the data collection methods themselves. While one volunteer is testing the other is "spotting," which allows watching for safety in addition to recording the performance for a specific event. In addition, Capt Mitchell, an investigator and trained PTL, will be on site at each testing session to help in any case where safety could be a concern.

f. Confidentiality protection:

Subjects will utilize easy-to-remember subject codes being comprised of the first letter of their last name followed by the last four digits of their SSN. This code will replace subject names on all documentation (including the Air Force Portal print-out) in order to protect confidentiality. Any on-site test data collection sheets will use that code instead of a person's name.

9. Risk Analysis

Because this research involves physical activities and strenuous exercises, there are slight medical risks to the participants in this study. However, this is a test of active duty military personnel who typically have an established fitness program that requires multiple fitness sessions per week. A standard Air Force Fitness Screening Questionnaire will eliminate the most at-risk volunteers. All events to be tested will be properly demonstrated to help avoid potential injuries. All testing participants will be lead in proper warm-up and cool-down procedures. Nonetheless, physical fitness tests that include these types of physical events can lead to injuries such as sprains, bruises, lower back pain, cramping, muscle fatigue, strains, exhaustion, nausea, headaches, or other reasonable injuries caused from elevated levels of stress on the body. As a result of these possibilities, a medical first aid kit will be on site at all testing sessions and the investigator conducting the testing session will also serve as a medical observer. In any case of additional medical advice being required, the investigator on site many contact the research Medical Monitor, or in an emergency situation, can call for an ambulance or 911.

The nature of this research is non-controversial and would not cause any harm to the subject either personally or professionally. Data such as performance measures will be referenced with consent from the subject, and subject names will not be included in any reports.

The risk to gain ratio for this research has been minimized, and certain higher-difficulty test events have been altered to minimize risk for a volunteer. For example, the fireman's drag and carry within the Marine's CFT was designed to be using a live person as the casualty. But since Air Force personnel receive little training on a proper fireman's drag and/or carry, a standard female-weight (120 pounds) dummy will be used as the casualty. Subjects will also receive instruction on the proper way to execute these "casualty" transport procedures. Additionally, Air Force PT sessions are performed in official PT uniform. The Marine CFT is designed to be done wearing a combat uniform, such as the Air Force Battle Uniform (ABU). Because the Air Force is not used to performing physical activity in this type of uniform, for safety purposes the test subjects will be given the option to wear their usual PT uniforms. These are limitations that are being injected into the research for the sole purpose of minimizing potential injuries during this testing.

10. References

a. Worden, Thomas E., Captain, USAF. *A Comparison of the US Air Force Fitness Test and Sister Services' Combat-Oriented Fitness Tests*. *MS thesis, AFIT/GEM/ENC/09-01.* School of Engineering and Management, Air Force Institute of Technology (AFIT), Wright-Patterson AFB, OH, March 2009.
b. Swiderski, Steven J., Captain, USAF. *Fit-to-Fight: Waist vs. Waist/Height Measurements to Determine an Individual's Fitness Level – a Study in Statistical Regression and Analysis. MS thesis, AFIT/GCA/ENC/05-03.* School of Engineering and Management, Air Force Institute of Technology (AFIT), Wright-Patterson AFB, OH, June 2005.
c. Hoffman, Michael. "Fit to Fight? Fix the Fitness Test Now" *Air Force Times* 68, no. 47 (9 June 2008): 14-16.
d. Hoffman, Michael. "More Want Combat Element in Fitness Test" *Air Force Times* (7 March 2010).
e. ArmyPRT.com. Army Physical Readiness Training Program. (March 2010)
f. Shaugnhessy, Larry. "Get in Shape Like a Soldier—the Army's new fitness test" CNN.com (8 April 2011).
g. See the Bibliography of this thesis for additional references

11. Attachments

a. Informed Consent Document
b. Fitness Screening Questionnaire
c. Description of Test, Events, and Performance Measures
d. Sample Recruiting Advertisement

Attachment A: Informed Consent Document

INFORMATION PROTECTED BY THE PRIVACY ACT OF 1974
Informed Consent Document
For
A Women-Only Comparison of the US Air Force Fitness Test and the Marine Combat- Fitness Test

Air Force Institute of Technology (AFIT), Wright-Patterson AFB (WPAFB), Ohio

Principal Investigator:	Dr. Edward D. White, DSN 785-3636x4540, AFIT/ENC edward.white@afit.edu
Associate Investigators:	Capt Tarah D. Mitchell, (314) 602-7807, AFIT/ENV tarah.mitchell@afit.edu
	Lt Col Eric Unger, DSN 785-3636x7402, AFIT/ENV eric.unger@afit.edu

1. **Nature and purpose:** You have been offered the opportunity to participate in the research study entitled *"A Women-Only Comparison of the US Air Force Fitness Test and the Marine Combat- Fitness Test*." Your participation will occur at Wright-Patterson AFB, at the Wright Field Fitness Center or the area directly outside of the Wright-Field Fitness Center.

   The purpose of this research is to compare our current Air Force Physical Fitness Test (PFT) with the Marines Combat Fitness Test (CFT), with the goal of determining if general fitness is a good predictor of combat fitness. Statistical analysis will be used on the data in order to form conclusions that will be meaningful to the Air Force and/or the United States Marine Corps.

   The time requirement for each volunteer subject is anticipated to be a total of one visit of approximately one to two hours. At least 34 female subjects will be enrolled in this study, although for aiding in statistical hypothesis testing the goal is to collect as much data as possible, and so there could be over 100 subjects. To be eligible for participation you must pass the same screening requirements which are used for the current Air Force PFT. You are still encouraged to participate even if you believe that you do not excel in physical aptitude.

   You must also be willing to submit an Air Force Portal print-out of your Air Force PFT records. This information will be used for research only and names will not be included in any reports or documents. Names will be replaced with a subject code consisting of the first letter of your last name followed by the last four digits of your social security number in order to protect your privacy.
2. **Experimental procedures:** If you decide to participate, you will be given the Marine CFT which is designed to be more combat-fitness focused rather than general-fitness focused. There are no scoring standards for this test and there are no minimums or maximums. A participant may stop the testing at any time. Participants

may wear the normal Air Force PT uniform or a combat uniform with combat boots (either the ABU or the BDU) and will be given a chance to change between indoor and outdoor events if desired.

The Marine CFT has three events, with sufficient rest time between events to allow for recovery, food and/or drink, or a restroom break. The first event is the 880 yard run (half-mile), known as Maneuver to Contact (MTC). Although walking is authorized, it is not encouraged. The goal is to complete the ½ mile run in the shortest time possible. The second event is the 30 pound lift, known as the Ammunition-Can Lift (ACL), where you lift a weight from chest height to above the head with your arms extended. You will repeat this action for as many repetitions as you can for two minutes. The final event is a 12-leg obstacle course, known as Maneuver Under Fire (MANUF), which is roughly 25 yards long each way and 5 yards wide. The MANUF includes running, running with weights, throwing a mock-grenade, and moving a 120 pound mock-casualty. You will start by completing the first three legs: a sprint, a high-crawl on hands and knees, and a zigzag though 5 markers spaced 5 yards apart. You will then pick up a dummy casualty into an underarm carry, drag the dummy through two markers covering about 10 yards, lift the dummy into a fireman's carry, and run the remaining leg plus 2 more legs before placing the dummy back onto the ground. Next, you will pick up two 30 pound dumbbells, run 2 legs, and run another leg in zigzag fashion while still carrying the weights. You then will place the weights down and pick up a mock-grenade, throw it at a target space about 22.5 yards away, and drop to the ground into prone position to "take cover." After getting back up from prone position and re-lifting the two 30 pound weights, you will run another zigzag leg with the weights, and the final 2 legs straight with the weights to the finish line.

Obviously this test is different than the current Air Force PFT and so each event will be properly demonstrated to you prior to your execution of it. This is because this test focuses more on skills demanded in combat situations. Safety will be a priority and if the test is to be done outdoors there will be limitations as to temperature or weather prior to testing. If at any time during the testing you do not feel as though continuing would be a wise decision, you may stop at any time. Those testing will be paired up with a fellow volunteer and will alternate between one testing and the other spotting and/or counting.

3. **Discomfort and risks:** Potential risks exist during this testing, which are similar to what you risk every time you physically exert yourself. Proper stretching and warm-up prior to testing and cool-down following testing will minimize risks, as well as being properly shown how to execute each of the events. If an adverse event does occur, there will be a trained PTL on site and both a medical kit and /or quick transport to a medical facility available. Many of the participating personnel have been trained in Self Aide Buddy Care (SABC). There is also a research Medical Monitor available for further medical advice if necessary. Nonetheless, physical fitness tests that include these types of (in some cases, unfamiliar) events could lead to injuries such as sprains, bruises, lower back pain, cramping, muscle fatigue, strains, exhaustion, nausea, headaches, or other reasonable injuries caused from elevated levels of stress on the body.

4. **Precautions for female subjects or subjects who are or may become pregnant during the course of this study:** If you are pregnant you may not participate in this study.

5. **Benefits:** You are not expected to benefit directly from participation in this research study. This is exploratory research only with no direct beneficiary other than the Air Force or the Marine Corps.

6. **Compensation:** If you are active duty military you will receive your normal active duty pay, but no additional compensation will be given for volunteering for this study.

7. <u>Alternatives: Your alternative is to choose not to participate in this study. Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. Notify one of the investigators of this study to discontinue.</u>

8. **Entitlements and confidentiality:**
   a. Records of your participation in this study may only be disclosed according to federal law, including the Federal Privacy Act, 5 U.S.C. 552a, and its implementing regulations and the Health Insurance Portability and Accountability Act (HIPAA), and its implementing regulations, when applicable, and the Freedom of Information Act, 5 U.S.C. Sec 552, and its implementing regulations when applicable. It is intended that the only people having access to your information will be the researchers named above and this study's Medical Monitor or Consultant, the AFRL Wright Site IRB, the Air Force Surgeon General's Research Compliance office, the Director of Defense Research and Engineering office or any other IRB involved in the review and approval of this protocol. When no longer needed for research purposes your information will be destroyed in a secure manner (shredding). Complete confidentiality cannot be promised, in particular for military personnel, whose health or fitness for duty information may be required to be reported to appropriate medical or command authorities. If such information is to be reported, you will be informed of what is being reported and the reason for the report.

   b. Your entitlements to medical and dental care and/or compensation in the event of injury are governed by federal laws and regulations, and that if you desire further information you may contact the base legal office (ASC/JA, 257-6142 for Wright-Patterson AFB). You may contact an investigator regarding medical questions related to this research study. One of the investigators, Capt Tarah D. Mitchell, is a trained PTL and will be present at all testing sessions. In the event of a research related injury, you may contact the medical monitor, Col William P. Butler, of this research study at (937) 656-5436 or William.butler2@wpafb.af.mil.

c. The decision to participate in this research is completely voluntary on your part. No one may coerce or intimidate you into participating in this program. You are participating because you want to. Capt Tarah D. Mitchell, or an associate, has adequately answered any and all questions you have about this study, your participation, and the procedures involved. Capt Tarah D. Mitchell can be reached at (314) 602-7807. Capt Tarah D. Mitchell or another investigator will be available to answer any questions concerning procedures throughout this study. If significant new findings develop during the course of this research, which may relate to your decision to continue participation, you will be informed. Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. Notify one of the investigators of this study to discontinue. The investigator or medical monitor of this study may terminate your participation in this study if she or he feels this to be in your best interest. If you have any questions or concerns about your participation in this study or your rights as a research subject, please contact Col William P. Butler at (937) 656-5436 or William.butler2@wpafb.af.mil.

d. Your participation in this study may be photographed, filmed or audio/videotaped. The purpose of these recordings is for potential presentation or publication. Any release of records of your participation in this study may only be disclosed according to federal law, including the Federal Privacy Act, 5 U.S.C. 552a, and its implementing regulations. This means personal information will not be released to unauthorized source without your permission. These recording may be used for presentation or publication, with your signed permission. They will be stored in a locked cabinet in a room that is locked when not occupied. Only the investigators of this study will have access to these media. Any media not used in presentation or publication prior to June 2012 will be destroyed.

YOU ARE MAKING A DECISION WHETHER OR NOT TO PARTICIPATE. YOUR SIGNATURE INDICATES THAT YOU HAVE DECIDED TO PARTICIPATE HAVING READ THE INFORMATION PROVIDED ABOVE.

Volunteer Signature____ **Date**_______________
Volunteer Name (printed)____
Advising Investigator Signature ___________________________ **Date** __________________
Investigator Name (printed) ____
Witness Signature _______________________________________**Date** __________________
Witness Name (printed) ____

We may wish to present some of the video/audio recordings from this study at scientific conventions or use photographs in journal publications. If you consent to the use of your image for publication or presentation in a scientific or academic setting, please sign below.

Volunteer Signature____**Date**_______________

Privacy Act Statement

Authority: We are requesting disclosure of personal information... Researchers are authorized to collect personal information on research subjects under The Privacy Act-5 USC 552a, 10 USC 55, 10 USC 8013, 32 CFR 219, 45 CFR Part 46, and EO 9397, November 1943.

Purpose: It is possible that latent risks or injuries inherent in this experiment will not be discovered until some time in the future. The purpose of collecting this information is to aid researchers in locating you at a future date if further disclosures are appropriate.

Routine Uses: Information may be furnished to Federal, State and local agencies for any uses published by the Air Force in the Federal Register, 52 FR 16431, to include, furtherance of the research involved with this study and to provide medical care.

Disclosure: Disclosure of the requested information is voluntary. No adverse action whatsoever will be taken against you, and no privilege will be denied you based on the fact you do not disclose this information. However, your participation in this study may be impacted by a refusal to provide this information.

Attachment B: Fitness Screening Questionnaire

FITNESS SCREENING QUESTIONNAIRE

1. Do you have a health condition **not** addressed in a physical profile (AF Form 422) that could be aggravated by participating in your unit's physical training program/fitness testing or that would preclude your safe participation?

_ Yes Stop here; notify your Unit Fitness Program Manager (UFPM) and contact your Primary Care Manager for evaluation.

_ No Proceed to next question.

2. Do you have any of the following?

- Chest discomfort with exertion
- Unusual shortness of breath
- Dizziness, fainting, blackouts

_ Yes Stop here; notify your UFPM and contact your Primary Care Manager for evaluation.

_ No Proceed to next question.

3. Are you less than 35 years of age?

_ Yes Stop here; sign form and return to your Unit Fitness Program Manager.

_ No Proceed to next question.

4. Do **two (2) or more** of the following risk factors apply to you?

- Physically inactive; that is, you have not participated in physical activities of at least a moderate level (i.e., that caused light sweating and slight-to-moderate increases in breathing or heart rate) for at least 30 minutes per session and for a minimum of 3 days per week for at least 3 months
- Smoked cigarettes in the last 30 days
- Diabetes
- High blood pressure that is not controlled
- High cholesterol that is not controlled
- Family history of heart disease (developed in father/brother before age 55 or mother/ sister before age 65)
- Abdominal circumference >40" for males; >35" for females
- Age = 45 years for males; = 55 years for females

_ Yes Stop here; notify your UFPM and contact your Primary Care Manager for evaluation.

_ No Sign form and return to Unit Fitness Program Manager.

You must notify Detachment Personnel if you have a change in health that may affect your ability to safely participate in unit physical training.

Signature:____ Date: ______________________

Printed Name: ____Rank: ______________________

Duty Phone: ___________________________________ Office Symbol: ______________________

Authority: 10 USC 8013.

Routine Use: This information is not disclosed outside DoD.

Attachment C: Description of Test, Events, and Performance Measures

DESCRIPTION OF MARINE COMBAT FITNESS TEST (CFT), EVENTS WITHIN THE CFT, AND PERFORMANCE MEASURES

Test Summary: This test has three events, with sufficient rest time between events to allow for recovery, food and/or drink, or a restroom break. The 3rd event is the most dissimilar from what the Air Force is used to.

Event 1: 880 Yard (1/2 Mile) Run
Equipment Used: Track (Indoor/Outdoor)
Description: Same as the Air Force PT test run, but a shorter distance. Walking is authorized.
Duration: As fast as possible
Performance Measure: Completion Time

Event 2: 30-Pound Lifts
Equipment Used: 30-pound dumbbells, spotter
Description: Lift a weight from chest height to above the head with arms fully extended. Bring weight back down to chest height. Repeat until time is up.
Duration: 2 minutes
Performance Measure: Repetitions

Event 3: Four-Part Obstacle Course ("Maneuver Under Fire" Drill)
Equipment Used: Cones, 120-pound "casualty" dummy, 2x30-pound dumbbells, mock-grenade
Description: This event consists of 12 legs of 25 yards each. The first three legs are as follows: a sprint, a high-crawl on hands and knees, and a zigzag though 5 markers spaced 5 yards apart. The participant will pick up a dummy casualty into an underarm carry, drag the dummy through two markers covering about 10 yards, lift the dummy into a fireman's carry, and run the remaining leg plus 2 more legs before placing the dummy back onto the ground. Afterwards, the participant will pick up two 30 pound dumbbells, run 2 legs, and run another leg in zigzag fashion while still carrying the weights. The participant will then place the weights down and pick up a mock-grenade, throw it at a target space about 22.5 yards away, and drop to the ground into prone position to "take cover." After getting back up from prone position and re-lifting the two 30 pound weights, the participant will run another zigzag leg with the weights, and the final 2 legs straight with the weights to the finish line.
Duration: As fast as possible
Performance Measure: Completion time (5 seconds added on if the mock-grenade throw misses its target.

Attachment D: Sample Recruiting Advertisement

Ladies…Are you ready for combat?

Participate in this research study and find out!

What: Participants will be given a series of physical tests to determine their combat fitness level. **All** physical fitness levels are encouraged to participate. This is a women-only study.

When: Choose any 1 hour session. Sessions are held on Tuesdays and Thursdays from 1100-1200 and Saturdays from 0700-0800.

Where: Wright Field Fitness Center Track (Area B)

Why: Results from this study can possibly impact the PT programs within the Armed Services

Contact Capt Tarah Mitchell via e-mail at tarah.mitchell@afit.edu for more information and to sign-up! Research Protocol # F-WR-2011-0059

This research study has been approved by the Air Force Research Laboratory Institutional Review Board pursuant to AFI 40-402 and AFRLI 40-402.

This proposed advertisement would be the primary one used for recruitment. The graphics/font may be slightly changed; however, if the advertisement is changed in any way or if additional flyers are created, they will be sent to the IRB first for approval.

Appendix C. Institutional Review Board Amendment Approval Letter

DEPARTMENT OF THE AIR FORCE
AIR FORCE RESEARCH LABORATORY
WRIGHT-PATTERSON AIR FORCE BASE OHIO 45433

1 6 JUN 2011

MEMORANDUM FOR AFIT/ENV (DR. EDWARD D. WHITE)

FROM: 711 HPW/IR (AFRL IRB)

SUBJECT: IRB approval for the use of human volunteers in research

1. Protocol title: A Women-Only Comparison of the US Air Force Fitness Test and the Marine Combat-Fitness Test

2. Protocol number: FWR20110059H

3. Protocol version: 1.01

4. Risk: Minimal

5. Approval date: 16 June 2011

6. Expiration date: 4 May 2012

7. Scheduled renewal date: 4 April 2012

8. Type of review: Amendment – Expedited

9. Assurance Number and Expiration Date:
    - AFRL MPA50002: 14 March 2014
    - AFIT DoD F50301: 30 November 2011

10. CITI Training: Completed

11. The above protocol has been reviewed and approved by the AFRL IRB via expedited review procedures. All requirements, as set by the IRB and its legal counsel, have been fully complied with. The study involves a comparison of the current Air Force Physical Fitness Test with the Marines Combat Fitness Test with the goal of determining if general fitness is a good predictor of combat fitness. This study involves minimal risk to the subjects. The amendments offered include using 30 lb. ammunition cans instead of 30 lb. dumbbells, allowing Reservists and Guard females to participate, and implementing the Maneuver Under Fire (MAUNF) course outdoors instead of indoors (changes the course dimensions). These amendments add no appreciable risk to the participants in this minimal risk study. This protocol therefore meets the criteria for expedited review in accordance with 32 CFR 219.110 (b)(1) and U.S. Department of Health and Human Services category (7): Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity,

language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

12. HIPAA authorization is not required, since no HIPAA protected information will be recorded in the execution of this protocol.

13. FDA regulations do not apply since no drugs, supplements, or unapproved medical devices will be used in this research.

14. This approval applies to human use research (as defined in 32 CFR 219 and AFI 40-402) portions of this project only. Attitude and opinion surveys associated with this research must be conducted IAW AFI 38-501, AF Survey Program. If the study is being conducted under an IDE or IND, a copy of the FDA IDE or IND approval letter must be submitted by the Principal Investigator to the IRB.

15. Any serious adverse event or issues resulting from this study should be reported immediately to the IRB. Amendments to protocols and/or revisions to informed consent documents must have IRB approval prior to implementation. Please retain both hard copy and electronic copy of the final approved protocol and informed consent document.

16. All inquiries and correspondence concerning this protocol should include the protocol number and name of the primary investigator. Please ensure the timely submission of all required progress and final reports and use the templates provided on the AFRL IRB web site http://www.wpafb.af.mil/library/factsheets/factsheet.asp?id=7496 .

17. For questions or concerns, please contact the IRB administrator, Lt Patricia Brennan at patricia.brennan@wpafb.af.mil or (937) 904-8100. All inquiries and correspondence concerning this protocol should include the protocol number and name of the primary investigator.

WILLIAM P. BUTLER, Col, USAF, MC, CFS
Director, AFRL IRB

cc:
AFMSA/SGE-C

1st Indorsement to AFIT/ENV (DR. EDWARD D. WHITE) Memo, 16 June 2011, Amendments expedited approval FWR20110059H

MEMORANDUM FOR 711 HPW/IR (COL BUTLER)

I have reviewed the hardcopy and electronic records and found them to be complete and accurate.

Patricia C. Brennan

PATRICIA C. BRENNAN, 1 Lt, USAF
Lead Administrator, AFRL IRB

2nd Indorsement to AFIT/ENV (DR. EDWARD D. WHITE) Memo, 16 June 2011, Amendments expedited approval FWR20110059H

MEMORANDUM FOR AFMSA/SGE-C

This protocol has been reviewed and approved by the AFRL IRB. I concur with the recommendation of the IRB and approve this research.

17 JUN 2011

RICHARD E. BACHMANN, JR.
Colonel, USAF, MC, CFS
Vice Director
711th Human Performance Wing

Appendix D. Institutional Review Board Second Amendment Approval Letter

DEPARTMENT OF THE AIR FORCE
AIR FORCE RESEARCH LABORATORY
WRIGHT-PATTERSON AIR FORCE BASE OHIO 45433

27 SEP 2011

MEMORANDUM FOR AFIT/ENV (DR. EDWARD D. WHITE)

FROM: 711 HPW/IR (AFRL IRB)

SUBJECT: IRB approval for the use of human volunteers in research

1. Protocol title: A Women-Only Comparison of the US Air Force Fitness Test and the Marine Combat-Fitness Test
2. Protocol number: FWR20110059H
3. Protocol version: 1.02
4. Risk: Minimal
5. Approval date: 27 September 2011
6. Expiration date: 4 May 2012
7. Scheduled renewal date: 4 April 2012
8. Type of review: Amendment – Expedited
9. Assurance Number and Expiration Date:
   - AFRL MPA50002: 14 March 2014
   - AFIT DoD F50301: 30 November 2011
10. CITI Training: Completed
11. The amendments to the above protocol were reviewed and approved by the AFRL IRB via expedited review procedures. All requirements, as set by the IRB and its legal counsel, have been fully complied with. The study involves a comparison of the current Air Force Physical Fitness Test with the Marines Combat Fitness Test with the goal of determining if general fitness is a good predictor of combat fitness. This study involves minimal risk to the subjects. The amendments offered include using 30 lb. ammunition cans instead of 30 lb. dumbbells, allowing Reservists and Guard females to participate, and implementing the Maneuver Under Fire (MAUNF) course outdoors instead of indoors (changes the course dimensions). The amendments to the study are minor and consist of changing the investigator from Lt Col Unger to Major Ritschel. Lt Col Unger is retiring and Major Ritschel is replacing him. This protocol therefore meets the criteria for expedited review in accordance with 32 CFR 219.110 (b)(2): minor changes in

previously approved research during the period of one year or less for which approval is authorized.

12. Per the memorandum issued by the AFRL AIO, Mr. Wells, these changes can be approved by the AFRL IRB Chair, and they do not need to be forwarded to the AIO for approval. The amendment will be presented to the convened IRB in the agenda.

13. HIPAA authorization is not required, since no HIPAA protected information will be recorded in the execution of this protocol.

14. FDA regulations do not apply since no drugs, supplements, or unapproved medical devices will be used in this research.

15. This approval applies to human use research (as defined in 32 CFR 219 and AFI 40-402) portions of this project only. Attitude and opinion surveys associated with this research must be conducted IAW AFI 38-501. If the study is being conducted under an IDE or IND, a copy of the FDA IDE or IND approval letter must be submitted by the Principal Investigator to the IRB.

16. Any serious adverse event or issues resulting from this study should be reported immediately to the IRB. Amendments to protocols and/or revisions to informed consent documents must have IRB approval prior to implementation. Please retain both hard copy and electronic copy of the final approved protocol and informed consent document.

17. All inquiries and correspondence concerning this protocol should include the protocol number and name of the primary investigator. Please ensure the timely submission of all required progress and final reports and use the templates provided on the AFRL IRB web site http://www.wpafb.af.mil/library/factsheets/factsheet.asp?id=7496 .

13. For questions or concerns, please contact the IRB administrator, Lt Patricia Brennan at patricia.brennan@wpafb.af.mil or (937) 656-5431. All inquiries and correspondence concerning this protocol should include the protocol number and name of the primary investigator.

WILLIAM P. BUTLER, Col, USAF, MC, CFS
Director, AFRL IRB

DEPARTMENT OF THE AIR FORCE

15 MAR 2009

MEMORANDUM FOR HQ USAF/SGRC

FROM: 711 HPW/CL
2610 Seventh Street
Wright-Patterson AFB OH 45433-7901

SUBJECT: Delegation of Approval Authority for Minor Amendments

1. In order to reduce the approval time for minor amendments, the IRB proposes delegating the authority to approve minor amendments to the IRB Chairperson

2. Minor amendments are defined as administrative changes to the protocol or ICD that consist of at least one of the following:

a. Personnel changes that do not require a new assurance.

b. Language changes to the ICD that revise old versions to meet current templates and corresponding changes to the protocol.

THOMAS S. WELLS, SES
Director
711th Human Performance Wing

Appendix E. JMP ® Variables

Volunteer Code

Age

Height

Weight

BMI

AFPFT Cardio (raw) – seconds

AFPFT Cardio (score)

AFPFT Cardio % stratification/ranking

AFPFT Waist (raw)

AFPFT Waist (score)

AFPFT Waist % stratification/ranking

AFPFT Push-Ups (raw)

AFPFT Push-Ups (score)

AFPFT Push-Ups % stratification/ranking

AFPFT Sit-Ups (raw)

AFPFT Sit-Ups (score)

AFPFT Sit-Ups % stratification/ranking

Total AFPFT score

Total AFPFT % stratification/ranking (score)

AFPFT ranking (1 = 90+, 2 = 80+, 3 = <75)

MCFT MTC (raw) – seconds

MCFT MTC (score)

MCFT MTC % stratification/ranking

MCFT AL (raw)

MCFT AL (score)

MCFT AL % stratification/ranking

MCFT MANUF (raw) – seconds

MCFT MANUF (score)

MCFT MANUF % stratification/ranking

Total MCFT score

Total MCFT % stratification/ranking

Failure in 1 or more MCFT events (Y/N)

MCFT Classification

Appendix F. Marine Combat Fitness Test Scoring Charts

8. Score. The CFT is a scored event. Calculating a cumulative score for a completed CFT can be derived from Tables 3-5 through 3-7.

MOVEMENT TO CONTACT

	17-26		27-39		40-45		46+	
TIME	M	F	M	F	M	F	M	F
2:45	100	x	x	x	x	x	x	x
2:46	99	x	x	x	x	x	x	x
2:47	99	x	x	x	x	x	x	x
2:48	98	x	x	x	x	x	x	x
2:49	98	x	x	x	x	x	x	x
2:50	97	x	x	x	x	x	x	x
2:51	97	x	100	x	x	x	x	x
2:52	96	x	99	x	x	x	x	x
2:53	96	x	99	x	x	x	x	x
2:54	95	x	98	x	x	x	x	x
2:55	95	x	98	x	x	x	x	x
2:56	95	x	97	x	x	x	x	x
2:57	94	x	97	x	x	x	x	x
2:58	94	x	97	x	x	x	x	x
2:59	93	x	96	x	x	x	x	x
3:00	93	x	96	x	x	x	x	x
3:01	92	x	95	x	x	x	x	x
3:02	92	x	95	x	x	x	x	x
3:03	91	x	95	x	100	x	x	x
3:04	91	x	94	x	99	x	x	x
3:05	91	x	94	x	99	x	100	x
3:06	90	x	93	x	99	x	99	x
3:07	90	x	93	x	99	x	99	x
3:08	89	x	93	x	98	x	99	x
3:09	89	x	92	x	98	x	99	x
3:10	88	x	92	x	98	x	98	x
3:11	88	x	91	x	97	x	98	x
3:12	87	x	91	x	97	x	98	x
3:13	87	x	91	x	97	x	97	x
3:14	87	x	90	x	97	x	97	x
3:15	86	x	90	x	96	x	97	x
3:16	86	x	89	x	96	x	96	x
3:17	85	x	89	x	96	x	96	x
3:18	85	x	88	x	95	x	96	x
3:19	84	x	88	x	95	x	95	x
3:20	84	x	88	x	95	x	95	x
3:21	83	x	87	x	94	x	95	x
3:22	83	x	87	x	94	x	95	x

Table 3-5. - Movement to Contact

MOVEMENT TO CONTACT

	17-26		27-39		40-45		46+	
TIME	M	F	M	F	M	F	M	F
3:23	83	100	86	x	94	x	94	x
3:24	82	99	86	x	93	x	94	x
3:25	82	99	86	x	93	x	94	x
3:26	81	98	85	x	93	x	93	x
3:27	81	98	85	x	92	x	93	x
3:28	80	98	84	x	92	x	93	x
3:29	80	97	84	x	92	x	92	x
3:30	79	97	84	100	91	x	92	x
3:31	79	97	83	99	91	x	92	x
3:32	79	96	83	99	91	x	91	x
3:33	78	96	82	98	90	x	91	x
3:34	78	96	82	98	90	x	91	x
3:35	77	96	82	98	90	x	90	x
3:36	77	95	81	97	89	x	90	x
3:37	76	95	81	97	89	x	90	x
3:38	76	95	80	97	89	x	89	x
3:39	75	94	80	96	88	x	89	x
3:40	75	94	80	96	88	x	89	x
3:41	75	94	79	96	88	x	88	x
3:42	74	93	79	95	87	x	88	x
3:43	74	93	78	95	87	x	88	x
3:44	73	93	78	95	86	x	87	x
3:45	73	92	78	94	86	x	87	x
3:46	72	92	77	94	86	x	87	x
3:47	72	92	77	94	85	x	86	x
3:48	71	91	76	93	85	x	86	x
3:49	71	91	76	93	84	100	86	x
3:50	71	91	76	93	84	99	85	x
3:51	70	90	75	92	84	99	85	x
3:52	70	90	75	92	84	98	85	x
3:53	69	90	74	92	83	98	84	x
3:54	69	90	74	91	83	98	84	x
3:55	68	89	74	91	83	97	84	100
3:56	68	89	73	91	82	97	84	99
3:57	67	89	73	90	82	96	83	99
3:58	67	88	72	90	82	96	83	99
3:59	67	88	72	90	81	96	83	99
4:00	66	88	72	89	81	95	82	98
4:01	66	87	71	89	81	95	82	98
4:02	65	87	71	89	80	95	82	98
4:03	65	87	70	88	80	94	81	97
4:04	64	86	70	88	80	94	81	97

Table 3-5. - Movement to Contact

MOVEMENT TO CONTACT

	17-26		27-39		40-45		46+	
TIME	M	F	M	F	M	F	M	F
4:05	64	86	70	88	79	93	81	97
4:06	63	86	69	87	79	93	80	96
4:07	63	85	69	87	79	93	80	96
4:08	63	85	68	87	78	92	80	96
4:09	62	85	68	86	78	92	79	95
4:10	62	85	67	86	78	92	79	95
4:11	61	84	67	86	77	91	79	95
4:12	61	84	67	85	77	91	78	94
4:13	60	84	66	85	77	90	78	94
4:14	x	83	66	85	77	90	78	94
4:15	x	83	65	84	76	90	77	93
4:16	x	83	65	84	76	89	77	93
4:17	x	82	65	84	76	89	77	93
4:18	x	82	64	83	75	89	76	92
4:19	x	82	64	83	75	88	76	92
4:20	x	81	63	83	75	88	76	92
4:21	x	81	63	83	74	88	75	91
4:22	x	81	63	82	74	87	75	91
4:23	x	80	62	82	74	87	75	91
4:24	x	80	62	82	73	86	74	90
4:25	x	80	61	81	73	86	74	90
4:26	x	79	61	81	73	86	74	89
4:27	x	79	61	81	72	85	74	89
4:28	x	79	60	80	72	85	73	89
4:29	x	79	x	80	72	85	73	88
4:30	x	78	x	80	71	84	73	88
4:31	x	78	x	79	71	84	72	88
4:32	x	78	x	79	71	83	72	87
4:33	x	77	x	79	71	83	72	87
4:34	x	77	x	78	70	83	71	87
4:35	x	77	x	78	70	82	71	86
4:36	x	76	x	78	70	82	71	86
4:37	x	76	x	77	69	82	70	86
4:38	x	76	x	77	69	81	70	85
4:39	x	75	x	77	69	81	70	85
4:40	x	75	x	76	68	80	69	85
4:41	x	75	x	76	68	80	69	84
4:42	x	74	x	76	68	80	69	84
4:43	x	74	x	75	67	79	68	84
4:44	x	74	x	75	67	79	68	83
4:45	x	73	x	75	67	79	68	83
4:46	x	73	x	74	66	78	67	83
4:47	x	73	x	74	66	78	67	82

Table 3-5. - Movement to Contact

MOVEMENT TO CONTACT

	17-26		27-39		40-45		46+	
TIME	M	F	M	F	M	F	M	F
4:48	x	73	x	74	66	78	67	82
4:49	x	72	x	73	65	77	66	82
4:50	x	72	x	73	65	77	66	81
4:51	x	72	x	73	65	76	66	81
4:52	x	71	x	72	64	76	65	81
4:53	x	71	x	72	64	76	65	80
4:54	x	71	x	72	64	75	65	80
4:55	x	70	x	71	64	75	64	80
4:56	x	70	x	71	63	75	64	79
4:57	x	70	x	71	63	74	64	79
4:58	x	69	x	70	63	74	63	79
4:59	x	69	x	70	62	73	63	78
5:00	x	69	x	70	62	73	63	78
5:01	x	68	x	69	62	73	62	78
5:02	x	68	x	69	61	72	62	77
5:03	x	68	x	69	61	72	62	77
5:04	x	68	x	68	61	72	61	77
5:05	x	67	x	68	60	71	61	76
5:06	x	67	x	68	x	71	61	76
5:07	x	67	x	67	x	71	60	76
5:08	x	66	x	67	x	70	x	75
5:09	x	66	x	67	x	70	x	75
5:10	x	66	x	66	x	69	x	75
5:11	x	65	x	66	x	69	x	74
5:12	x	65	x	66	x	69	x	74
5:13	x	65	x	65	x	68	x	74
5:14	x	64	x	65	x	68	x	73
5:15	x	64	x	65	x	68	x	73
5:16	x	64	x	64	x	67	x	73
5:17	x	63	x	64	x	67	x	72
5:18	x	63	x	64	x	66	x	72
5:19	x	63	x	63	x	66	x	72
5:20	x	62	x	63	x	66	x	71
5:21	x	62	x	63	x	65	x	71
5:22	x	62	x	62	x	65	x	71
5:23	x	62	x	62	x	65	x	70
5:24	x	61	x	62	x	64	x	70
5:25	x	61	x	61	x	64	x	69
5:26	x	61	x	61	x	63	x	69
5:27	x	60	x	61	x	63	x	69
5:28	x	x	x	60	x	63	x	68
5:29	x	x	x	x	x	62	x	68
5:30	x	x	x	x	x	62	x	68

Table 3-5. - Movement to Contact

MOVEMENT TO CONTACT

	17-26		27-39		40-45		46+	
TIME	M	F	M	F	M	F	M	F
5:31	x	x	x	x	x	62	x	67
5:32	x	x	x	x	x	61	x	67
5:33	x	x	x	x	x	61	x	67
5:34	x	x	x	x	x	61	x	66
5:35	x	x	x	x	x	60	x	66
5:36	x	x	x	x	x	60	x	66
5:37	x	x	x	x	x	x	x	65
5:38	x	x	x	x	x	x	x	65
5:39	x	x	x	x	x	x	x	65
5:40	x	x	x	x	x	x	x	64
5:41	x	x	x	x	x	x	x	64
5:42	x	x	x	x	x	x	x	64
5:43	x	x	x	x	x	x	x	63
5:44	x	x	x	x	x	x	x	63
5:45	x	x	x	x	x	x	x	63
5:46	x	x	x	x	x	x	x	62
5:47	x	x	x	x	x	x	x	62
5:48	x	x	x	x	x	x	x	62
5:49	x	x	x	x	x	x	x	61
5:50	x	x	x	x	x	x	x	61
5:51	x	x	x	x	x	x	x	61
5:52	x	x	x	x	x	x	x	60

Table 3-5. - Movement to Contact

AMMO LIFT

REPS	17-26		27-39		40-45		46+	
	M	F	M	F	M	F	M	F
97	x	x	100	x	x	x	x	x
96	x	x	99	x	x	x	x	x
95	x	x	99	x	x	x	x	x
94	x	x	98	x	x	x	x	x
93	x	x	98	x	x	x	x	x
92	x	x	97	x	x	x	x	x
91	100	x	97	x	x	x	x	x
90	99	x	96	x	x	x	x	x
89	99	x	95	x	100	x	x	x
88	98	x	95	x	99	x	x	x
87	97	x	94	x	99	x	x	x
86	97	x	94	x	98	x	100	x
85	96	x	93	x	98	x	99	x
84	95	x	92	x	97	x	99	x
83	94	x	92	x	97	x	98	x
82	94	x	91	x	96	x	98	x
81	93	x	91	x	96	x	97	x
80	92	x	90	x	95	x	97	x
79	92	x	90	x	95	x	96	x
78	91	x	89	x	94	x	95	x
77	90	x	88	x	93	x	95	x
76	90	x	88	x	93	x	94	x
75	89	x	87	x	92	x	94	x
74	88	x	87	x	92	x	93	x
73	88	x	86	x	91	x	93	x
72	87	x	86	x	91	x	92	x
71	86	x	85	x	90	x	91	x
70	86	x	84	x	90	x	91	x
69	85	x	84	x	89	x	90	x
68	84	x	83	x	88	x	90	x
67	83	x	83	x	88	x	89	x
66	83	x	82	x	87	x	89	x
65	82	x	81	x	87	x	88	x
64	81	x	81	x	86	x	87	x
63	81	x	80	100	86	x	87	x
62	80	x	80	99	85	x	86	x
61	79	x	79	98	85	x	86	x
60	79	100	79	98	84	x	85	x
59	78	99	78	97	84	x	85	x
58	77	98	77	96	83	x	84	x
57	77	97	77	95	82	x	83	x
56	76	96	76	94	82	x	83	x
55	75	95	76	94	81	x	82	x
54	74	94	75	93	81	x	82	x
53	74	93	74	92	80	x	81	x
52	73	93	74	91	80	x	81	x

Table 3-6. - Ammo Lift

AMMO LIFT

REPS	17-26		27-39		40-45		46+	
	M	F	M	F	M	F	M	F
51	72	92	73	90	79	x	80	x
50	72	91	73	90	79	x	79	x
49	71	90	72	89	78	x	79	x
48	70	89	72	88	77	x	78	x
47	70	88	71	87	77	x	78	x
46	69	87	70	86	76	x	77	x
45	68	86	70	86	76	100	77	x
44	68	85	69	85	75	99	76	x
43	67	84	69	84	75	98	75	x
42	66	83	68	83	74	97	75	x
41	66	82	68	82	74	96	74	100
40	65	81	67	82	73	95	74	99
39	64	80	66	81	73	94	73	98
38	63	80	66	80	72	93	73	97
37	63	79	65	79	71	92	72	96
36	62	78	65	78	71	91	72	95
35	61	77	64	78	70	90	71	94
34	61	76	63	77	70	89	70	93
33	60	75	63	76	69	88	70	92
32	x	74	62	75	69	87	69	91
31	x	73	62	74	68	86	69	90
30	x	72	61	74	68	85	68	89
29	x	71	61	73	67	84	68	88
28	x	70	60	72	66	83	67	86
27	x	69	x	71	66	82	66	85
26	x	68	x	70	65	81	66	84
25	x	67	x	70	65	80	65	83
24	x	67	x	69	64	79	65	81
23	x	66	x	68	64	78	64	80
22	x	65	x	67	63	77	64	79
21	x	64	x	66	63	76	63	78
20	x	63	x	66	62	75	62	76
19	x	62	x	65	62	74	62	75
18	x	61	x	64	61	73	61	74
17	x	60	x	63	60	72	61	73
16	x	x	x	62	x	71	60	71
15	x	x	x	62	x	70	x	70
14	x	x	x	61	x	69	x	69
13	x	x	x	60	x	68	x	68
12	x	x	x	x	x	66	x	66
11	x	x	x	x	x	65	x	65
10	x	x	x	x	x	64	x	64
9	x	x	x	x	x	63	x	63
8	x	x	x	x	x	61	x	62
7	x	x	x	x	x	60	x	61
6	x	x	x	x	x	x	x	60

Table 3-6. - Ammo Lift

MANEUVER UNDER FIRE

TIME	17-26		27-39		40-45		46+	
	M	F	M	F	M	F	M	F
2:14	100	x	x	x	x	x	x	x
2:15	99	x	x	x	x	x	x	x
2:16	99	x	x	x	x	x	x	x
2:17	98	x	x	x	x	x	x	x
2:18	98	x	x	x	x	x	x	x
2:19	97	x	x	x	x	x	x	x
2:20	97	x	x	x	x	x	x	x
2:21	97	x	x	x	x	x	x	x
2:22	96	x	x	x	x	x	x	x
2:23	96	x	x	x	x	x	x	x
2:24	96	x	x	x	x	x	x	x
2:25	95	x	x	x	x	x	x	x
2:26	95	x	100	x	x	x	x	x
2:27	94	x	99	x	x	x	x	x
2:28	94	x	99	x	x	x	x	x
2:29	94	x	99	x	x	x	x	x
2:30	93	x	99	x	x	x	x	x
2:31	93	x	99	x	x	x	x	x
2:32	93	x	98	x	x	x	x	x
2:33	92	x	98	x	x	x	x	x
2:34	92	x	98	x	100	x	x	x
2:35	91	x	97	x	99	x	x	x
2:36	91	x	97	x	99	x	x	x
2:37	91	x	97	x	99	x	x	x
2:38	90	x	96	x	99	x	x	x
2:39	90	x	96	x	98	x	x	x
2:40	90	x	96	x	98	x	x	x
2:41	89	x	96	x	98	x	x	x
2:42	89	x	95	x	98	x	x	x
2:43	88	x	95	x	98	x	x	x
2:44	88	x	95	x	97	x	x	x
2:45	88	x	94	x	97	x	x	x
2:46	87	x	94	x	97	x	x	x
2:47	87	x	94	x	97	x	x	x
2:48	87	x	94	x	97	x	x	x
2:49	86	x	93	x	97	x	x	x
2:50	86	x	93	x	96	x	x	x
2:51	85	x	93	x	96	x	x	x
2:52	85	x	92	x	96	x	100	x
2:53	85	x	92	x	96	x	99	x
2:54	84	x	92	x	96	x	99	x
2:55	84	x	92	x	95	x	99	x
2:56	84	x	91	x	95	x	99	x
2:57	83	x	91	x	95	x	98	x
2:58	83	x	91	x	95	x	98	x
2:59	82	x	90	x	95	x	98	x
3:00	82	x	90	x	94	x	98	x

Table 3-7. - Maneuver Under Fire

MANEUVER UNDER FIRE

TIME	17-26		27-39		40-45		46+	
	M	F	M	F	M	F	M	F
3:01	82	100	90	x	94	x	98	x
3:02	81	99	89	x	94	x	97	x
3:03	81	99	89	x	94	x	97	x
3:04	81	99	89	x	94	x	97	x
3:05	80	99	89	x	93	x	97	x
3:06	80	99	88	x	93	x	97	x
3:07	79	99	88	100	93	x	96	x
3:08	79	98	88	99	93	x	96	x
3:09	79	98	87	99	93	x	96	x
3:10	78	98	87	99	93	x	96	x
3:11	78	98	87	99	92	x	96	x
3:12	78	98	87	98	92	x	95	x
3:13	77	97	86	98	92	x	95	x
3:14	77	97	86	98	92	x	95	x
3:15	76	97	86	98	92	x	95	x
3:16	76	97	85	97	91	x	95	x
3:17	76	96	85	97	91	x	94	x
3:18	75	96	85	97	91	x	94	x
3:19	75	96	85	97	91	x	94	x
3:20	74	96	84	97	91	x	94	x
3:21	74	96	84	96	90	100	94	x
3:22	74	95	84	96	90	99	93	x
3:23	73	95	83	96	90	99	93	x
3:24	73	95	83	96	90	99	93	x
3:25	73	95	83	95	90	99	93	x
3:26	72	95	82	95	90	98	93	x
3:27	72	94	82	95	89	98	92	x
3:28	71	94	82	95	89	98	92	x
3:29	71	94	82	95	89	98	92	x
3:30	71	94	81	94	89	98	92	x
3:31	70	93	81	94	89	97	92	x
3:32	70	93	81	94	88	97	91	x
3:33	70	93	80	94	88	97	91	x
3:34	69	93	80	93	88	97	91	x
3:35	69	93	80	93	88	96	91	x
3:36	68	92	80	93	88	96	91	x
3:37	68	92	79	93	87	96	90	x
3:38	68	92	79	93	87	96	90	x
3:39	67	92	79	92	87	96	90	x
3:40	67	91	78	92	87	95	90	x
3:41	67	91	78	92	87	95	90	x
3:42	66	91	78	92	86	95	89	x
3:43	66	91	78	91	86	95	89	x
3:44	65	91	77	91	86	95	89	100
3:45	65	90	77	91	86	94	89	99
3:46	65	90	77	91	86	94	88	99

Table 3-7. - Maneuver Under Fire

MANEUVER UNDER FIRE

TIME	17-26		27-39		40-45		46+	
	M	F	M	F	M	F	M	F
3:47	64	90	76	91	86	94	88	99
3:48	64	90	76	90	85	94	88	99
3:49	64	89	76	90	85	93	88	99
3:50	63	89	75	90	85	93	88	99
3:51	63	89	75	90	85	93	87	98
3:52	62	89	75	89	85	93	87	98
3:53	62	89	75	89	84	93	87	98
3:54	62	88	74	89	84	92	87	98
3:55	61	88	74	89	84	92	87	97
3:56	61	88	74	89	84	92	86	97
3:57	61	88	73	88	84	92	86	97
3:58	60	88	73	88	83	92	86	97
3:59	x	87	73	88	83	91	86	96
4:00	x	87	73	88	83	91	86	96
4:01	x	87	72	88	83	91	85	96
4:02	x	87	72	87	83	91	85	96
4:03	x	86	72	87	82	91	85	96
4:04	x	86	71	87	82	90	85	95
4:05	x	86	71	87	82	90	85	95
4:06	x	86	71	86	82	90	84	95
4:07	x	86	71	86	82	90	84	95
4:08	x	85	70	86	82	89	84	94
4:09	x	85	70	86	81	89	84	94
4:10	x	85	70	86	81	89	84	94
4:11	x	85	69	85	81	89	83	94
4:12	x	84	69	85	81	89	83	93
4:13	x	84	69	85	81	88	83	93
4:14	x	84	68	85	80	88	83	93
4:15	x	84	68	84	80	88	83	93
4:16	x	84	68	84	80	88	82	92
4:17	x	83	68	84	80	88	82	92
4:18	x	83	67	84	80	87	82	92
4:19	x	83	67	84	79	87	82	92
4:20	x	83	67	83	79	87	82	92
4:21	x	82	66	83	79	87	81	91
4:22	x	82	66	83	79	86	81	91
4:23	x	82	66	83	79	86	81	91
4:24	x	82	66	82	78	86	81	91
4:25	x	82	65	82	78	86	81	90
4:26	x	81	65	82	78	86	80	90
4:27	x	81	65	82	78	85	80	90
4:28	x	81	64	82	78	85	80	90
4:29	x	81	64	81	78	85	80	89
4:30	x	81	64	81	77	85	80	89

Table 3-7. - Maneuver Under Fire

MANEUVER UNDER FIRE

TIME	17-26		27-39		40-45		46+	
	M	F	M	F	M	F	M	F
4:31	x	80	63	81	77	85	79	89
4:32	x	80	63	81	77	84	79	89
4:33	x	80	63	80	77	84	79	88
4:34	x	80	63	80	77	84	79	88
4:35	x	79	62	80	76	84	79	88
4:35	x	79	62	80	76	84	79	88
4:36	x	79	62	80	76	84	78	88
4:37	x	79	62	80	76	83	78	88
4:38	x	79	61	79	76	83	78	87
4:39	x	79	61	79	76	83	78	87
4:40	x	78	61	79	75	83	78	87
4:41	x	78	61	79	75	82	77	87
4:42	x	78	60	78	75	82	77	86
4:43	x	78	x	78	75	82	77	86
4:44	x	77	x	78	75	82	77	86
4:45	x	77	x	78	74	82	77	86
4:46	x	77	x	78	74	81	76	85
4:47	x	77	x	77	74	81	76	85
4:48	x	77	x	77	74	81	76	85
4:49	x	76	x	77	74	81	76	85
4:50	x	76	x	77	74	81	76	84
4:51	x	76	x	76	73	80	75	84
4:52	x	76	x	76	73	80	75	84
4:53	x	75	x	76	73	80	75	84
4:54	x	75	x	76	73	80	75	84
4:55	x	75	x	76	73	79	75	83
4:56	x	75	x	75	72	79	74	83
4:57	x	75	x	75	72	79	74	83
4:58	x	74	x	75	72	79	74	83
4:59	x	74	x	75	72	79	74	82
5:00	x	74	x	74	72	78	74	82
5:01	x	74	x	74	71	78	73	82
5:02	x	74	x	74	71	78	73	82
5:03	x	73	x	74	71	78	73	81
5:04	x	73	x	74	71	78	73	81
5:05	x	73	x	73	71	77	73	81
5:06	x	73	x	73	71	77	72	81
5:07	x	72	x	73	70	77	72	80
5:08	x	72	x	73	70	77	72	80
5:09	x	72	x	72	70	77	72	80
5:10	x	72	x	72	70	76	72	80
5:11	x	72	x	72	70	76	71	80
5:12	x	71	x	72	69	76	71	79
5:13	x	71	x	72	69	76	71	79

Table 3-7. - Maneuver Under Fire

MANEUVER UNDER FIRE

TIME	17-26		27-39		40-45		46+	
	M	F	M	F	M	F	M	F
5:13	x	71	x	72	69	76	71	79
5:14	x	71	x	71	69	75	71	79
5:15	x	71	x	71	69	75	71	79
5:16	x	70	x	71	69	75	70	78
5:17	x	70	x	71	68	75	70	78
5:18	x	70	x	70	68	75	70	78
5:19	x	70	x	70	68	74	70	78
5:20	x	70	x	70	68	74	70	77
5:21	x	69	x	70	68	74	69	77
5:22	x	69	x	70	67	74	69	77
5:23	x	69	x	69	67	74	69	77
5:24	x	69	x	69	67	73	69	77
5:25	x	68	x	69	67	73	68	76
5:26	x	68	x	69	67	73	68	76
5:27	x	68	x	69	67	73	68	76
5:28	x	68	x	68	66	72	68	76
5:29	x	68	x	68	66	72	68	75
5:30	x	67	x	68	66	72	67	75
5:31	x	67	x	68	66	72	67	75
5:32	x	67	x	67	66	72	67	75
5:33	x	67	x	67	65	71	67	74
5:34	x	66	x	67	65	71	67	74
5:35	x	66	x	67	65	71	66	74
5:36	x	66	x	67	65	71	66	74
5:37	x	66	x	66	65	71	66	73
5:38	x	66	x	66	64	70	66	73
5:39	x	65	x	66	64	70	66	73
5:40	x	65	x	66	64	70	65	73
5:41	x	65	x	65	64	70	65	73
5:42	x	65	x	65	64	70	65	72
5:43	x	65	x	65	63	69	65	72
5:44	x	64	x	65	63	69	65	72
5:45	x	64	x	65	63	69	64	72
5:46	x	64	x	64	63	69	64	71
5:47	x	64	x	64	63	68	64	71
5:48	x	63	x	64	63	68	64	71
5:49	x	63	x	64	62	68	64	71
5:50	x	63	x	63	62	68	63	70
5:51	x	63	x	63	62	68	63	70
5:52	x	63	x	63	62	67	63	70
5:53	x	62	x	63	62	67	63	70
5:54	x	62	x	63	61	67	63	69
5:55	x	62	x	62	61	67	62	69
5:56	x	62	x	62	61	67	62	69

Table 3-7. - Maneuver Under Fire

MANEUVER UNDER FIRE

TIME	17-26		27-39		40-45		46+	
	M	F	M	F	M	F	M	F
5:57	x	61	x	62	61	66	62	69
5:58	x	61	x	62	61	66	62	69
5:59	x	61	x	61	60	66	62	68
6:00	x	61	x	61	x	66	61	68
6:01	x	61	x	61	x	66	61	68
6:02	x	60	x	61	x	65	61	68
6:03	x	x	x	61	x	65	61	67
6:04	x	x	x	60	x	65	61	67
6:05	x	x	x	x	x	65	60	67
6:06	x	x	x	x	x	64	60	67
6:07	x	x	x	x	x	64	60	66
6:08	x	x	x	x	x	64	60	66
6:09	x	x	x	x	x	64	60	66
6:10	x	x	x	x	x	64	x	66
6:11	x	x	x	x	x	63	x	65
6:12	x	x	x	x	x	63	x	65
6:13	x	x	x	x	x	63	x	65
6:14	x	x	x	x	x	63	x	65
6:15	x	x	x	x	x	63	x	65
6:16	x	x	x	x	x	62	x	64
6:17	x	x	x	x	x	62	x	64
6:18	x	x	x	x	x	62	x	64
6:19	x	x	x	x	x	62	x	64
6:20	x	x	x	x	x	61	x	63
6:21	x	x	x	x	x	61	x	63
6:22	x	x	x	x	x	61	x	63
6:23	x	x	x	x	x	61	x	63
6:24	x	x	x	x	x	61	x	62
6:25	x	x	x	x	x	60	x	62
6:26	x	x	x	x	x	x	x	62
6:27	x	x	x	x	x	x	x	62
6:28	x	x	x	x	x	x	x	61
6:29	x	x	x	x	x	x	x	61
6:30	x	x	x	x	x	x	x	61
6:31	x	x	x	x	x	x	x	61
6:32	x	x	x	x	x	x	x	61
6:33	x	x	x	x	x	x	x	60

Table 3-7. - Maneuver Under Fire

9. Altitude Considerations. Units located at altitudes of 4,500 feet or more above sea level will provide Marines a 30-day acclimatization period prior to conducting a CFT. Marines scheduled to report to commands at altitude in June or December will complete their CFTs prior to detaching. Calculating a cumulative score for a completed CFT at altitude can be derived from Tables 3-8 (Movement to Contact) and 3-9 (Maneuver Under Fire). There is no altitude compensation for the Ammo lift.

Appendix G. Air Force Physical Fitness Test Female Scoring Charts

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FITNESS ASSESSMENT CHART – FEMALE: AGE: < 30

Cardiorespiratory Endurance				Body Composition				Muscle Fitness				
Run Time (mins:secs)	Health Risk Category	Points		AC (inches)	Health Risk Category	Points		Push-ups (reps/min)	Points		Sit-ups (reps/min)	Points
≤ 10:23	Low-Risk	60.0		≤ 29.0	Low Risk	20.0		≥ 47	10.0		≥ 54	10.0
10:24 - 10:51	Low-Risk	59.9		29.5	Low Risk	20.0		42	9.5		51	9.5
10:52 - 11:06	Low-Risk	59.5		30.0	Low Risk	20.0		41	9.4		50	9.4
11:07 - 11:22	Low-Risk	59.2		30.5	Low Risk	20.0		40	9.3		49	9.0
11:23 - 11:38	Low-Risk	58.9		31.0	Low Risk	20.0		39	9.2		48	8.9
11:39 - 11:56	Low-Risk	58.6		31.5	Low Risk	20.0		38	9.1		47	8.8
11:57 - 12:14	Low-Risk	58.1		32.0	Moderate Risk	17.6		37	9.0		46	8.6
12:15 - 12:33	Low-Risk	57.6		32.5	Moderate Risk	17.1		36	8.9		45	8.5
12:34 - 12:53	Low-Risk	57.0		33.0	Moderate Risk	16.5		35	8.8		44	8.0
12:54 - 13:14	Low-Risk	56.2		33.5	Moderate Risk	15.9		34	8.6		43	7.8
13:15 - 13:36	Low-Risk	55.3		34.0	Moderate Risk	15.2		33	8.5		42	7.5
13:37 - 14:00	Low-Risk	54.2		34.5	Moderate Risk	14.5		32	8.4		41	7.0
14:01 - 14:25	Low-Risk	52.8		35.0	Moderate Risk	13.7		31	8.3		40	6.8
14:26 - 14:52	Low-Risk	51.2		35.5 *	Moderate Risk	12.8		30	8.2		39	6.5
14:53 - 15:20	Moderate Risk	49.3		36.0	High Risk	11.8		29	8.1		38 *	6.0
15:21 - 15:50	Moderate Risk	46.9		36.5	High Risk	10.7		28	8.0		37	5.5
15:51 - 16:22 *	Moderate Risk	44.1		37.0	High Risk	9.6		27	7.5		36	5.3
16:23 - 16:57	High Risk	40.8		37.5	High Risk	8.3		26	7.3		35	5.0
16:58 - 17:34	High Risk	36.7		38.0	High Risk	6.9		25	7.2		34	4.5
17:35 - 18:14	High Risk	31.8		38.5	High Risk	5.4		24	7.0		33	4.3
18:15 - 18:56	High Risk	25.9		39.0	High Risk	3.8		23	6.5		32	4.0
18:57 - 19:43	High Risk	18.8		39.5	High Risk	2.0		22	6.3		31	3.5
19:44 - 20:33	High Risk	10.3		≥ 40.0	High Risk	0.0		21	6.0		30	3.0
≥ 20:34	High Risk	0.0						20	5.8		29	2.8
								19	5.5		28	2.5
								18 *	5.0		27	2.0
NOTES:								17	4.5		26	1.8
Health Risk Category = low, moderate or high risk for current and future								16	4.3		25	1.7
cardiovascular disease, diabetes, certain cancers, and other health problems								15	4.0		24	1.5
								14	3.5		23	1.0
Passing Requirements - member *must*: 1) meet minimum value in each of								13	3.0		≤ 22	0.0
the four components, *and* 2) achieve a composite point total ≥ 75 points								12	2.8			
								11	2.5			
* Minimum Component Values								10	2.0			
Run time ≤ 16:22 mins:secs / Abd Circ ≤ 35.5 inches								9	1.5			
Push-ups ≥ 18 repetitions/one minute / Sit-ups ≥ 38 repetitions/one minute								8	1.0			
								≤ 7	0.0			
Composite Score Categories:												
Excellent ≥ 90.0 pts / Satisfactory = 75.0 - 89.9 / Unsatisfactory < 75.0												

FITNESS ASSESSMENT CHART – FEMALE: AGE: 30 – 39

Cardiorespiratory Endurance			Body Composition			Muscle Fitness			
Run Time (mins:secs)	Health Risk Category	Points	AC (inches)	Health Risk Category	Points	Push-ups (reps/min)	Points	Sit-ups (reps/min)	Points
≤ 10:51	Low-Risk	60.0	≤ 29.0	Low Risk	20.0	≥ 46	10.0	≥ 45	10.0
10:52 - 11:22	Low-Risk	59.5	29.5	Low Risk	20.0	40	9.5	42	9.5
11:23 - 11:38	Low-Risk	59.0	30.0	Low Risk	20.0	39	9.4	41	9.4
11:39 - 11:56	Low-Risk	58.6	30.5	Low Risk	20.0	38	9.3	40	9.0
11:57 - 12:14	Low-Risk	58.1	31.0	Low Risk	20.0	37	9.3	39	8.8
12:15 - 12:33	Low-Risk	57.6	31.5	Low Risk	20.0	36	9.2	38	8.5
12:34 - 12:53	Low-Risk	57.0	32.0	Moderate Risk	17.6	35	9.1	37	8.3
12:54 - 13:14	Low-Risk	56.2	32.5	Moderate Risk	17.1	34	9.1	36	8.2
13:15 - 13:36	Low-Risk	55.3	33.0	Moderate Risk	16.5	33	9.0	35	8.0
13:37 - 14:00	Low-Risk	54.2	33.5	Moderate Risk	15.9	32	8.9	34	7.8
14:01 - 14:25	Low-Risk	52.8	34.0	Moderate Risk	15.2	31	8.9	33	7.5
14:26 - 14:52	Low-Risk	51.2	34.5	Moderate Risk	14.5	30	8.8	32	7.0
14:53 - 15:20	Low-Risk	49.3	35.0	Moderate Risk	13.7	29	8.7	31	6.8
15:21 - 15:50	Moderate Risk	46.9	35.5 *	Moderate Risk	12.8	28	8.6	30	6.5
15:51 - 16:22	Moderate Risk	44.1	36.0	High Risk	11.8	27	8.6	29 *	6.0
16:23 - 16:57 *	Moderate Risk	40.8	36.5	High Risk	10.7	26	8.5	28	5.5
16:58 - 17:34	High Risk	36.7	37.0	High Risk	9.6	25	8.3	27	5.0
17:35 - 18:14	High Risk	31.8	37.5	High Risk	8.3	24	8.2	26	4.5
18:15 - 18:56	High Risk	25.9	38.0	High Risk	6.9	23	8.0	25	4.0
18:57 - 19:43	High Risk	18.8	38.5	High Risk	5.4	22	7.9	24	3.5
19:44 - 20:33	High Risk	10.3	39.0	High Risk	3.8	21	7.8	23	3.3
≥ 20:34	High Risk	0.0	39.5	High Risk	2.0	20	7.6	22	3.0
			≥ 40.0	High Risk	0.0	19	7.5	21	2.5
						18	7.0	20	2.0
NOTES:						17	6.8	19	1.8
Health Risk Category = low, moderate or high risk for current and future						16	6.5	18	1.5
cardiovascular disease, diabetes, certain cancers, and other health problems						15	6.0	17	1.3
						14 *	5.0	16	1.2
Passing Requirements - member *must*: 1) meet minimum value in each of						13	4.5	15	1.0
the four components, *and* 2) achieve a composite point total ≥ 75 points						12	4.3	≤ 14	0.0
						11	4.0		
* Minimum Component Values						10	3.5		
Run time ≤ 16:57 mins:secs / Abd Circ ≤ 35.5 inches						9	3.0		
Push-ups ≥ 14 repetitions/one minute / Sit-ups ≥ 29 repetitions/one minute						8	2.0		
						7	1.5		
Composite Score Categories:						6	1.0		
Excellent ≥ 90.0 pts / Satisfactory = 75.0 - 89.9 / Unsatisfactory < 75.0						≤ 5	0.0		

FITNESS ASSESSMENT CHART – FEMALE: AGE: 40 – 49

Cardiorespiratory Endurance				Body Composition				Muscle Fitness				
Run Time (mins:secs)	Health Risk Category	Points		AC (inches)	Health Risk Category	Points		Push-ups (reps/min)	Points		Sit-ups (reps/min)	Points
≤ 11:22	Low-Risk	60.0		≤ 29.0	Low Risk	20.0		≥ 38	10.0		≥ 41	10.0
11:23 - 11:56	Low-Risk	59.9		29.5	Low Risk	20.0		33	9.5		38	9.5
11:57 - 12:14	Low-Risk	59.8		30.0	Low Risk	20.0		32	9.4		37	9.4
12:15 - 12:33	Low-Risk	59.6		30.5	Low Risk	20.0		31	9.2		36	9.2
12:34 - 12:53	Low-Risk	59.4		31.0	Low Risk	20.0		30	9.1		35	9.1
12:54 - 13:14	Low-Risk	59.1		31.5	Low Risk	20.0		29	9.0		34	9.0
13:15 - 13:36	Low-Risk	58.7		32.0	Moderate Risk	17.6		28	8.9		33	8.8
13:37 - 14:00	Low-Risk	58.2		32.5	Moderate Risk	17.1		27	8.8		32	8.5
14:01 - 14:25	Low-Risk	57.7		33.0	Moderate Risk	16.5		26	8.7		31	8.3
14:26 - 14:52	Low-Risk	56.9		33.5	Moderate Risk	15.9		25	8.6		30	8.2
14:53 - 15:20	Low-Risk	56.0		34.0	Moderate Risk	15.2		24	8.6		29	8.0
15:21 - 15:50	Low-Risk	54.8		34.5	Moderate Risk	14.5		23	8.5		28	7.5
15:51 - 16:22	Low-Risk	53.3		35.0	Moderate Risk	13.7		22	8.4		27	7.0
16:23 - 16:57	Moderate Risk	51.4		35.5 *	Moderate Risk	12.8		21	8.3		26	6.8
16:58 - 17:34	Moderate Risk	49.0		36.0	High Risk	11.8		20	8.2		25	6.4
17:35 - 18:14 *	Moderate Risk	45.9		36.5	High Risk	10.7		19	8.1		24 *	6.0
18:15 - 18:56	High Risk	42.0		37.0	High Risk	9.6		18	8.0		23	5.5
18:57 - 19:43	High Risk	37.1		37.5	High Risk	8.3		17	7.8		22	5.0
19:44 - 20:33	High Risk	30.8		38.0	High Risk	6.9		16	7.5		21	4.5
20:34 - 21:28	High Risk	22.9		38.5	High Risk	5.4		15	7.0		20	4.0
21:29 - 22:28	High Risk	12.8		39.0	High Risk	3.8		14	6.5		19	3.5
≥ 22:29	High Risk	0.0		39.5	High Risk	2.0		13	6.0		18	3.3
				≥ 40.0	High Risk	0.0		12	5.5		17	3.0
								11 *	5.0		16	2.5
NOTES:								10	4.5		15	2.3
Health Risk Category = low, moderate or high risk for current and future								9	4.0		14	2.0
cardiovascular disease, diabetes, certain cancers, and other health problems								8	3.5		13	1.5
								7	3.0		12	1.3
Passing Requirements - member ***must***: 1) meet minimum value in each of								6	2.0		11	1.2
the four components, ***and*** 2) achieve a composite point total ≥ 75 points								5	1.5		10	1.0
								4	1.0		≤ 9	0.0
* Minimum Component Values								≤ 3	0.0			
Run time ≤ 18:14 mins:secs / Abd Circ ≤ 35.5 inches												
Push-ups ≥ 11 repetitions/one minute / Sit-ups ≥ 24 repetitions/one minute												
Composite Score Categories:												
Excellent ≥ 90.0 pts / Satisfactory = 75.0 - 89.9 / Unsatisfactory < 75.0												

FITNESS ASSESSMENT CHART – FEMALE: AGE: 50 – 59

Cardiorespiratory Endurance			Body Composition			Muscle Fitness			
Run Time (mins:secs)	Health Risk Category	Points	AC (inches)	Health Risk Category	Points	Push-ups (reps/min)	Points	Sit-ups (reps/min)	Points
≤ 12:53	Low-Risk	60.0	≤ 29.0	Low Risk	20.0	≥ 35	10.0	≥ 32	10.0
12:54 - 13:36	Low-Risk	59.8	29.5	Low Risk	20.0	30	9.5	30	9.5
13:37 - 14:00	Low-Risk	59.6	30.0	Low Risk	20.0	29	9.4	29	9.0
14:01 - 14:25	Low-Risk	59.3	30.5	Low Risk	20.0	28	9.3	28	8.9
14:26 - 14:52	Low-Risk	58.9	31.0	Low Risk	20.0	27	9.2	27	8.8
14:53 - 15:20	Low-Risk	58.4	31.5	Low Risk	20.0	26	9.1	26	8.6
15:21 - 15:50	Low-Risk	57.7	32.0	Moderate Risk	17.6	25	9.0	25	8.5
15:51 - 16:22	Low-Risk	56.8	32.5	Moderate Risk	17.1	24	8.8	24	8.0
16:23 - 16:57	Low-Risk	55.6	33.0	Moderate Risk	16.5	23	8.7	23	7.6
16:58 - 17:34	Low-Risk	54.0	33.5	Moderate Risk	15.9	22	8.6	22	7.0
17:35 - 18:14	Low-Risk	51.9	34.0	Moderate Risk	15.2	21	8.6	21	6.5
18:15 - 18:56	Moderate Risk	49.2	34.5	Moderate Risk	14.5	20	8.5	20 *	6.0
18:57 - 19:43 *	Moderate Risk	45.5	35.0	Moderate Risk	13.7	19	8.4	19	5.5
19:44 - 20:33	High Risk	40.7	35.5 *	Moderate Risk	12.8	18	8.3	18	5.3
20:34 - 21:28	High Risk	34.3	36.0	High Risk	11.8	17	8.2	17	5.0
21:29 - 22:28	High Risk	25.9	36.5	High Risk	10.7	16	8.1	16	4.5
22:29 - 23:34	High Risk	14.7	37.0	High Risk	9.6	15	8.0	15	4.3
≥ 23:35	High Risk	0.0	37.5	High Risk	8.3	14	7.5	14	4.0
			38.0	High Risk	6.9	13	7.0	13	3.6
			38.5	High Risk	5.4	12	6.5	12	3.0
			39.0	High Risk	3.8	11	6.0	11	2.5
			39.5	High Risk	2.0	10	5.5	10	2.0
			≥ 40.0	High Risk	0.0	9 *	5.0	9	1.8
						8	4.5	8	1.7
NOTES:						7	4.0	7	1.5
Health Risk Category = low, moderate or high risk for current and future						6	3.5	6	1.0
cardiovascular disease, diabetes, certain cancers, and other health problems						5	3.0	≤ 5	0.0
						4	2.0		
Passing Requirements - member *must*: 1) meet minimum value in each of						3	1.0		
the four components, *and* 2) achieve a composite point total ≥ 75 points						≤2	0.0		
* Minimum Component Values									
Run time ≤ 19:43 mins:secs / Abd Circ ≤ 35.5 inches									
Push-ups ≥ 9 repetitions/one minute / Sit-ups ≥ 20 repetitions/one minute									
Composite Score Categories:									
Excellent ≥ 90.0 pts / Satisfactory = 75.0 - 89.9 / Unsatisfactory < 75.0									

FITNESS ASSESSMENT CHART – FEMALE: AGE: 60+

Cardiorespiratory Endurance			Body Composition			Muscle Fitness			
Run Time (mins:secs)	Health Risk Category	Points	AC (inches)	Health Risk Category	Points	Push-ups (reps/min)	Points	Sit-ups (reps/min)	Points
≤ 14:00	Low-Risk	60.0	≤ 29.0	Low Risk	20.0	≥ 21	10.0	≥ 31	10.0
14:01 - 14:52	Low-Risk	59.8	29.5	Low Risk	20.0	19	9.5	28	9.5
14:53 - 15:20	Low-Risk	59.5	30.0	Low Risk	20.0	18	9.4	27	9.4
15:21 - 15:50	Low-Risk	59.1	30.5	Low Risk	20.0	17	9.0	26	9.0
15:51 - 16:22	Low-Risk	58.6	31.0	Low Risk	20.0	16	8.8	25	8.9
16:23 - 16:57	Low-Risk	57.9	31.5	Low Risk	20.0	15	8.5	24	8.8
16:58 - 17:34	Low-Risk	57.0	32.0	Moderate Risk	17.6	14	8.0	23	8.7
17:35 - 18:14	Low-Risk	55.8	32.5	Moderate Risk	17.1	13	7.5	22	8.6
18:15 - 18:56	Low-Risk	54.2	33.0	Moderate Risk	16.5	12	7.0	21	8.5
18:57 - 19:43	Low-Risk	52.1	33.5	Moderate Risk	15.9	11	6.5	20	8.4
19:44 - 20:33	Moderate Risk	49.3	34.0	Moderate Risk	15.2	10	6.0	19	8.3
20:34 - 21:28	Moderate Risk	45.6	34.5	Moderate Risk	14.5	9	5.7	18	8.2
21:29 - 22:28 *	Moderate Risk	40.8	35.0	Moderate Risk	13.7	8	5.3	17	8.0
22:29 - 23:34	High Risk	34.4	35.5 *	Moderate Risk	12.8	7 *	5.0	16	7.8
23:35 - 24:46	High Risk	26.0	36.0	High Risk	11.8	6	4.5	15	7.5
24:47 - 26:06	High Risk	14.8	36.5	High Risk	10.7	5	4.0	14	7.3
≥ 26:07	High Risk	0.0	37.0	High Risk	9.6	4	3.0	13	7.0
			37.5	High Risk	8.3	3	2.0	12	6.5
			38.0	High Risk	6.9	2	1.0	11 *	6.0
			38.5	High Risk	5.4	≤1	0.0	10	5.5
			39.0	High Risk	3.8			9	5.3
			39.5	High Risk	2.0			8	4.5
			≥ 40.0	High Risk	0.0			7	4.3
								6	4.0
								5	3.5
								4	2.5
								3	2.0
								2	1.5
								≤ 1	0.0

NOTES:

Health Risk Category = low, moderate or high risk for current and future cardiovascular disease, diabetes, certain cancers, and other health problems

Passing Requirements - member ***must***: 1) meet minimum value in each of the four components, ***and*** 2) achieve a composite point total ≥ 75 points

* Minimum Component Values

Run time ≤ 22:28 mins:secs / Abd Circ ≤ 35.5 inches

Push-ups ≥ 7 repetitions/one minute / Sit-ups ≥ 11 repetitions/one minute

Composite Score Categories:

Excellent ≥ 90.0 pts / Satisfactory = 75.0 - 89.9 / Unsatisfactory < 75.0

Appendix H. Variable Ranges for Predictive Models

Variable	Minimum	Maximum
Age	18	40
Height (inches)	58.5	72
Weight	102	185
BMI	18.13	33.8
AFPFT Cardio (raw) – seconds	581	942
AFPFT Cardio (score)	39	60
AFPFT Waist (raw)	24.5	34
AFPFT Waist (score)	15.2	20
AFPFT Push-Ups (raw)	19	51
AFPFT Push-Ups (score)	5.8	10
AFPFT Sit-Ups (raw)	34	78
AFPFT Sit-Ups (score)	6	10
Total AFPFT score	37.5	100
MCFT MTC (raw) – seconds	177	288
MCFT MTC (score)	73	100
MCFT AL (raw)	10	61
MCFT AL (score)	60	100
MCFT MANUF (raw) – seconds	211	890
MCFT MANUF (score)	60	93
Total MCFT score	196	289

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Vita

Capt Tarah D. Mitchell graduated from East Anchorage High School in Anchorage, Alaska in 2003. She entered undergraduate studies at the University of Rochester in Rochester, New York and graduated with a Bachelor of Arts degree in Economics, with a minor in Biology, in May 2007. She was commissioned through Detachment 538 AFROTC at Rochester Institute of Technology (R.I.T.) after being nominated for a Regular Commission.

Her first assignment was to the 375th Comptroller Squadron at Scott AFB, Illinois in August 2004, where she served as a physical training leader (PTL), unit fitness program manager (UFPM), alternate unit deployment manager (UDM), installation control center (ICC) executive officer, chief of command support staff, budget officer, and financial services flight commander. In July 2009, she was sent to Advanced Combat Skills Training (ASCT) in Fort Dix, NJ in preparation for a budget officer tasking in Iraq. She deployed to the International Zone in Baghdad, Iraq and worked in the Multi-National Security Transition Command Iraq (MNSTC-I) Iraqi Security Assistance Mission (ISAM) as a budget officer and training team member.

In May 2010, she earned an MBA with a concentration in Finance from Kaplan University in Ft. Lauderdale, FL. While enrolled at Kaplan, she was inducted into both the Sigma Beta Delta Honor Society and the Alpha Beta Kappa National Honor Society. In August 2010, she entered the Cost Analysis program in the Graduate School of Engineering and Management, Air Force Institute of Technology.

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13. SUPPLEMENTARY NOTES

14. ABSTRACT
In 2009, Captain Thomas Worden determined the Air Force Physical Fitness Test (AFPFT) poorly predicted combat capability for his 86 study participants. With only 5 of these 86 volunteers being women, this limited Worden's findings to primarily men. This follow-on research investigated whether these results carried over to women. We recruited 61 female volunteers and compared their performance on the AFPFT to the Marine Combat Fitness Test, the proxy for combat capability. Like Worden's research, we discovered little association between the two (R^2 of 0.161). However, this association significantly increased (adj R^2 of 0.572) when utilizing the raw scores of the AFPFT instead of using the scoring tables. Improving upon these associations, we built multiple regression models using Ordinary Least Squares. Similar to Capt Worden's mostly male-study we arrived at comparable conclusions. The best two-event model for combat fitness capability incorporates a half-mile run and 30-lb ammunition can lifts (adj R^2 of 0.864) and the best three event model adds a Maneuver Under Fire (adj R^2 of 0.91). By adopting either model, we greatly improve the Air Force’s ability to assess combat capability for women.

15. SUBJECT TERMS
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