

A DESCRIPTION OF THE ANTHROPOMETRIC
AND PHYSIOLOGICAL PROFILE OF
TACTICAL OFFICERS

By

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CHAPTER I

INTRODUCTION

Special Weapons and Tactics (SWAT) teams are considered highly specialized law enforcement units trained to resolve conflicts that cause a threat to public safety, which otherwise exceeds the training and capabilities of traditional law enforcement officers (NTOA, 2008). SWAT teams, also known as tactical units, are typically called upon in situations where the use of force is highly likely (Williams & Westall, 2003). These situations include hostage rescue, high-risk warrant service, high-risk apprehension, dignitary protection, terrorism response, and instances involving snipers or barricaded suspects (Klinger & Rojek, 2008; NTOA, 2008; Williams & Westall, 2003).

According to Mijares (1993) members of SWAT teams, or tactical officers, have one of the most physically demanding assignments in all law enforcement. Furthermore, after a task analysis of any tactical unit, it is not unreasonable to assume that tactical officers are required to perform one of the most physically demanding and dangerous non-athletic, civilian occupations. For this reason, most agencies and their officials understand that the physical fitness demands for the tactical officer exceed those of standard patrol and other law enforcement officers (Alexander, 2010; Kleiner, 2008). In fact, based on these intense physical demands tactical officers are referred to by some as “tactical athletes” (Stephenson, 2008).

Based on the physiological demands and stress placed on these officers during tactical operations it is critical that they possess an adequate level of operational fitness to successfully perform their duties in a safe, effective and efficient manner (Stephenson, 2008). Consequently, to be a member of one of these specialized units typically requires meeting and maintaining a certain level or standard of physical fitness. However, at this time there are no standardized testing batteries, fitness norms, or references available to assess the tactical officer's operational fitness level. Presently, most units or agencies are responsible for the implementation and development of their own physical fitness standards, assessment and selection criteria. While the Tactical officer's operational performance is the ultimate test of job effectiveness it would be beneficial if field and laboratory tests were available as a method of determining the specific physical attributes and abilities associated with operational readiness and performance.

In addition, to ensure these selection criteria do not unintentionally discriminate against certain protected classes, especially females, it is essential that the tests utilized demonstrate job-relatedness to be considered legal (Mijares, 1993). This poses an interesting challenge since very little research exists that can be used to extrapolate the physiological, biomechanical, or metabolic demands required to perform most of the essential job tasks of SWAT. In addition, while many of the underlying physical fitness components required to perform these essential-job tasks have been identified (CIAR, 2002; Hoffman & Collingwod, 2006) this area still requires further investigation. Therefore at this time it is difficult to establish appropriate testing batteries and pass/fail criteria, or cut-scores, with good content validity, that are legally defensible. Thus, there is a need to identify the underlying physical fitness components essential to perform the job duties of SWAT to better determine those traits or factors that have the greatest impact on successful

operational performance. Once these underlying components are identified the necessary level of fitness needed to perform each of these essential job-tasks may then be better identified.

At this time there are no verifiable sources in the literature that accurately describes physical and performance characteristics of tactical officers. Thus, a basic description related to these characteristics, in addition to the physical attributes required to perform essential job-tasks related to SWAT, may further aid in the development of criterion based standards for this population that are truly predictive of operational readiness and performance. Furthermore, by attaining this information more specific training programs can be developed to help maximize and improve the health, tactical performance, and reduce the risk of some types of injuries for these elite law enforcement professionals.

Purpose

The purpose of this study was to investigate the current physical and performance characteristics of tactical officers on full-time, part-time and multi-jurisdictional teams and to identify the underlying physical fitness components required to perform the essential job-tasks of SWAT.

Hypotheses and Research Questions

The following hypothesis will be tested at the .05 level of significance.

Null Hypothesis One

There will be no significant differences between the mean ages for full-time, part-time and multi-jurisdictional tactical officers.

Null Hypothesis Two

There will be no significant differences between the mean years of experience for part-time and multi-jurisdictional tactical officers.

Null Hypothesis Three

There will be no significant differences between the mean heights of full-time, part-time and multi-jurisdictional tactical officers.

Null Hypothesis Four

There will be no significant differences between the mean bodyweights of full-time, part-time and multi-jurisdictional tactical officers.

Null Hypothesis Five

There will be no significant differences between the mean Body Mass Index of full-time, part-time and multi-jurisdictional tactical officers.

Null Hypothesis Six

There will be no significant differences between the mean body fat percentages of full-time and part-time tactical officers.

Null Hypothesis Seven

There will be no significant differences between mean body fat percentages for full-time tactical officers and the Cooper Single Fitness Norms.

Null Hypothesis Eight

There will be no significant differences between the mean body fat percentages for part-time tactical officers and the Cooper Single Fitness Norms.

Null Hypothesis Nine

There will be no significant differences between the mean amounts lean mass of full-time and part-time tactical officers.

Null Hypothesis Ten

There will be no significant differences between the mean amounts of fat mass of full-time and part-time tactical officers.

Null Hypothesis Eleven

There will be no significant differences between the mean 1 RM bench press ratio scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms.

Null Hypothesis Twelve

There will be no significant differences between the mean 1-minute push-up scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms.

Null Hypothesis Thirteen

There will be no significant differences between the mean 1-minute push-up scores of multi-jurisdictional tactical officers and the traditional law enforcement officers.

Null Hypothesis Fourteen

There will be no significant differences between the mean scores of full-time, part-time and multi-jurisdictional tactical officers on 2-minute push-up scores.

Null Hypothesis Fifteen

There will be no significant differences between the mean 1-minute sit-up scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms.

Null Hypothesis Sixteen

There will be no significant differences between the mean 1-minute sit-up scores of multi-jurisdictional tactical officers and traditional law enforcement officers .

Null Hypothesis Seventeen

There will be no significant differences between the mean 2-minute sit-up scores of full-time and part-time tactical officers.

Null Hypothesis Eighteen

There will be no significant differences between the mean maximal pull-up scores of full-time and part-time tactical officers.

Null Hypothesis Nineteen

There will be no significant differences between the mean vertical jump height scores of full-time and part-time tactical officers.

Null Hypothesis Twenty

There will be no significant differences between the mean vertical jump height scores of full-time tactical officers and traditional law enforcement officers.

Null Hypothesis Twenty-One

There will be no significant differences between the mean vertical jump height scores of part-time tactical officers and traditional law enforcement officers.

Null Hypothesis Twenty-Two

There will be no significant differences between the mean 300 meter run time scores of fulltime, part-time and multi-jurisdictional tactical officers.

Null Hypothesis Twenty-Three

There will be no significant differences between the mean 300 meter run time scores of fulltime, part-time and multi-jurisdictional tactical officers traditional law enforcement officers.

Null Hypothesis Twenty-Four

There will be no significant differences between the mean 1.5 mile run times scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms

Null Hypothesis Twenty-Five

There will be no significant differences between the mean 1.5 mile run times scores of multi-jurisdictional tactical officers and traditional law enforcement officers.

Delimitations

The following delimitations may affect the results and conclusions drawn in this study.

1. Archived data related to a variety of health, performance and fitness scores for seventy-one (n=71) tactical officers between the ages of 28-56 belonging to either a full-time (n=28), part-time (n=21) and multi-jurisdictional (n=21) team.
2. Data was provided to the primary investigator by the participating agencies and organizations between May 2010 and January 2011.
3. All identifiers were removed prior to the primary investigator receiving this data in order to uphold the confidentiality of the tactical officers. Subject numbers were added used in place of names to maintain organization of the data
4. The following health, fitness and performance metrics were selected for descriptive and comparative purposes by the primary investigator: anthropometric measures (height, body weight, body mass index; body composition); muscular endurance (push-up and sit-up test scores for 1 and 2 minutes); muscular strength (maximum pull-ups and 1RM bench press scores); aerobic fitness (1.5 mile run times), anaerobic power (300 meter run and vertical jump height scores) and agility (Illinois agility test and the pro-agility shuttle).
5. Not all the Tactical officers included in this study performed each individual test.
6. This study was limited to archival data voluntarily provided to the primary investigator via the participating agencies.

Limitations

The limitations in this study reflect the effect of the delimitation's on the collection and interpretation of data and the ability to expand the scope of inference beyond the

sample population. Generalizations made from the results will be comprised by the following limitations:

1. Tactical officers were not randomly sampled.
2. Tactical officers were limited to seventy-one (n=71) male Tactical officers between the ages of 28-56 from a full-time, part-time and multi-jurisdictional team.
3. Only metrics that could be compared against well-established health, fitness and performance standards and norms were selected for description and comparison in this study.

Assumptions

The following statements were assumed true when analyzing the results of this study.

1. Tactical officers performed to their maximum capability during all testing sessions.
2. The data provided to the primary investigator was true and accurate.
3. The testing administrators that collected the health, fitness and performance data for analysis in this study possessed all the appropriate knowledge, skills and abilities to collect this information accurately and in the manner described in the methods section of this paper.

Definition of Terms

The following section will provide a list of relevant terms related to this research investigation.

300-meter run: a test used to measure anaerobic power.

1.5 mile run test: a sub-maximal field test used to measure aerobic fitness levels and estimate VO₂ max.

Aerobic power: the maximum amount of power that can be expressed via the aerobic energy system

Agility: the ability to start, stop, and change directions rapidly and efficiently.

Anaerobic power: the maximum amount of power that can be expressed via the anaerobic energy system.

Anthropometry: the measurement of the human body (Hoffman, 2006)

Body composition: the amount of lean mass an individual possess in relation to fat mass.

Body composition analysis: a measurement used to determine relative amount of fat free mass in relation to lean mass.

Body mass index (BMI): an anthropometric measure used to assess body mass in relation to height. This measure is calculated using the Quetelet index, which is calculated by dividing bodyweight in kilograms by height in meters squared (kg/m^2) (ACSM, 2010).

Cardiovascular fitness: the ability of the heart, lungs, and circulatory system to deliver oxygen to the working skeletal tissues.

Civil service personnel: include fire, police, and emergency medical personnel.

E-blast: a mass e-mail communication sent by an organization or business to its current or previous customers; members with the primary purpose of communicating a message or acquiring information.

Essential job-task: those elements of an occupation that are considered necessary in order to perform effectively at ones job.

Fitness norms: a representation of how individuals compare to one another with regard to performance (CIAR, 2006).

Fitness standards: minimal scores that must be attained on each physical fitness or job task simulation test to indicate that an individual can perform his/her job (CIAR, 2006).

Full-time SWAT team: a tactical unit whose member's primary duty is to serve on a special weapons and tactics team (Klinger & Rojek, 2008).

Law enforcement officer: a civil service professional responsible for aiding in the enforcement of laws and codes set forth by governmental agencies.

Multi-jurisdictional SWAT team: a tactical unit whose member's consist of officers from several police agencies that are called to serve on special weapons and tactics team as part of their ancillary duties (Klinger & Rojek, 2008).

Muscular endurance: the muscles ability to overcome a given resistance for multiple repetitions, or for an extended period of time without undue fatigue (Hoffman & Collingwood, 2005).

Muscular strength: the maximal force that a muscle or muscle group can generate with no emphasis on time (Knuttggen & Kraemer, 1987).

Operational fitness: a term used to describe a tactical officer's level of preparedness to perform the essential physical tasks to successfully complete a tactical mission. The required level of operational fitness is highly task dependent and may vary dramatically between operations.

Part-time SWAT team: a tactical unit whose members serve on a special weapons and tactics team on a part-time basis as an ancillary duty to traditional law enforcement work (Klinger & Rojek, 2008).

Physical ability testing (PAT): tests used by an employer to ascertain an individual's ability to perform certain essential occupational tasks. These types of tests are used

frequently for those that are seeking employment in physically demanding occupations

Power: The ability to exert force in the shortest amount of time (Clark, 2001).

Push-up: an exercise used to develop the muscles of the upper body, specifically in the area of the chest, shoulder and triceps.

Pull-up: an upper-body pulling exercise used to develop the muscles of the back and biceps.

Sit-up: an exercise used to condition the trunk and abdominal musculature.

Special Response Teams (SRT's): another term commonly used to describe a SWAT team.

SWAT: an acronym used to describe a Special Weapons and Tactics team.

Tactical Action Groups (TAG's): another term commonly used to describe a SWAT team.

Tactical Enforcement Units (TEU's): another term commonly used to describe a SWAT team.

Tactical officer: those officers that serve wither full or part-time on a SWAT team, or tactical enforcement unit.

Vertical Jump: a test frequently used to assess anaerobic power of the lower extremities by measuring jump height.

CHAPTER II

REVIEW OF LITERATURE

This literature review will cover three major areas including the history of SWAT; physical fitness and law enforcement; and physical testing frequently used to predict successful job performance amongst law enforcement officers.

History of SWAT

The Los Angeles Police Department (LAPD) is credited with forming the first tactical law enforcement unit, or special weapons and tactics team (SWAT) in 1966. It is believed this specialized unit was created in response to several critical incidents, such as the increasing threats of violence associated with anti-war protests and race riots, and incidents, such as the Charles Whitman shootings at the University of Texas in Austin (Balko, 2001; Heatly, 1966; Weber, 1999). The LAPD has also been credited with coining the acronym “SWAT” to describe this elite unit of specially trained officers (Weber, 1999). Since its inception, the number of SWAT units has increased dramatically across the United States. In fact, it has been reported that approximately 90% of cities with populations of 50,000 or more and 65% of towns with populations of 25,000-50,000 have at least one tactical law enforcement unit (Kraska & Cubellis, 1997; Kraska, 1999).

SWAT teams vary greatly in size and structure and are often referred to as Tactical

Enforcement Units (TEU's), Special Response Teams (SRT's), and Tactical Action Groups (TAG's) to name a few (Klinger & Rojek, 2010). However, for the sake of simplicity, in this study these terms will be limited to SWAT teams or TEU's. While some agencies have their own TEU's, others collaborate with other agencies and provide officers to serve on multi-jurisdictional teams or task forces. According to research conducted by Klinger and Rojek (2008), of 1,183 agencies surveyed over 88% worked on TEU's as ancillary duty, 8% of the SWAT teams surveyed had officers whose primary responsibility was work related to SWAT, and only 4% of the agencies surveyed had TEU's that consisted of a combination of both full-time and part-time members. According to Kraska (1999) TEU's typically range from 10-40 members. However, other authors have found that the number of team members between various TEU's ranged from 7-104 officers, with the average team consisting of 16 officers (Klinger & Rojek, 2008).

The term tactical officer is frequently used to describe those individuals that are members of SWAT teams. However, due to the physically demanding nature of their work these officers have been referred to by some as "tactical athletes" (Stephenson, 2008). For descriptive purposes, in this study members of SWAT will be termed as tactical officers, whereas those that do not belong to these specialized units will be referred to as law enforcement officers.

Tactical officers typically have specialized training that exceeds the requirements of most law enforcement officers (Klinger & Rojek, 2008; NTOA, 2008; Williams & Westall, 2003). Tactical officers are frequently required to utilize and operate special weapons, such as sub-machine guns, high-powered rifles, grenades, gas-grenades, rocket propelled tear gas, stun guns, and guns that shoot bean bags (Williams & Westall, 2003). Tactical officers must also use special tactics, such as stealthy movements similar to military type training, forcing a suspect to move positions, mechanical/explosive breaching and hostage rescue in order to successfully complete their missions (NTOA, 2008; Williams & Westall, 2003). Consequently, many SWAT teams tend to exhibit a more military-style ethos than most traditional law enforcement

structures (Weber, 1999). This is likely due to their specialized training and to a highly emphasized team/unit orientation.

Physical Fitness in Law Enforcement

Physical fitness is a major concern in the law enforcement community. Consequently, over the last several years there has been a growing interest in the development of appropriate strength and conditioning programs for those that must be involved in physically demanding occupations. In addition, several leading strength and conditioning organizations have sought to provide scientifically validated information to the law enforcement, public safety, and military. Many have advocated training these individuals in a manner more similar to the training of athletes, rather than just training to improve general health and fitness (Dawes, 2008; Stephenson, 2008; Sell, 2006 :NSCA, <http://www.nscs-lift.org/tsac>; retrieved on January 17, 2011,) As a result, in recent years there have been numerous programs created seeking to address the needs of these “occupational athletes”. Crossfit™ is a program that has gained a great deal of attention in the tactical community. In fact, on the CrossFit™ website this program claims to be the “principal strength and conditioning program for many police academies and tactical operations teams, and military special operations units”. Regardless, many of the training methods used in this training program are quite controversial amongst strength and conditioning professionals and law enforcement personnel. However, at this time Crossfit™ may be the most popular source amongst those working in physically demanding occupations to receive fitness advice (<http://www.uscrossfit.com/about/crossfit.php> retrieved June 3, 2011).

The National Strength and Conditioning Association (NSCA) created the Tactical Strength and Conditioning (TSAC) program for military personnel, law enforcement personnel, tactical officers, firefighters, and other first responders in 2007. This program was developed to emphasize the importance of injury prevention, strength, power, speed and agility in this population and to provide these occupational athletes with information on effective testing and

training methods to improve tactical fitness (<http://www.nscf-lift.org/tsac>; retrieved on January 17, 2011).

In a personal conversation with Coach David Boyle, board of director member for the Australian strength and Conditioning Association (ASCA), the researcher was told that the ASCA will be launching a tactical strength and conditioning program in Australia by fall of 2011 (David Boyle, personal communication, February 13, 2011).

The Cooper Institute for Aerobics Research (CIAR) has worked with law enforcement, public safety, and military groups since 1976 to help influence the fitness programming for these physically demanding occupations. A primary focus of this organization has been helping agencies establish scientifically valid and defensible fitness tests, standards, and programs.

According to the CIAR(2006) the Cooper Single Fitness Norms (CSFN) have been found to be job related for law enforcement officers, and defensible if validated for a specific agency and absolute cut-scores are used. The use of absolute cut-scores require everyone, regardless of age or gender, be able to pass the same absolute fitness standards in order to perform the same job. Essentially this means those performing the same jobs must be able to meet the same standards of performance. Therefore, these cut-scores must be reflective of the minimal fitness standards required for the job and must also be job-related to be predictive of occupational success. According to the CIAR (2006) minimal fitness levels have been validated for two federal, five state, and nine municipal agencies.

The CSFN were originally developed based on a sample of approximately 50,000 patients from the general population who came to the Cooper Clinic for medical exams and performed a fitness testing battery (FitForce™, 2007). These tests included the sit and reach for flexibility, 1 minute sit-up and 1 minute push-up test to assess muscular endurance, body fat percentage to determine health risk, and the 1 RM bench press and leg press to determine muscular strength. The 1.5 mile run norms were developed from interpolated treadmill tests and were not true norms (FitForce™, 2007). According to FitForce™ (2007) no law

enforcement officers were included in this sample. The age and gender norms from these tests were later combined and collapsed to create the CSFN. The CIAR then promoted these norms be used by law enforcement agencies. Previously these norms were used by law enforcement agencies because fitness was recognized as important for law enforcement officers, but the level of fitness required was unknown. Consequently, without established standards available it was expected that law enforcement officers should at least be as fit as those in their age and gender norm groups. Thus, specific percentile ranks for each these groups were recommended. Since, different raw scores were considered acceptable for each group it is evident that using percentile rankings did not reflect the appropriate minimum standard to perform job-related tasks and these norms could not be considered predictive of job performance. According to FitForce™ (2007), the Cooper norms are not standards. They do not predict the ability to perform essential job tasks and should not be used for the purposes of hiring officers, as academy graduation standards, or for incumbent retention. FitForce™ (2007) states the CSFN are best used as a tool to develop goals for voluntary fitness programs that do not require mandatory participation or the meeting of a specific standard.

FitForce™ (2007), a private company focused on fitness for public safety, has declared they have conducted over 130 validation studies and maintains a database of over 4000 randomly selected law enforcement officers at agencies for whom standards were developed. Based on research by this group the 300-meter run, and vertical jump were added to the Cooper Fitness Battery for law enforcement officers and the leg press was removed due to logistical problems with executing this test. Thus, it appears FitForce™ has filled a much needed gap in this area by conducting validation studies and collecting information from actual law enforcement officers.

Due to their similarities, and Cooper's history in public safety, many tactical teams also use these norms. However, based on the physical demands of the tactical officer's essential job-tasks it stands to reason that these cut-scores should be higher than the traditional law

enforcement officers. While research conducted by FitForce™ (2007) has investigated over 180 federal, state, and municipal agencies and identified a spread of scores that were defined as standards for many of the tests used by the CIAR for law enforcement standards have not been established for the tactical officer. Furthermore, while many of the job tasks performed by both the tactical and traditional law enforcement officers appear to overlap (CIAR, 2006; NTOA, 2008). Despite this one could certainly make an argument that the necessary fitness levels for the tactical officer are greater based on the increased physical demands required, such as wearing specialized gear and carrying distinctive weaponry and equipment. More research is therefore currently needed in this area to identify the minimum fitness standards required to successfully perform the essential job-tasks of SWAT.

In recent years there has also been an increase in the popularity of SWAT competitions in the tactical community. Probably, the most popular of these is the SWAT Roundup™. During this competition SWAT teams perform several obstacle course types of events that consist of several job-simulation tasks and physical challenges. These events consist of a simulated hostage rescue; obstacle course requiring the engagement of a moving target, breaching and traversing a variety of objects and obstacles; a simulated officer rescue in a canal filled with water, while engaging multiple targets with multiple weapons in a simulated chemical environment; a tower climb with followed by rappelling; and an obstacle course with sixteen physical challenges that require a combination of fitness components to complete successfully (<http://www.swatroundup.net/> , retrieved on April 15, 2011). The primary investigator sought to obtain information related to completion times/scores for these events from the coordinators of this event, however at this time these totals have not yet been made available (Anonymous, personal communication April 21, 2011).

Despite the increased interest in tactical fitness and tactical fitness programs, the level of fitness required for the tactical officer to perform their job duties safely and effectively is still unclear. In addition, there is a need to identify the underlying physical fitness components

predictive of successful operational performance in these tasks, and the best methods to evaluate these components (Alexander, 2010; Corey Luby, personal communication, December 5, 2010; Mark D. Stephenson, personal communication, June 1, 2010). The underlying physical fitness components believed to be predictive of successful job performance in a variety of law enforcement tasks have been identified and documented (CIAR, 2006; Hoffman & Collingwood, 2005). However, the underlying physical fitness components predictive of performance have not been studied for those in the tactical community. Many of the job-related tasks performed by the law enforcement officer match those of the tactical officer. However, there are certain essential-job tasks related to SWAT that warrant further investigation to determine the necessary components and level of fitness to perform each task. Thus, based on the lack of research in this area a review of other occupations with similar physical demands should be explored in order to develop a frame of reference for the physical fitness levels required for the tactical officer to successfully and safely perform essential job tasks.

The use of physical ability and physical fitness testing as an employment qualification is very common among occupations that are physically demanding (Jackson, 1994; Jamnick, 2008). Most law enforcement agencies require officer candidates to meet a certain physical fitness level, or standard, as part of their selection process (Lonsway, 2003; Reilly & Karlstad, 2004). According to Hoover (1992) these standards generally include job simulation exercises, physical agility or stamina tests, and norm referenced fitness/wellness tests. If the candidate is unable to successfully pass this portion of the selection process they are typically no longer considered as a viable officer candidate (Wrobelski & Hess, 2006).

Typically, to become a member of SWAT additional physical fitness standards beyond the demands of the traditional law enforcement personnel must be met. Often times these are in the form of additional tests or tasks, or be the same assessments may be used but performance standard, or absolute cut-points, are generally higher required (Mark D. Stephenson, personal communication, June 1, 2010). Furthermore, for the tactical officer employment is often

contingent on consistently demonstrating an adequate level of operational fitness. Thus, physical evaluations are traditionally performed on a regular basis to ensure minimal physical standards are achieved. If a tactical officer fails to maintain the appropriate level of fitness deemed necessary by their unit or agency they may be put on probation. Should they fail to improve their performance in a given amount of time it may lead to permanent dismissal from the team (Israel Soza, personal communication December 4, 2010; Mark D. Stephenson personal communication June 1, 2010). This is not typically the case with the traditional law enforcement officers. In fact, after selection many law enforcement officers are not required to engage in periodic fitness assessments, except on a voluntary basis.

While most would likely agree that having a physical fitness standard is a positive step to ensuring both the safety of the officer, teammates, and the community a tremendous amount of controversy exists around the topic of physical ability and physical fitness testing. It has been documented by several authors that such testing may likely discriminate against certain protected groups, such as women, minorities, older individuals and the disabled (Campion, 1983; Hoover, 1992; CIAR, 2006). Thus in order to be legally defensible in a court of law, any physical standards required as part of a pre-employment or employment screening must be job-related, essential to perform the job in a safe and effective manner, and be scientifically valid (Avery, Nutting, & Landon, 1992; Companion, 1983; CIAR, 2006). If an agency fails to demonstrate that a test or testing battery used for selection meets these criteria they may be found guilty of violating laws set forth by the United States Constitution (e.g. Equal Protection Clause found under the Fourteenth amendment), and several federal statutes (e.g. the Title VII of the Civil Rights Act of 1964, and the Age Discrimination in Employment Act of 1967) (Brooks, 2001; CIAR, 2006; Sharp, Moorman, & Claussen, 2010).

The first step in identifying the necessary level of physical ability or fitness required for operational success is to conduct a job-task analysis. Once this has been accomplished the essential job-tasks can be separated from those that are non-essential and the appropriate

physical fitness components required to perform each of these tasks can be identified and analyzed further. Research conducted by the Cooper Institute for Aerobic Research (CIAR) (2006) has identified several strenuous/critical physical tasks considered job-related for law enforcement officers (Appendix D). While the tactical officer must be able to successfully perform many of these same essential job-functions, based on their expertise and specialized training they are typically called upon to handle a larger percentage of potentially dangerous situations, such as high-risk warrant serves, apprehending armed and dangerous suspects fleeing from the law, and rescuing hostages being held against their will (Klinger & Rojek, 2008). These essential job tasks were detailed by the National Tactical Officers Association (NTOA) in 2008(Appendix E). Based on the strenuous and often dangerous nature of these activities, one would assume that the tactical officer should possess higher-levels of fitness than the non-tactical law enforcement officer. Kleiner (2008) and Alexander (2010) claim that most operators and agencies understand that the physical fitness demands for the tactical officer is greater than that of other law enforcement or patrol officers. Even so, at this time, the minimal physical fitness standards a tactical officer should possess to perform the essential job-tasks related to SWAT is unknown. Determining the level of fitness that is necessary to perform these essential job tasks safely and effectively may not only enhance the tactical officer's operational success, but potentially minimize the risk of human casualties in high risk situations.

Physical Ability/Fitness Testing in Law Enforcement

Physical Agility Tests (PAT's) are frequently used by law enforcement agencies as a pre-employment selection test (Lonsway, 2003; Maher, 1988; Spitler, Jones, & Hawkins, 1987; Stanish, Wood & Campagna, 1999; Trottier & Brown, 1994). Classically, these tests are designed to replicate general movement patterns or situations that may occur during police work. These tasks typically include timed obstacle courses; running a set distance; climbing stairs, walls, fences, ladders through windows and over barriers; jumping and/or vaulting over objects of various sizes; balancing or traversing high and low areas; carrying or pulling heavy

objects to simulate victim rescues; vehicle pushes; simulated fight scenarios; and in some cases even swimming (Rhoades & Farenholtz, 1992; Lonsway, 2003; Maher, 1988; Spitler, Jones, & Hawkins, 1987; Stanish, Wood & Campagna, 1999). These tasks may be performed separately, or combined as part of larger obstacle course (Arvey, Nutting, Landon, 1992; Lonsway, 2003; Stanish, Wood & Campagna, 1999).

Many of these assessments are evaluated on a pass/no-pass system. In some cases a passing score is given to candidates if they are simply able to complete a task, however in most cases these tests must be completed under time constraints. Cut-scores, or selected points on the scoring scale of a test, are often used to determine whether an individual has met a certain level of proficiency for a particular task (Zieky & Perie, 2006). The use of cut-scores is often very controversial in terms of their validity and defensibility in a court of law (CIAR, 2006). According to Biddle and Shepard-Sill (1999) a main concern when setting cut-scores for protective services is the need to set a standard that is necessary for the maintenance of public safety. For the tactical officer certain amount of physical fitness must be achieved in order to ensure safety of the public, their teammates and themselves. However, if the standards are set too high, or only the top percentage of candidates are selected from a pool of applicants, then the agency may be at risk for charges of discrimination and potential litigation. Biddle and Shepard-Sill (1999) recommend using one of three primary methods for establishing cut scores for physical ability tests to ensure they appropriately discriminate between those that are able to perform essential job-tasks and those that are not. These methods include the modified Angoff method, norm referencing, and criterion referencing.

In addition to setting appropriate cut scores, PAT's must represent the skills that are relevant to one's ability to successfully perform the essential job-tasks of an occupation, and demonstrate validity (CIAR, 2006; Lonsway, 2003). In a study by Anderson, Plecas, and Segger (2001) the authors claim that a well designed PAT that simulates getting to the problem,

controlling the problem, and removing the problem utilizing a core of bona fide occupational requirements is a valid selection tool for police recruits. However, most agencies have developed their own task-oriented occupational tests to discriminate between those that can perform essential job-duties and those that cannot. Therefore, very few of these PAT's have gone through a scientific validation process. Thus, it is difficult to determine what cut-scores are appropriate for these tests, and would likely be even more difficult to defend in a court of law should discrimination charges be filed.

Two PATs created to address the specific job-related occupational fitness of law enforcement officers is the Police Officers Physical Abilities Test (POPAT) and the Physical Activity Requirement Evaluation (PARE) (Stanish, Wood & Campagna, 1999; Trottier & Brown, 1994). Both of these tests were designed to imitate one of the most physically demanding tasks of police work, a chase followed by a physical struggle with a male suspect of average size (Stanish, Wood, & Campagna, 1999). These tests both require the candidate or officer to successfully maneuver an obstacle course, and then use pushing and pulling movements on a wall mounted pulley system to simulate a fight or struggle with an assailant.

The POPAT was created based on descriptive records of police job tasks created by 217 randomly selected law enforcement representatives over the period of one month. The POPAT is in the form of a circuit and requires an individual to perform several tasks, such as a 400-meter mobility; agility run, a simulated fight station using a wall mounted cable system, a vault station, and a weight carry station. The criterion pass time for completion of this test is 4 minutes and 15 seconds (Lonsway, 2003; Regina Police Department, retrieved from http://www.reginapolice.ca/recruit_popat.php, retrieved on January 09, 2011).

According to Stanish, Wood and Campagna (1999) the PARE was modified from the POPAT. The PARE can be broken down into two main components, an obstacle course and a fight simulation test. The obstacle course involves running six laps for a total of 1218 ft. and includes five standardized obstacles that must be successfully overcome. These obstacles

include long jumping over a two foot matt, a two-sided stair case climb with five steps on each side, clearing two-1.5 ft high hurdles positioned in a linear and diagonal fashion from one another, vaulting a 3-ft high barrier, and a controlled fall in the form of a modified push-up or sit-up. The simulated fight station involves several pushing and pulling movements on a wall mounted pulley system, a controlled fall accompanied by two push-ups and two sit-ups. Both the obstacle course and fight simulation are performed consecutively with no break between them. The criterion pass time for completion of this test established by the Royal Canadian Mounted Police (RCMP) is 4 minutes and 45 seconds.

While both of these tests have been used to determine job-related fitness, they provide very little information regarding the specific physical components where deficiencies may exist. Thus, if a candidate or officer were to score poorly on the POPAT or PARE it would be difficult to identify which fitness component(s) (e.g. muscular strength; endurance, power, cardiorespiratory endurance, agility, etc) should be addressed to improve operational fitness and performance. For this reason, characterizing the underlying physical fitness components required to perform specific occupational tasks has been the focus of research (Jamnick, 2008; Jamnick, Thomas, Shaw, & Gledhill, 2010; Rhodes & Farenholtz, 1992; Sheaff, 2009; Stanish, Wood & Campagna, 1999).

Research conducted by Rhodes and Farenholtz (1992) compared performance scores on the POPAT to a variety of commonly used laboratory and field test for measuring performance. They discovered that approximately 50% of the variability in the obstacle course section of the POPAT could be explained by maximal aerobic and anaerobic capacity. Based on this research the authors concluded that the POPAT was a valid job-related test that measures both motor abilities, as well as generalized fitness parameters for traditional law enforcement officers.

Stanish, Wood and Campagna (1999) investigated several field tests of physical fitness to determine the most accurate predictors of performance on the PARE. A Pearson-product moment correlation was used to determine the fitness measures most highly correlated with

PARE performance. Subsequently, the fitness variables used as predictors of PARE performance were narrowed from 11 to five. These measures included an agility run test, 1.5 mile run, 70-lb bench press test, standing long jump, and 40 m sprint time. Once this was completed the researchers used a multiple regression analysis and a forward selection procedure using coefficient of determination (R^2) statistics to predict PARE performance based on these five measures. The results of this study indicated that 60% of the subjects were successful in completing the PARE in relation to the 4 minute and 45 second criterion time set by the RCMP. However, it appears that of the subjects involved in this study a disproportionate number of males (91%) compared to females (37%) were able to successfully pass the PARE. Of the five measures selected for prediction it was found that performance on the 70-lb bench press, agility run, and standing long jump explained 79% of the variability in male PARE performance, whereas agility accounted for 43% of the variability in female PARE performance. Agility and 1.5 mile run times were able to predict successful PARE performance in females with 93% accuracy. Interestingly, the agility run alone was able to predict successful PARE performance with 85% accuracy for the female subjects involved in this research.

The Correctional officers physical ability test (COPAT) was designed to replicate a correctional officer responding to a critical incident. Jamnik (2008) described this PAT as consisting of a timed circuit immediately followed by an untimed weight carry (70lb). In order to receive a passing score on the COPAT, participants must complete the timed portion of this test within 2 minutes and 50 seconds, and then demonstrate the physical ability to lift and carry the 70 lb torso bag 25 feet.

While PAT's are commonly used in law enforcement as part of the selection process many question their actual ability to predict performance. According to Maher (1988) physical fitness seems to be the truly significant issue for police agencies rather than PAT's that have questionable value in identifying job-related fitness. Additionally, the CIAR (2006) does not

recommend using job-task simulation tasks because they are not as accurate and predictive of physical ability as testing the underlying physical fitness components required to perform essential job tasks. In fact, the CIAR (2006) claims that PATs that are based on job-simulation tasks alone may only account for 20-25% of performance for all the physical tasks essential to law enforcement. The CIAR (2006) also states that testing the underlying components of fitness predicts within 50-90% accuracy the ability to perform essential job tasks for patrol officers, thus testing the underlying physical fitness components is more defensible in a court of law than using PATs. Consequently, the CIAR (2006) recommends that fitness tests be used over job-simulation tasks whenever possible. The CIAR also states that if an agency were to choose a PAT as a method of selection or assessment, only those that have been validated through research studies should be utilized.

While many agree that the physical demands of the tactical officer are greater than that of the average peace officer (Alexander, 2010; Kleiner, 2008; Corey Luby, personal communication, December 5, 2010; Mark D. Stephenson, personal communication, June 1, 2010) the ideal level of operational fitness has yet to be established for tactical officers. In the following section, the underlying components of physical fitness associated with the essential job-tasks of SWAT will be discussed. Tests regularly used to assess these specific physical fitness components will also be discussed in greater detail.

Anthropometry and Body Composition

Anthropometry refers to using measurement of the human body, such as height, weight, girth and skin-fold assessments (Hoffman, 2006). These assessments have been used in several studies as evaluative tools to predict health risk and performance potential amongst law enforcement officers (Boyce, Ciulla, Jones, Boone, Elliot, & Combs, 2008; Boyce, Jones, Lloyd, & Boone, 2008; Shepard & Bonneau, 2002; Spitler, Jones, Hawkins, & Dudka, 1987). According to several authors, until the late 1970's in the United States and the early 1980's in

Canada, many police agencies used height and weight standards as part of their selection criteria (Lonsway, 2003; Maher, 1988; Shepard & Bonneau, 2002). These standards were eventually deemed as discriminatory in the United States by the courts based on Title VII of the Civil rights act of 1964 (Avery, Nutting, & Landon, 1992). However, attaining anthropometric information may be of importance to the tactical officer when seeking to evaluate current health status, health risks and opportunities to improve tactical performance via appropriate strength and conditioning programs.

Body Mass Index (BMI) is an anthropometric measure used to assess body mass in relation to height. BMI is calculated using the Quetlet index, which is calculated by dividing bodyweight in kilograms by height in meters squared (kg/m^2) (ACSM, 2010). BMI is frequently used as a method of predicting morbidity and mortality risk (ACSM, 2010; Hoffman, 2006). A second method is which provides greater detail in relation to body mass by separating total body mass into both lean and fat tissue in order to determine body composition.

While both BMI and body composition analysis are frequently used the latter of these methods is likely the most accurate predictor of overall health and wellness for the tactical officer. This is because BMI tends to overestimate body fatness for athletic and very muscular individuals (Hoffman, 2006; Kaiser, Womack, Green, Pollard, Miller, & Crouse, 2008). Since many tactical officers typically have athletic; muscular builds, using BMI may incorrectly stratify these individuals as overweight or obese (Shell, 2005).

According to Boyce, Jones, Lloyd, and Boone (2008) body composition may also affect performance since heavier and obese officers may have a reduced ability to perform their job at a higher rate than their lower weight counterparts. However, the authors also emphasize that these performance reductions may be ameliorated with increases in lean mass rather than fat mass, since lean mass is associated with increased muscular strength. For example, when comparing two officers of equal body weight, the officer with greater body fatness in relation to total body weight will have less lean mass (i.e. less force production capabilities) to contribute to the

strength, power and speed requirements of many essential job-tasks. In addition, the officer with greater body fatness must overcome the same amount of inertia as the officer with greater lean mass; however they must do so with less force production potential. In other words, increased body fatness would contribute to the total mass that must be moved, but not the force production capabilities. This may also contribute have a negative impact on an officers ability to produce high-speed movements, as well reduce their time to reaching muscular fatigue (Potteiger, Smith, Maier, & Foster, 2010). In addition, increased adiposity may hinder performance by restricting joint range of motion when low and high crawling to objectives and; or when climbing or crawling in narrow spaces, such as tunnels, vents, and shafts (CIAR, 2006).

This physical fact is aptly demonstrated in research conducted by Riggs and Reilly (1987) and that of Reilly, Williams, Neville and Frank (2000). These investigators found that rugby and soccer athletes with lower body-fat percentages had a propensity to score better on change of directions tests than their fatter counterparts. Potteiger et al.(2010) found a similar a relationship between body fat percentage and ice-skating speed in Division I male hockey players, with lower body fat percentages correlating to better on-ice skating speed. Similarly, Thompson, Dain, and Jones (2010) found that increased weight did not correlate positively with power, speed and agility variables amongst Division III football players. In this study it was discovered that these players had lower BMI's and higher body fat percentages than their Division I Football counterparts. Thus, they had less lean mass in relative terms which may help explain the lower correlations between performance variables and body weight. This is contrasted by the research of Stuempfle, Katch and Petrie (2002) that found no correlation between commonly administered performance tests, such as the 10- and 40 yard sprints, pro agility shuffle, vertical jump, sit and reach and bench press in Division III football players.

In a recent study by Dawes, Murray, Spaniol, Temple, Melrose, and Bonnette (2011) it was found that increased body fatness amongst part-time tactical officers may have a negative

impact on certain measures of upper-body muscular endurance performance, specifically the 2-minute push-up ($r = -.449, p < 0.05$), 2-minute Sit-up ($r = -.502, p < 0.05$) and maximal pull-up tests. ($r = -.761, p < 0.01$). Research conducted by Escó, Olson and Wiliford (2008) found similar results when it was discovered that firefighters with lower subcutaneous fat levels performed more repetitions in a push-up and sit-up tests.

Based on this research, attaining and maintaining body composition percentages in the ranges recommended by the American College of Sports Medicine (ACSM) for reducing the risk of morbidity and mortality may be beneficial in maintaining the overall health for the tactical officer. Furthermore, increased lean muscle mass may positively contribute to force production capabilities and positively influence certain performance characteristics, such as running speed, agility, power, endurance, and strength. Conversely, adiposity is inert and does not actively contribute to force production. This may increase the physiological burden of moving for the individual resulting in an increase in overall movement time. Increased body fatness may also impede range of motion due to greater anatomical limitations (Sharkey & Gaskill, 2007). For this reason it is recommended that the tactical officer strive to attain and maintain appropriate body composition levels as defined by the ACSM (2010) based on their age, gender and performance needs.

Muscular Fitness

Muscular fitness characteristics are of particular interest to those in law enforcement as there appears to be a strong relationship between these attributes and successful performance for a variety of essential job-tasks. Muscular fitness consists of both muscular strength and muscular endurance. According to Mejares (1993) both strength and endurance is of significant importance when selecting tactical officers. Muscular strength is defined as the maximal force that a muscle or muscle group can generate with no emphasis on time (Knuttgen & Kraemer, 1987). Muscular

endurance is defined as the muscles ability to overcome a given resistance for multiple repetitions or for an extended period of time without undue fatigue (Hoffman & Collingwood, 2005).

Muscular strength appears to be particularly important for many essential job-tasks for the tactical officer, such as use of force situations lasting less than 2 minutes; climbing to gain an objective or tactical position; lifting and carrying necessary equipment; and lifting, dragging, or pulling wounded officers/citizens to safety (NTOA, 2008; Lonsway, 2003; CIAR, 2006). Furthermore, tactical officers are required to wear specialized protective gear (e.g. vests, helmets, etc) in addition to carrying equipment (e.g. guns, ammunition, shields, battering rams, and other specialized equipment) that according to Stephenson (personal communication, January 3, 2010) averages approximately 67 lbs, or 30 kg, of additional weight that must be carried when in full gear. This is similar to the loads reportedly carried by firefighters (Peterson, 2010) and military soldiers (Santitila, Kyrolainen, & Hakkinen, 2009). In contrast, Brian Odem, State Trooper for the Oklahoma Highway Patrol (OHP) (personal communication, January 12, 2011) said that an OHP officer's gear, including belt, vest and boots is approximately 20 lbs. Thus, it appears that the tactical officer has an increased physiological burden in the form of protective gear and specialized weaponry that exceed the demands of the traditional law enforcement officer. This fact, further justifies need for greater strength by the tactical officer compared to traditional law enforcement officer to safely and effectively perform their necessary job duties.

Maximal force production is important, but muscular endurance or the ability to sustain and resist forces over time, may also be an essential factor in determining operational success. Muscular endurance is considered important in the performance of many essential job-related tasks for the tactical officer. These activities include, but are not limited to; use of force situations lasting greater than 2 minutes; maintaining a tactical position for an extended period of time; climbing multiple flights of stairs, ladders, fire escapes, ropes, poles and trees to gain an objective or tactical position; carrying necessary equipment; lifting, dragging, pulling

necessary equipment and/or wounded officers/citizens to safety (CIAR, 2006; Hoffman & Collingwood, 1995; Lonsway 2008; Shepard & Bonneau, 2002; Spitler, Jones, Hawkins, & Dudka, 1987). According to Hoffman and Collingswood (2006) muscular strength and endurance may also be important for the promotion and maintenance of good general health by helping prevent injuries and lower-back-pain.

Several studies have examined muscular strength and endurance amongst law enforcement officers. Lonsway (2003) reviewed the physical agility testing protocols for 62 police agencies at the city, county and state level and found that virtually all used some form of muscular strength/endurance assessment during the selection process. These measures included both standard fitness tests and those created by individual agencies to replicate specific job tasks. These tests included, dummy drags ranging in weight from 125-185 lbs for a total of 10-115 feet for time or as part of an obstacle course; wall climbing events, such as walls, ladders and chain link fences; maximum number of push-ups in either 1-2 minutes; maximum number of pull-ups the individual could perform; a push pull resistance of 50-75 lbs; the bench press; vehicle push from 10-50 ft.; victim carry of 95-150 lbs over a distance of 10-50 ft.; cable pulls; 300 lb. sled pushes for 3 feet; and a leg press of 1.43 to 1:46 of the candidates bodyweight.

In a study conducted by Spitler, Jones, Hawkins, and Dudka (1987) the strength and endurance characteristics of twelve (m = 9, f =3) law enforcement officers were measured using a Cybex II dynamometer, a grip strength dynamometer and a one repetition maximum (1 RM) bench press. Muscular endurance was evaluated using the 1-minute maximum push-up, chin-up and sit-up tests. Specific job strength and endurance tests, including a victim carry, window climb, 6 foot wall scale and culvert crawl. While these measures revealed the law enforcement officers in this study displayed average to above average health and physical fitness scores for their age classifications, the researchers noted that they did not consider these individuals significantly bigger, stronger, or healthier than the average person.

Stanish, Wood, and Campagna (1999) found moderate negative correlations between upper-body muscular endurance as measured by the 70-lb bench press (-0.51), as well as push-ups (-0.49) and PARE completions times. The investigators speculated this association may be related to the importance of upper-body muscular endurance in the simulated fight station.

The one repetition maximum (1RM) bench press is a test regularly used to assess upper-body muscular strength of law enforcement officers (Lonsway, 2008; Spitler et al., 1987). In order to perform this test, the individual should begin by lying down in a standard bench press rack and positioning themselves on the flat bench using a standard 5-point contact (head, shoulders and glutes in contact with the bench and both feet on the floor with the eyes lined up directly with the barbell on the rack directly above the bench). The bar should then be lifted off the rack until is positioned directly over the chest. In a controlled manner, the lifter lowers the bar to the chest, lightly touches the bar against the chest.

According to the CIAR (2006) the 1-RM Bench press test is highly predictive of performing job tasks in all cases for the law enforcement officer. In addition, this test has been frequently used for conducting upper-body strength assessments in other physically demanding occupations. Findley, Brown, Whitehurst, Gilbert, and Apold (1995) used the 1-RM bench press on a fixed weight variable resistance device to assess upper-body muscular strength for male firefighters. In this research it was discovered that male firefighters were able to maintain their maximal and relative upper-body strength levels across different age strata. This is important for this population as decreases in performance may occur with age-related losses of physical fitness. Research conducted by Von Heimberg, Rasmussen, and Medbo (2006) found that firefighters that had greater upper-body strength as measured by the 1RM Bench Press were able to complete a simulated hospital rescue faster than their smaller and weaker counterparts. This is in agreement with research conducted by Michaelides et al, (2011) in which the 1RM bench press significantly correlated to a number of firefighting tasks, such as a rolled hose lift and move ($r = -$

.031), a sled push (-0.41), a rescue mannequin drag (-0.31) and a charged hose advance (-0.36). Sell (2006) also found low to moderate, but significant, correlations between 1-RM bench press ratios and several simulated firefighting tasks.

Rhea (2004) found high correlations between the 5-RM Bench press and a series of job performance tasks amongst firefighters. A significant relationship between upper-body strength and time to completion in a hose pull (-0.80), victim drag (-0.65), and a stair climb (-0.39) was discovered. While this study does not use the 1-RM bench press to assess strength the relationship between the 5-RM and the selected firefighting tasks still illustrates the importance of muscular strength for this population.

When comparing the essential job-tasks of SWAT it appears that the strength demands may be similar to those of the firefighter when the additional protective gear and specialized equipment is considered. Several researchers have found significant correlations between upper-body strength and time to completion on a variety of simulated firefighting tasks comparable to many essential SWAT job tasks (Michaelides, 2011; Von Heimberg, Rasmussen, & Medbo, 2006, Sell, 2006). However, at this time there is no research available discussing the upper-body muscular strength of tactical officers.

The push-up is an exercise performed by placing the hands shoulder width, or slightly wider than shoulder width, apart with the arms fully extended at the elbows, toes in contact with the floor, torso held rigid and head in a neutral position. Once this position has been achieved the individual should bend the elbows to lower the body toward the floor, while keeping the torso flat and rigid. Once the elbows are at approximately a 90 degree angle then the individual should push themselves back to the starting position.

The sit-up is an exercise often used to improve muscular strength and endurance of the trunk. To perform this exercise one should lie in a supine position and bend the knees until the feet are flat on the ground. The arms should then be crossed over the chest and the hands

should be placed on the opposite side shoulder (i.e., left hand on right shoulder). Once in position the participant will flex the trunk, elevating the shoulders off the floor until the elbows touch the knees. A partner may hold the participant's feet down and in place to assist in keeping the feet flat on the floor throughout the exercise movement. The participant will then return to the starting position using the same path as the upward movement.

Both push-ups and sit-ups to fatigue, or for a set amount of time (e.g. 1 or 2 minutes), are commonly used as an assessment of muscular endurance amongst law enforcement officers (Boyce, et al., 2008(a); Lonsway, 2008; Reily & Karlsted, 2004; Spitler et al., 1987), as well as other physically demanding occupations (Boyce, et al., 2008(a); Garver, Jankovitz, Danks, Fitz, Smith and Davis, 2005; Reily & Karlsted, 2004). According to the CIAR (2006) both the maximum push-up test and the 1 minute sit-up test is predictive of ability to perform essential job tasks for the law enforcement officer in most cases.

Both push-up and sit-up assessments are commonly used as field tests amongst a variety of physically demanding occupations. Garver, Jonkovitz, Danks, Fitz, Smith and Davis (2005) used a push-up and sit-up assessment to measure the muscular endurance of firefighters belonging to either an industrial or municipal fire department. Roberts, O'Dea, Boyce, and Mannix (2002) used a traditional push-up for male firefighters and modified push-up (knees touching ground) for females to assess changes in upper-body muscular endurance of firefighter recruits before and after a supervised exercise training program.

Sell (2011) used both of these measures for the development of a physical fitness profile of interagency hotshot firefighters. The fitness battery selected for this research reflected areas of physical fitness previously identified as important for job performance, health and injury prevention. Based on the similarities in physical demands and the job-tasks required of this population in relation to the tactical officer it is logical to use these two assessments in this investigation to develop a preliminary profile for this group.

Findley et. al. (1995) employed the 2-minute sit-up test and push-up test to volitional fatigue with male firefighters to assess upper-body muscular endurance. This investigation discovered that with age there was a statistically significant ($p < 0.05$) decrease in sit-ups across age groups with no decrease in push-up scores. Based on the load carriage tasks required for these individuals a reduction in abdominal muscular endurance may lead to increased stress placed on the trunk when wearing specialized gear and carrying equipment during firefighting tasks. According to research by Lautner (1998), greater muscular endurance leads to longer work periods and reductions in recovery times for firefighters. For this population, and for the tactical officer, this is critical in an operational situation when the ability to rest is typically not an option.

The pull-up is an exercise used to develop the strength and endurance in the upper-body, specifically the back and biceps. The starting position for this exercise requires the participant to fully extend the arms overhead, grasp a bar, and hang vertically with a slightly wider than shoulder-width overhand grip. Once in position the participant will initiate this movement by pulling until the body is lifted upward and the chin passes above the bar being held. The participant will then lower the body back down to the starting position. Maximum pull-up tests are frequently used as a measure of upper-body strength and endurance for police officers (Lonsway, 2008; Spitler et al., 1987) and other physically demanding occupations (Hoffman, 2006; Sell, 2011).

Sell (2011) utilized a pull-up to fatigue test to assess muscular endurance in the creation of a profile for a specialized group of firefighters. This assessment is also used by the United States Marine Corp (USMC) with male recruits. In order to successfully pass basic training a recruit must be able to perform a minimum of three pull-ups (Hoffman, 2006). Based on the needs of the tactical officer to climb barriers or scale certain objects to gain a tactical advantage this assessment was included in this research. It appears that muscular strength and endurance are undoubtedly important to perform many essential job-duties for the tactical officer (Mejiras,

1993). However, at this time there is no published research that describes the ideal levels of muscular fitness required for the tactical officer.

Anaerobic Power

Anaerobic power has been defined by Enoka (2002) as the rate of doing work. In sporting events that require jumping, sprinting, throwing and striking power production is considered critical for success (Stone, Stone, & Sands, 1987). Several studies have also identified the importance of anaerobic power for those that work in physically demanding occupations (Peterson et al, 2008; Shepard & Bonneau, 2002; Stanish, Wood, & Campagna, 1999). Anaerobic power is a physiological attribute that is essential in tactical situations that requires force to be expressed rapidly, such as when sprinting and dodging; lifting, carrying, pushing or dragging a victim to safety; jumping and vaulting over obstacles of varying sizes; stair climbing and in use of force situations (CIAR, 2006; Peterson et al, 2008; Shepard & Bonneau, 2002). Therefore, it appears that the rate of force development may be of greater importance for the tactical officer than maximum force production in many tactical situations (Winchester, McBride, Maher, Mikat, Allen, Kline & McGuigan, 2008).

The vertical jump is commonly performed in numerous sports and is often chosen by coaches, trainers, and researchers to test anaerobic power of the lower body. Due to the explosive nature of this activity, this movement is dependent on fuel from the ATP-PC system (Wilmore & Costill, 1999). Several studies have used the vertical jump as a predictor of physical ability (Baur, Thayer, & Baras, 1990; Silvester et al., 1982; Stone, Johnson & Carter, 1979; Wathen & Shutes, 1981). According to the CIAR (2006) the vertical jump is highly predictive of performing job-tasks in all cases for the law enforcement officer. The vertical jump has also been used to predict job performance amongst firefighters (Rhea, 2004; Sell, 2006; Sell, 2011). Sell (2006) found a strong relationship ($r = -0.58$) between time to completion on simulated firefighting task scenarios (SFTS) and vertical jump height. It was discovered that firefighters with a vertical

jump height of at least 17 inches were more likely to achieve passing scores on the SFTS investigated in this study. Similarly, Michaelides et al (2011) found significant correlations between vertical jump and a simulation rescue using a mannequin (-0.31). However, at this time there is no published data available discussing vertical jump height or short duration anaerobic power for the tactical officers.

The 300-meter run is a test commonly used to assess anaerobic power, primarily of the glycolytic energy system and to a lesser extent the phosphagen system (Sinnott, Berg, Latin, & Noble, 2001; Collingwood, Hoffman & Smith, 2004). This test appears to have direct application to the job-tasks of the SWAT officer, as performing short intense bursts of effort may be required (CIAR, 2006; Collingwood, Hoffman & Smith, 2004). This test would likely be better described as an anaerobic endurance event based on the average duration necessary to complete this test. Essential job functions of SWAT that may require anaerobic power include sprinting for cover, attempting to gain a tactical advantage in positioning in relation to a perpetrator(s), victim rescue, and use of force situations (CIAR, 2006; NTOA, 2008). This timed test requires an officer to run at maximal speed, on the inside lane of a 400 meter track for $\frac{3}{4}$ of a lap as quickly as possible. According to the CIAR (2006), the 300 meter run has shown to be highly predictive of performing job-tasks in all cases for the law enforcement officer.

Similar anaerobic endurance tests have been researched by other investigators exploring predictors of job-performance in physically demanding occupations. Research conducted by Rhea et al (2007) found strong correlation ($r = 0.79, p \leq 0.05$) between time to completion when conducting simulated firefighting tasks and 400 meter run times amongst firefighters. Michaelides et al (2011) found significant correlations with performance on a timed stair climb (-.39, $p < 0.01$), and a rolled hose lift and move (- 0.30, $p < 0.05$). Currently, there is no published data available discussing the level of anaerobic endurance for tactical officers.

Aerobic Power

Aerobic power has been consistently identified in the literature as a predictor of performance for a variety of physically demanding occupations, such as law enforcement officers (CIAR, 2006; Lonsway, 2008; Roberts, O’Dea, Boyce, & Mannix, 2002; Rhodes & Farenholtz, 1992; Spitler et al, 1987; Stanish, Wood, & Camapgna, 1999), correctional officers, (Jamnick, Thomas, Shaw, and Gledhill, 2010) and firefighters (Perroni, Tessitore, Cortis, Lupo, D’Artibale, Cignitti, & Capranica, 2009). Aerobic power may be important should a situation where a sustained pursuit, stair climbing, or use of force for greater than a few minutes becomes necessary (CIAR, 2006). While a certain amount of aerobic fitness is necessary to reduce the risk of morbidity and mortality the optimal level required for performing essential-job tasks required of the SWAT officer is still unclear.

The 1.5 mile Run is a field test commonly used by law enforcement agencies to predict aerobic capacity, or VO₂ max (CIAR, 2006; Hoffman & Collingwood, 1995; Spitler et al., 1987). To perform this test the officer must cover a 1.5 mile distance around a 400 meter track as fast as possible. The CIAR (2006) test has been shown to be highly predictive of job performance in all cases for law enforcement officers. This claim is supported by the findings of Rhodes and Farenholtz (1992) and Stanish, Wood and Campagna (1999).

While not as commonly used by law enforcement agencies, the Multi-stage fitness test (MSFT) is another field test that can be used to measure aerobic fitness levels. This test requires the subjects to run between two 20 meter lines, while listening to pre-recorded sound signal. Participants are instructed to keep cadence with this sound signal until they are no longer physically able to maintain the set pace. The starting signal for this test corresponds to a speed of 8.5 km/h and increases by 0.5 km/h for each minute of the test. The test is terminated when the subject was no longer able to maintain the set pace set by the recording.

In a report to the police advisory board of England and Wales by Lilleshall Consultancy Services (2010), 275 police officers from 15 police forces participated in a study used to replicate the demands of 10 specialist unit activities. Based on the MSFT, and physiological data collected during a dynamic push-pull strength test using a Concept II DYNO machine, recommendations were made for the minimum pass standards for the MSFT for specialist police officers. Based on this information it was recommended that, method of entry officers (MOE's) be able to achieve the 4th shuttle on the 5th level for this test, which corresponds to a predicted VO₂Max of 35 mL .kg⁻¹ min⁻¹.

In addition, several studies involving firefighters and military soldiers have utilized cycle ergometry to assess aerobic power (Findley, et al, 1995; Swank, et al (2000), Santilla, Kyrolainen & Hakkinen, 2009). However, there are practical issues related to using this measure including the need for specialized testing equipment (e.g , a bicycle ergometer). For this reason, the 1.5 mile run is a field test commonly used to determine aerobic power/endurance.

The CIAR (2006) recommends using the 1.5 mile run as a field test for law enforcement officers, claiming it is highly predictive of job performance in all cases. This popular field test is commonly used by law enforcement agencies (Hoffman & Collingwood, 2005), as well as those involved in other physically demanding occupations, such as Naval personnel (Hodgdon, 1999) and firefighters (Rhea, 2004; Sell, 2011). In such studies, this assessment has been used as a method of measuring fitness status, assessment, and selection.

Rhea (2004) utilized the 1.5 mile run to predict job performance of firefighters. In this investigation low, but significant correlations were found between aerobic fitness and several firefighting tasks, such as a victim drag (-0.33), and a stair climb (-0.36). However, the researcher acknowledges that the apparent need for aerobic endurance may be less in this investigation than previous research because full recovery was allowed between job-tasks. Thus the need for aerobic endurance to complete each task was likely reduced.

In a recent study conducted by Sell (2011) the 1.5 mile run was used to measure the physical fitness status of interagency hotshot firefighters. These firefighters performed this test in 9.45 ± 0.14 minutes thus stratifying them in the excellent category when compared to age and gender corrected norms.

Agility

Agility is the ability to start, stop, and change directions rapidly and efficiently in order to perform well and reduce injury risk (Dawes, 2010). Agility is critical for the Tactical officer when dodging, pursuing an assailant, rescuing a victim, low and high crawling, or fleeing a dangerous area (Dawes & Roozen, 2009; Perroni et al, 2009). For this reason agility is of great importance to law enforcement agencies. In fact, research by Lonsway (2008) reported that approximately half of the 62 law enforcement officers that were surveyed used some form of agility training assessment. In a study conducted by Stanish, Wood and Campagna (1999) they found that performance on the Barrow zigzag agility run was significantly correlated to PARE time for both males and females. Furthermore, these researchers found that PARE success could be classified in females with an 85% accuracy using the agility test alone, and 93% accuracy using the agility test and 1.5 mile run test for aerobic fitness.

Currently, there is a scarcity of agility performance scores that can be found in the scientific literature related to for law enforcement officers, and those in other physically demanding occupations. This may likely be due to the fact that most measures of agility in these populations are part of a larger PAT test. Research conducted by FitForce™ (2007) of over 180 state, federal and municipal agencies did show median scores for law enforcement officers was between 18.1 and 18.2 seconds for the Illinois Agility Test. Hoffman, Collingwood, and Smith(2004) state that Agility as measured by the Illinois Agility Test is predictive of a law enforcement officer's capabilities to perform essential

job- tasks. While the researcher's state that this information was collected from 34 physical fitness standard validation studies, the number of individuals completing the Illinois Agility Run was not discussed.

According to several authors straight forward sprinting speed does not appear to have a very strong association with performance in tasks that require agility (Young, Hawken, & McDonald 1996; Baker, 1999; Tsitskarsis, Theoharopoulos, & Garefis, 2003). Draper and Lancaster (1985) reported significant but low correlation values ($r=0.472$) when comparing the relationship between performance of the Illinois Agility Test and a 20-metre sprint. Pauole, Madole, Garhammer, Lacourse, & Rozenek, (2000), also reported significant ($p<0.05$), but moderate correlations ($r = 0.53$) between a 40-yard sprint and a T-test for change of direction speed. This further justifies the need for to measure speed and agility separately as strait line speed and change of direction speed are distinctly different skills.

The Illinois Agility Test (Figure 3.1) is a pre-programmed agility test used to measure change of direction speed (Roopen, 2004). This test requires the participant to perform a combination of straight line running, weaving and quick changes of direction.

The pro-agility shuttle, also known as the 20 yard shuttle run, is another test commonly used to assess agility, especially for American Football players (Sierer, Battaglini, Mihalik, Shields, & Tomasini, 2008). This set-up for this test requires thee lines be created with either tape or field chalk, 5 yards apart, in a straight line covering a total distance of 10 yards (Figure 3.2).Typically this test is performed with an individual straddling a taped line with the hand down on the line in a three-point stance, however this test may be modified by using a two-point stance. This modification may make the assessment more sport or occupationally specific. On the "go" command, the individual turns and runs five yards to the right and touches the line with the right hand, then sprints 10 yards to the left and touches the far line with the left hand, then turns and

finishes by sprinting back through the start/finish line. At this time there no data exists on either of these tests for the tactical officer.

Figure 3.1: Illinois Agility Test
(Adapted from Cureton, 1951, p. 68, Roozen, 2004)

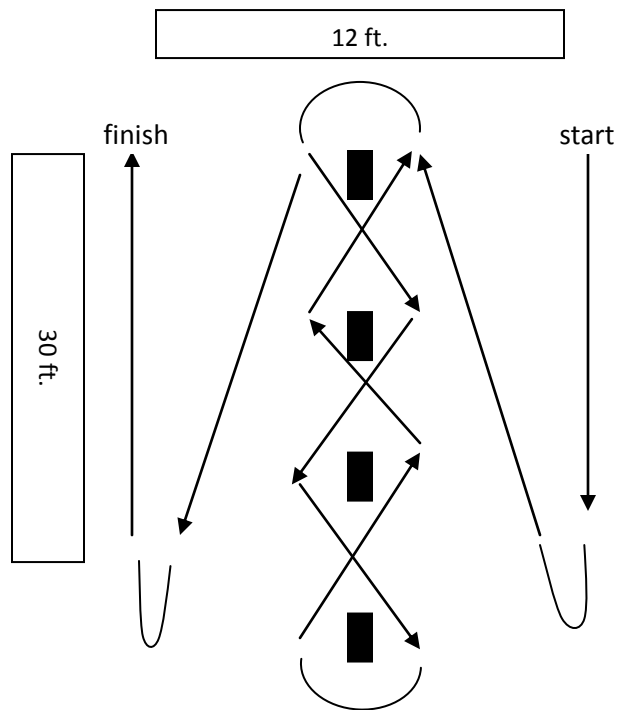
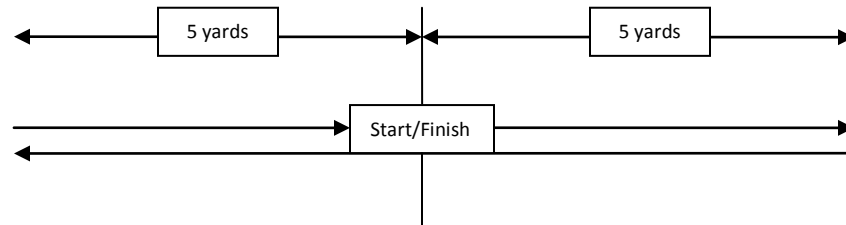


Figure 3.2: Pro-agility (20 yard shuttle run) Test

(Adapted from Hoffman, 2006)



Conclusion

In conclusion, when looking at the essential job-tasks of SWAT it is evident that the tactical officer may have one of the most physically demanding, non-athletic civilian occupations. Based on the physiological demands and stress placed on the tactical officer during operations in many ways they must perform feats of strength, power, endurance and speed like athletes (Dawes, 2008). Thus, it is critical that they possess an adequate level of fitness to successfully perform their duties in a safe, effective and efficient manner (Stephenson, 2008).

Currently, there is little information in the research literature that explores the physiological, biomechanical, or metabolic demands required to perform the essential job tasks of SWAT. In addition, there is also a need to fully understand the underlying physical fitness components required to perform these essential-job tasks, and the level of fitness an officer should possess to perform these tasks safely and effectively. Furthermore, there appears to be a significant gap in the literature regarding the fitness and performance profiles of tactical officers. Therefore, information related to the anthropometric and physical performance characteristics of specialized group of highly trained officers would be a useful contribution to this specific area of interest. Moreover, such information may also be used to help establish some provisional

benchmarks for evaluating the minimal physical fitness standards necessary to perform the essential job-tasks of SWAT.

CHAPTER III

METHODS AND PROCEDURES

The purpose of this study was to investigate the current anthropometric, physical and performance characteristics of tactical officers on full-time, part-time and multi-jurisdictional teams and to identify the underlying physical fitness components required to perform the essential job-tasks of SWAT.

Preliminary Procedures

Officials from the National Tactical officers Association (NTOA) were contacted by email to inform them about the purpose of this study. The primary investigator requested the NTOA send an e-blast to its membership requesting SWAT team data on a range of fitness and performance based metrics (Appendix B). In addition, the primary investigator requested the Tactical Strength and Conditioning Program Director of a non-profit agency provide testing data to the primary investigator for descriptive purposes (Appendix C). The primary investigator requested that each subject be assigned an identification number prior to receiving this data in order to protect the participant's identity. All data for this research was archival in nature and collected from several different participating agencies. Each agency utilized different tests and testing batteries for their tactical officers. Therefore, at times throughout the analysis of this data there are subject variations in the data collected for each measure. However, the primary

investigator has limited the data to be analyzed to include anthropometric information. (e.g., height, body weight, BMI and body composition) and performance measures (e.g., muscular strength and endurance; anaerobic power; aerobic power; and agility).

Participants

Archival data for seventy-one (N=71) tactical officers, from full-time (n= 29), part-time (n=21), and multi-jurisdictional (n=21), teams was used for descriptive and comparative purposes. These officers ranged from 28-56 years of age. Data for these officers was collected by members of the participating agencies/organizations and voluntarily provided to the primary investigator for the data analysis.

PROCEDURES

Consent was obtained by the Institutional Review Board at Oklahoma State University prior to the analysis of this data (Appendix A). The data collected for this study included the following descriptive information; age and anthropometric characteristics, as well as measures of muscular strength; endurance, aerobic and anaerobic power, and agility. No actual contact with human subjects was involved in this research. Thus, due to the retrospective nature of the data collected this study was qualified for exempt status under the guidelines set forth by the Institutional Review Board at Oklahoma State University. No comparisons were made between individual tactical officers. In addition all data was stored in a locked file cabinet and only the primary investigator had access to this information.

Anthropometric information, including height (in) measurements for sixty-one (n=61) tactical officers, and weight (lbs) measurements for seventy-one (n=71) tactical officers were collected by the by the respondents using standard procedures on a doctors beam scale (Cardinal; Detecto Scale Co, Webb City, MO).

Body Mass Index (BMI) values were used to assess weight relative to height and risk for obesity related health issues for sixty-one (n=61) tactical officers. BMI was calculated using the Quetelet index, which was calculated by dividing bodyweight in kilograms by height in meters squared (kg/m^2) (ACSM, 2010). Once BMI was calculated, predictions of percent body fat and health risk were made using information provided in the ACSM's Guidelines for Exercise Testing and Prescription 8th ed. (2010).

Body fat estimations were provided for forty-six (n=46) tactical officers. Twenty-five (n=25), teams of these officers belonged to a full-time team and twenty-one (n=21) were members of a part-time team. These measurements were collected using the three-site skin-fold assessment protocol recommended by Jackson and Pollock (1985) and outlined in the ACSM's Guidelines for Exercise Testing and Prescription 8th ed. (2010). Duplicate measures of the chest, abdomen, and thigh were taken on the right side of the body using Lange Skin-fold Calipers (Lange, Beta Technology Inc, Cambridge, MD). The first measurement were taken at the chest, which was a diagonal fold located approximately one half the distance between the auxiliary line and the nipple. The second measurement was taken at the abdomen. This measurement was collected by measuring the thickness of a vertical skin fold located 2 cm to the right of the umbilicus. The final skin-fold was taken at the thigh. This measurement was obtained by measuring the thickness of a vertical skin-fold located on the anterior midline of the thigh, midway between the proximal border of the patella and the hip. Three measurements were taken at each site and the averages of these measurements were recorded to the nearest centimeter. Each site measurement was collected one at a time starting at the chest, then the abdomen and finally the thigh. The tester rotated between these sites in the same order previously described in order to allow time for the skin to regain normal texture and thickness before the next measurement. The primary investigator calculated each tactical officer's lean body mass percentage (LBM %) and fat mass percentage (FM %) based on the provided measurements for weight and body composition.

Upper-body muscular strength for twenty-one (n=21) tactical officers were measured using the 1-repetition maximum (RM) bench press protocol outlined by Harmon and Garhammer in Baechle and Earle (2008). According to the testers, each officer was instructed to perform a specific warm-up of 5-10 repetitions with a light-to-moderate load. Two additional heavier warm-up sets of 2-5 repetitions were then be performed before the first 1RM attempt. Tactical officers were all required to achieve their 1RM within 3-5 attempts to minimize the effects of fatigue on the participant's performance. The final weight lifted successfully was recorded as the participant's 1-RM. This is consistent with the guidelines provided by Harmon and Garhammer (2008). The scores provided were converted to a 1RM Bench press ratio score (weight lifted; body weight).

Upper-body muscular endurance data was collected for twenty-one (n=21) tactical officers using the 1 minute push-up test and sixty-five (n=65) tactical officers using the 2 minute push-up test. The technique used for both of these assessments is detailed by Hoffman and Collingwood (2006). All tactical officers were required to begin the test in the standard "up" position with the body rigid and straight and the hands positioned slightly wider than shoulder-width apart and the fingers pointed forward. A partner then placed a fist on the floor directly under the individual's chest. On the "go command" the tester began the stopwatch and the participant would bend their elbows, lowering themselves until their chest was in contact with their partner's fist and then extend the elbows until back in the "up" position. The tactical officers then proceeded to perform as many push-ups as possible in the time allotted using this technique.

Data for the maximum pull-up test of forty-one (n=41) tactical officers was determined using the protocol and technique described by Hoffman (2006). Tactical officers began this assessment by hanging from the top bar of a squat rack, with the arms straight, and the hands wrapped around the bar in an overhand position. The participant was then instructed to bend the arms and pull their bodies upward until their chin was above the bar. After each pull-up was

completed the participant would return to the starting position before performing the next repetition. The participant's final score was the maximum number of pull-ups that could be completed with good technique and form.

Muscular endurance data for the abdominal muscles was provided for twenty-one (n=21) tactical officers via the 1-minute sit-up test and forty-seven (n=47) tactical officers using the 2-minute sit-up test. The technique used for these tests was adapted from the technique described by Hoffman and Collingwood (1995). Tactical officers were instructed by the agencies testers to lay on their back, with their knees bent, heels flat on the mat or ground, with the hands across the chest, and a partner anchoring them to the ground by holding their feet. The tactical officers were then instructed to perform as many correct sit-ups as possible within the time frame allotted.

Data for twenty-one (n=21) tactical officers on the 1.5 mile run was provided to the primary investigator by the participating agencies. According to the testing administrators of the participating agencies, prior to running tactical officers were asked to perform a 5-minute generalized warm-up consisting of light jogging and stretching. A one-quarter mile outdoor running track was used for this assessment. Tactical officers were instructed on the "go" command to begin running and cover the 1.5 mile distance around a 400 meter track as fast as possible. Upon completion each participant's time was recorded to the nearest 0.10 second (sec).

Vertical jump height for twenty-eight (n=28) tactical officers was collected using the Vertec™ apparatus (Vertec Scientific Ltd., Aldermaston, UK). After determining the standing upward reach height of each officer they were instructed to perform a rapid countermovement jump with an arm swing. All tactical officers were instructed to perform a maximal jump and attempt to displace the horizontal plastic fins on the Vertec™ apparatus, which was used to determine the vertical jump height of each officer. The best of 3 attempts were taken and maximal jump height was recorded to the nearest 1.3 cm (0.5 inch).

Vertical jump height was also attained for twenty-one (n=21) tactical officers using the Just Jump (ProBotics Inc, Huntsville, Al) electrical contact operated system. The Just Jump Mat is a 27 inch x 27 inch mat that calculates vertical jump height by measuring vertical displacement time. Vertical jump height for this device was calculated by measuring the amount of time the feet are not in contact with the matt. All tactical officers were instructed to step on the matt, and when ready perform a countermovement arm swing and jump as high as possible. This score was used to determine the vertical jump height of each officer. The best of 3 attempts were taken and maximal jump height was recorded to the nearest 1.3 cm (0.5 inch).

The 300-meter run times were collected for thirty-nine (n=39) tactical officers. Prior to performing the 300 meter run the tactical officers were instructed to perform light jogging and/or walking and flexibility drills prior to the start of the test. Once the warm-up was completed, these individuals were instructed to run at maximal speed, on the inside lane of a 400 meter track for $\frac{3}{4}$ of a lap. One test trial was allowed at sub-maximal speed and times for each participant were recorded to the nearest 0.10 second. Additionally, each subject was instructed to walk for 3-5 minutes upon completion of the sprint as a cool-down activity.

Agility, was assessed for twenty-one (n=21) tactical officers using the Illinois agility test protocol outlined by Roozen (2004). On the “go” signal officers were instructed by the testing administrators to sprint as quickly as possible 10 meters to the first cone. Upon reaching this marker the participant sprinted back to the first of the 4 cones in the center of the testing area, then weave in and out of the 4 cones using a zigzag motion, when they arrived at the last cone they turned around and repeated this weaving pattern through the four center cones. Once reaching the last center cone the participant sprinted to the far cone located 5 meters to the right of the farthest center cone, rounded this cone and then sprinted 10 meters past the last cone. A hand held stopwatch was used to record the time required to complete this test. All times were rounded to the nearest 0.10 sec. and the best of three trials was recorded for this measure.

Pro-agility times for twenty-one (n=21) tactical officers were provided to the primary investigator by the participating agencies. The protocol used for this test is outlined by Hoffman (2006). A hand held stopwatch was used to record the time required to complete this test. All times were rounded to the nearest .10 sec. and the best of three trials was recorded for this measure.

Statistical Analysis

Collected data was entered into a computer file suitable for statistical analysis using the Statistical Package for Social Sciences (SPSS) 17.0. A descriptive statistical analysis was conducted to determine the mean scores and standard deviations for the total sample of tactical officers for all group demographics, anthropometric characteristics, and performance scores. One-way analysis of variance (ANOVA) with appropriate post-hocs were used to compare the differences in mean scores between the full-time, part-time and multi-jurisdictional team on the following characteristics and measures; age, height, weight, BMI, 2- minute push-up scores and 300 meter run time.

Independent T-tests were used to compare the differences in mean scores between the full-time and part-time teams in the following measures: BF%, lean mass, fat mass, 2-minute sit-up scores, and vertical jump height. Independent sample T-tests were also used to determine if there were any mean score differences between part-time and multi-jurisdictional team members in the following areas SWAT experience and maximum pull-up scores.

One sample t-tests were utilized to determine if significant differences between the mean scores of the tactical officers on the following measures 1RM Bench press ratio, 1-min push-ups, 1-min.sit-ups, and 1.5 mile run times and the 50th percentile rankings provided by the CSFN(2002). One sample t-tests were utilized to determine if significant differences between the mean scores of the tactical officers on the following measures 300 meter run time and

vertical jump height when compared to the CSFN for law enforcement (2002). One sample t-tests were also conducted to compare the mean score differences in 1-min push-ups, 1-min.sit-ups, and 1.5 mile run times between tactical officers and traditional law enforcement officers based on the data provided by Hoffman and Collingwood (2005).

Finally, a discriminate analysis with stepwise linear regressions using the following predictor variables of height, body weight, BMI, 300 meter run time and 2 minute push-ups scores was used to predict group membership.

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS

This chapter includes basic descriptive statistics related to the group, anthropometric and performance characteristics of the total sample of tactical officers, and by each respective group. Mean score comparisons between each group of tactical officers based on the available data are presented in this section. Furthermore, comparisons between tactical officers and traditional law enforcement officers on selected tests and assessments, and comparisons between the tactical officers and the Cooper Single Fitness Norms (CSFN) at the 50th percentile are discussed. A proposed outline for the underlying physical fitness components of SWAT essential job tasks are also discussed in this chapter along with provisional recommendations for cut-scores on several of the selected performance tests investigated in this study.

Sample Characteristics

Information for seventy-one (N=71) tactical officers from a full-time (n = 29), part-time (n =21), and multi-jurisdictional (n =21) team was provided to the primary investigator for the purpose of data analysis. A summary of the group demographics and anthropometrics for each team can be found in Table I.

Table I
Demographics of Tactical Officers by Group

Category	N	Full-time	Part-time	Multi-jurisdictional	Total Sample
Age	68	40.12 ± 6.40	36.05 ± 4.06	37.76 ± 6.20	38.13 ± 5.88
Experience	42	ND	5.83 ± 4.60	8.33 ± 4.68	7.08 ± 4.64
Height(in.)	71	70.44 ± 2.40	69.07 ± 2.61	70.81 ± 3.23	70.06 ± 2.66
Bodyweight(lbs)	68	184.37 ± 18.36	205.14 ± 20.76	199.32 ± 33.49	195 ± 25.91
Body Mass Index (BMI)	62	26.28 ± 2.33	30.11 ± 3.21	28.65 ± 3.79	28.22 ± 3.45
Body Fat Percentage	47	10.72 ± 2.64	19.50 ± 4.26	ND	14.72 ± 5.6
Lean Mass (lbs)	46	165.92 ± 15.46	164.51 ± 14.21	ND	165.27 ± 14.76
Fat Mass (lbs)	46	20.08 ± 5.89	40.31 ± 11.54	ND	29.31 ± 13.47

ND= No Data Available

1 RM Bench Press Ratio= weight lifted(lbs)/bodyweight (lbs)

in. = inches

lbs= pounds

Comparison of Tactical Officers by Group: Anthropometrics

To determine whether anthropometric differences existed between the groups of tactical officers the following variables were analyzed and compared between groups ; height, bodyweight, body mass index(BMI), body fat percentage(BF%) fat mass, and lean mass.

A One-way analysis of variance (ANOVA) revealed significant differences in the mean bodyweights between the three groups of tactical officers, $F(2, 68) = 4.72, p < 0.001$. Further

statistical analysis using a Tukey’s post-hoc revealed significant differences in the mean bodyweights of full-time and part-time team members (Table II).

Table II

GROUP COMPARISON OF BODYWEIGHT USING A POST-HOC (TUKEYS HSD)(N=65)

Dependent Variable	Team 1	Team 2	Mean Difference	Std .Error
Bodyweight	MJ	FT	14.94	7.02
		PT	-5.82	7.52
	FT	MJ	-14.94	7.02
		PT	-20.77*	7.11
	PT	MJ	5.82	7.52
		FT	20.77*	7.11

MJ= Multi-jurisdictional team

FT = Full-time team

PT = Part-time team

*Significance at the $p \leq 0.01$

A one-way ANOVA showed a significant difference in BMI between the three groups of tactical officers, $F(2, 59) = 8.85, p < 0.0001$. Further analysis using a Tukey’s post-hoc test revealed significant differences in BMI between the tactical officers on multi-jurisdictional and full-time teams, $p = 0.05$, as well as significant differences in BMI between full-time and part-time tactical officers, $p < 0.0001$ (Table III).

Table III

GROUP COMPARISON OF BMI USING POST-HOC ANALYSIS
(TUKEYS HSD) (N=65)

Dependent Variable	Group 1	Group 2	Mean Difference	Std .Error
BMI	MJ	FT	2.37*	7.02
		PT	-1.47	7.52
	FT	MJ	-2.37*	7.02
		PT	-3.83**	7.11
	PT	MJ	1.46	7.52
		FT	3.83**	7.11

FT = Full-time tactical officers

PT = Part-time tactical officers

MJ = Multi-jurisdictional tactical officers

*Significance at $p = 0.05$

** Significance at $p < 0.0001$

A two-tailed independent sample t-test revealed a significant difference between the mean BF% of full-time and part-time tactical officers, $t(44) = -8, p < 0.0001$ (Table IV).

Table IV

GROUP COMPARISON OF BODYFAT PERCENTAGE :
FULL-TIME VS. PART -TIME TACTICAL OFFICERS (N=45)

Variable	GROUP		df	t
	FT	PT		
BF %	10.72 ± 2.64	19.50 ± 4.26	44	-8.55*

FT = Full-time tactical officers

PT = Part-time tactical officers

*Significance at the $p < 0.0001$

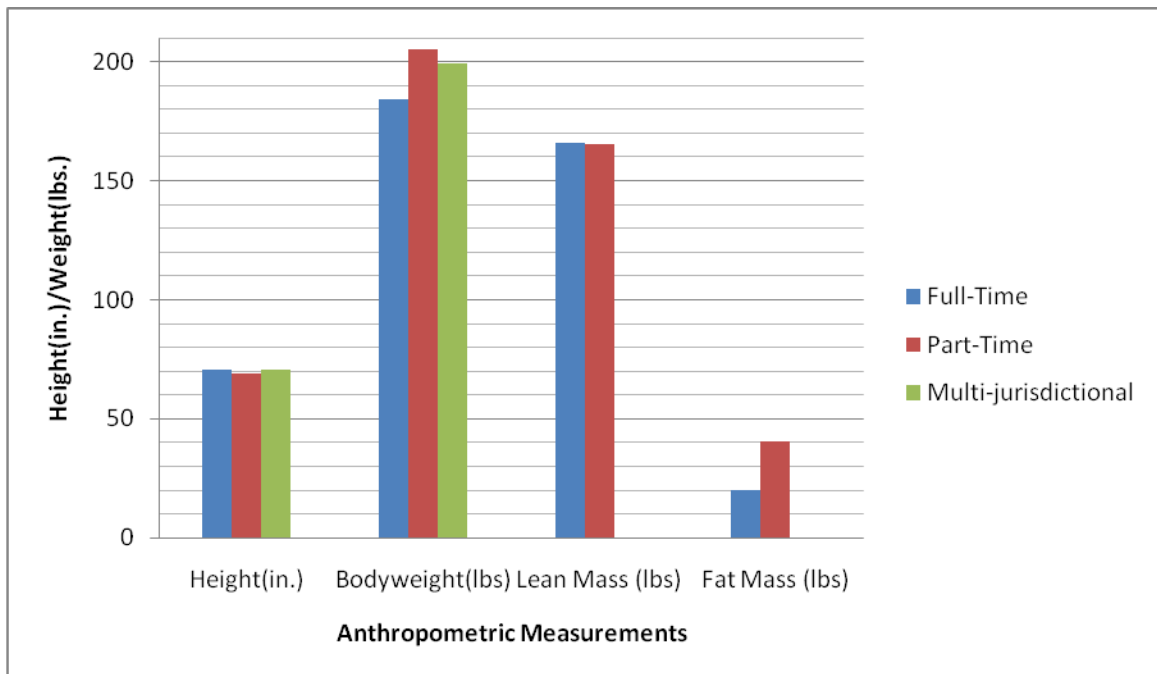
An independent sample t-test revealed significant differences in the amount of FM in pounds between the full-time and part-time tactical officers, $t(44) = -7.67, p < 0.0001$. (Table V).

Table V
 GROUP COMPARISON OF FAT MASS:
 FULL-TIME VS. PART-TIME TACTICAL OFFICERS (N=45)
 GROUP

Variable	FT	PT	df	t
Fat mass (lbs.)	20.08 ± 5.89	40.31 ± 11.53	44	-7.67*

FT = Full-time tactical officers
 PT = Part-time tactical o
 *Significance at the $p < 0.0001$

Figure 4.1: Summary Chart of Anthropometric Measures for Tactical Officers



Comparison of Physical Fitness/Performance Scores

The mean Physical Fitness/Performance scores for the tactical officers involved in this research are displayed in Table VI. In order to determine whether significant between groups differences existed amongst the three groups of tactical officers a series of statistical analysis were conducted.

Table VI

Physical Fitness/ Performance Scores of Tactical Officers by Group					
Category	N	Full-time	Part-time	Multi-jurisdictional	Total Sample
1-RM Bench Press	21	ND	ND	250.71 ± 58.58	250.71 ± 58.58
1 RM Bench Press Ratio	21	ND	ND	1.25 ± .17	1.25 ± .17
1-min. Push-ups	21	ND	ND	58.19 ± 7.52	58.19 ± 7.52
2-min. Push-ups	65	82.69 ± 8.52	64.52 ± 14.06	64.39 ± 12.41	74.46 ± 17.90
1-min. Sit-ups	21	ND	ND	49.52 ± 5.41	49.52 ± 5.41
2 min. Sit-ups	47	89.46 ± 12.95	56.52 ± 12.89	ND	71.00 ± 16.87
Maximum Pull-ups	42	ND	8.05 ± 5.93	13.00 ± 3.48	8.93 ± 1.35
Vertical Jump	49	27.14 ± 3.76	21.81 ± 2.62	ND	24.85 ± 4.23
300 Meter Run	59	46.83 ± 2.90	61.57 ± 4.84	50.56 ± 3.43	52.96 ± 7.4
Illinois Agility Shuttle (sec.)	21	ND	ND	15.45 ± 0.70	15.45 ± 0.70
Pro-Agility Shuttle (sec.)	21	ND	5.25 ± 0.22	ND	5.25 ± 0.22
1.5 Mile Run (min:sec)	21	ND	ND	11.35 ± 0.62	11.35 ± 0.62

ND = No Data Available
 Sec. = Seconds
 Min:Sec. = Minutes:seconds

A one-way ANOVA was utilized to determine if between group differences existed between 2-minute push-up mean scores and the three groups of tactical officers. Analysis revealed significant differences did exist between these groups, $F(2, 62) = 28.08, p < 0.0001$. A Tukey's post-hoc test revealed significant mean score differences between the mean scores of multi-jurisdictional and full-time tactical officers, $p < 0.0001$. Significant differences were also discovered between the mean 2-minute push-ups scores for the full time and part-time tactical officers, $p < 0.0001$ (Table VII).

Table VII

GROUP COMPARISON OF 2-MINUTE PUSH UP SCORES USING
A POST-HOC ANALYSIS (TUKEYS HSD) (N=65)

Dependent Variable	Group 1	Group 2	Mean Difference	Std .Error
2-minute Push-up	MJ	FT	-25.07*	4.04
		PT	-0.13	3.87
	FT	MJ	25.07*	4.04
		PT	24.94*	3.87
	PT	MJ	0.13	4.23
		FT	-24.94*	3.87

FT= Full-time tactical officers
PT = Part-time tactical officers
MJ = Multi-jurisdictional tactical officers
*Significance at the $p < 0.0001$

The mean 2-minute sit-up scores of full-time and part-time tactical officers were compared using a two-tailed independent samples t-test. This statistical analysis revealed significant differences between the 2-minute sit-up scores of these groups, $t(45) = 8.35, p < 0.0001$ (Table VIII).

Table VIII
 GROUP COMPARISON OF 2-MINUTE SIT-UP SCORES: FULL-TIME VS. PART-TIME
 TACTICAL OFFICERS (N=21)

Variable	Team		df	t
	FT	PT		
2 min. Sit-ups	82.69 ± 8.5	56.63 ± 12.89	45	8.35*

FT = Full-time team

PT = Part-time team

*Significance at the $p < 0.0001$

A two-tailed independent sample t-test showed a significant difference in the maximal pull-up scores between the part-time and multi-jurisdictional tactical officers, $t(39) = 3.27$, $p = .002$ (Table IX).

Table IX
 GROUP COMPARISON OF MAXIMUM PULL-UP SCORES:
 MULTI-JURISDICTIONAL VS. PART -TIME TACTICAL OFFICERS (N=41)

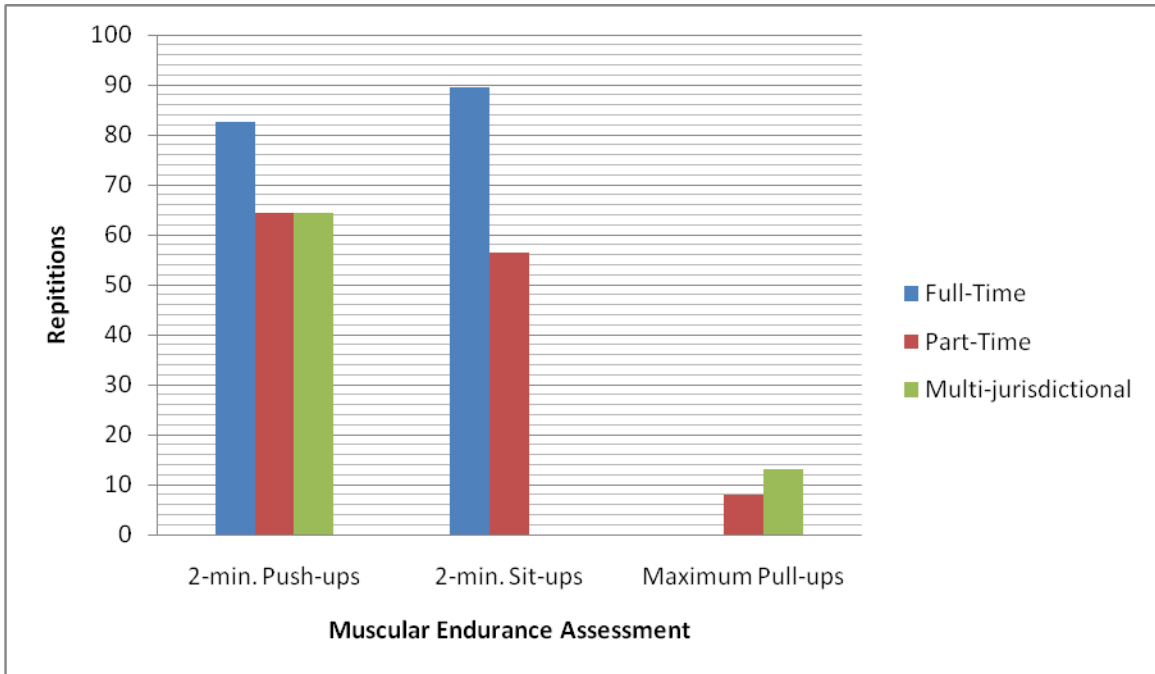
Variable	Team		df	t
	MJ	PT		
Maximum Pull-ups	13.00 ± 3.47	8.05 ± 5.93	39	3.27*

MJ = Multi-jurisdictional team

PT = Part-time team

*Significance at the $p \leq .002$

Figure 4.2: Summary Chart of Muscular Endurance Measures for Tactical Officers



The mean vertical jump height scores of full-time and part-time tactical officers were compared using a two-tailed independent samples t-test. This statistical analysis revealed significant differences between the mean vertical jump height scores between these groups, $p < 0.0001$ (Table X).

Table X
GROUP COMPARISON OF VERTICAL JUMP HEIGHT SCORES:
FULL-TIME VS. PART -TIME TACTICAL OFFICERS (N=49)

Variable	Team		df	t
	FT	PT		
Vertical Jump	27.14 ± 3.76	21.81 ± 2.62	47	5.56*

FT = Full-time tactical officers
PT = Part-time tactical officers
*Significance at the $p < 0.0001$

A one-way ANOVA revealed significant differences in the 300-meter run scores between the three groups of tactical officers, $F(2, 56) = 81.77, p < 0.0001$. Further statistical analysis using a Tukey's post hoc test showed significant differences between the means of the full-time and part-time tactical officers, $p < 0.0001$. Significant differences were also discovered between the means of full-time and multi-jurisdictional tactical officers, $p = 0.01$. In addition, significant differences between the means of part-time and multi-jurisdictional team members were also revealed, $p < 0.0001$ (Table XI).

Table XI

GROUP COMPARISON OF 300 METER RUN TIMES USING A POST HOC
(TUKEY'S HSD) (N=65)

Dependent Variable	Team 1	Team 2	Mean Difference	Std .Error
300 Meter Run Time	MJ	FT	3.73*	7.02
		PT	-11.01**	7.52
	FT	MJ	-3.73*	7.02
		PT	-14.74**	7.11
	PT	MJ	11.01**	7.52
		FT	14.74**	7.11

MJ= Multi-jurisdictional tactical officers

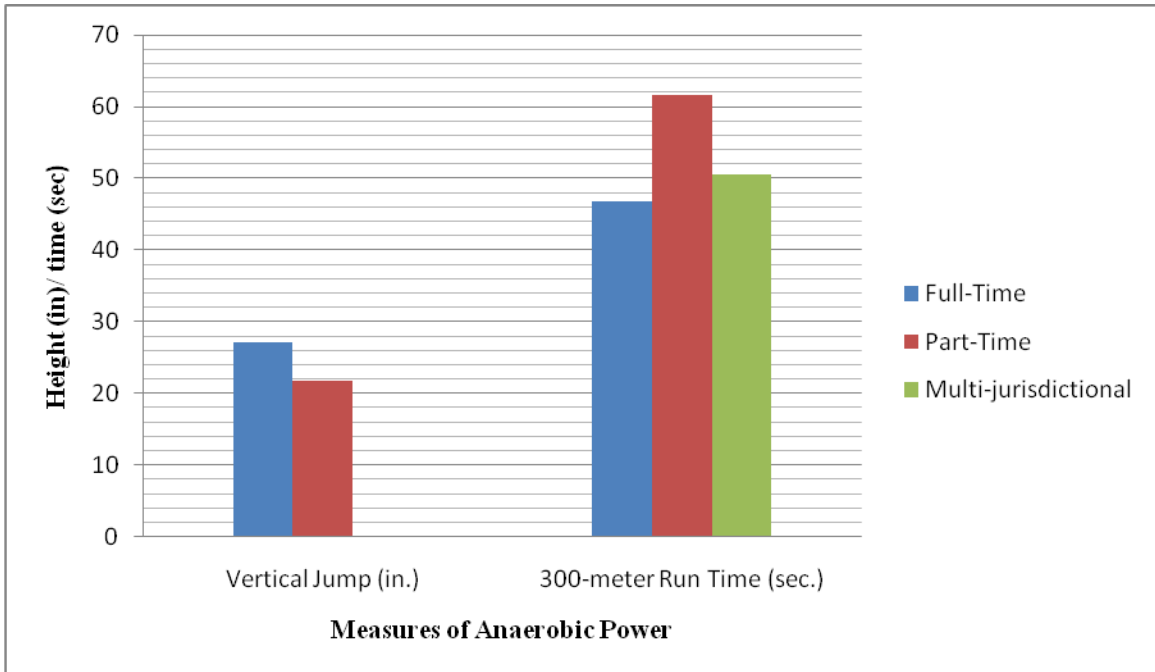
FT = Full-time tactical officers

PT = Part-time tactical officers

*Significance at the $p = 0.01$

**Significance at the $p < 0.0001$

Figure 4.3: Summary Chart of Anaerobic Power Measures for Tactical Officers



Finally, a discriminate analysis with stepwise linear regression was conducted to predict group membership. Predictor variables included the variables of height, weight, age, BMI, 300 meter run time and two-minute push-up scores. Any variables with missing or out of range data, at least one missing discriminate variable, or both were excluded from this analysis. Significant mean differences were observed for two predictor variables on the dependent variable (DV) of team. The discriminate function revealed a significant association between groups and all predictors, accounting for 79.70% of between group variability, although closer analysis of the structure matrix revealed two significant predictors, namely 300 meter run time (0.97) and 2-minute push-up scores (0.92). The cross validated classification results showed that overall 89.8% were correctly classified. These results are displayed in Tables XII-XIV.

Table XII

WILKS LAMBDA TABLE FOR DISCRIMINANT ANALYSIS

EXACT F									
STEP	NUMBER OF VARIABLES	LAMBDA	df1	df2	df3	STATISTICS	df1	df2	SIG.
1	1	0.26	1	2	56	81.77	2	56	.0001*
2	2	0.18	2	2	56	37.82	4	110	.0001*

*Significance at the $p < 0.0001$

Table XIII

STANDARDIZED CONONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	Function	
	1	2
Two-Minute Push-up Scores	-0.25	0.98*
300 Meter Run	0.93*	0.40

*Significance at the $p < 0.0001$

Table XIV

STANDARDIZED CONONICAL DISCRIMINANT FUNCTION COEFFICIENTS
STRUCTURE MATRIX

	Function	
	1	2
300 Meter Run	0.97	0.25
2-Minute Push-up Scores	-0.40	0.92*

*Significance at the $p < 0.0001$

Comparison of Tactical Officers to Law Enforcement

The mean physical/fitness and performance scores for the three groups of tactical officers was compared to traditional law enforcement officers to determine if significant differences existed in between these populations. The mean scores for the traditional law enforcement officers was provided by Hoffman (2006), Hoffman and Collingwood (2005), and the CIAR (2002) (Table XV).

Table XV

TACTICAL OFFICERS COMPARED TO LAW ENFORCEMENT OFFICERS

Category	N	Tactical Officers	Law Enforcement Officers
1-min. Push-ups	21	56.50 ± 10.80	31
1-min. Sit-ups	21	48.60 ± 6.81	34
1.5 Mile Run Time (min:sec)	21	11.35 ± 0.62	14.40
Vertical Jump (in.)	49	27.14 ± 3.76	17.5
300 Meter Run (sec.)	59	52.97 ± 3.43	64

min: sec= minutes and seconds

in. = inches

sec= seconds

A one-sample t-test revealed significant differences between the 1-minute push-up test scores of multi-jurisdictional tactical officers and the mean scores for Law Enforcement Personnel provided by Hoffman and Collingwood (2005), $t(20) = 16.57$, $p < 0.0001$ (Table XVI).

Table XVI

GROUP COMPARISON OF 1-MINUTE PUSH-UP SCORES:
TACTICAL OFFICERS VS. LAW ENFORCEMENT OFFICERS(N=21)

Variable	GROUP		df	t
	MJ	LE		
1-min. Push-up	58.19 ± 7.52	31	20	16.57*

MJ = Multi-jurisdictional tactical officers

LE = Law enforcement officers

*Significance at the $p \leq 0.01$

A one-sample t-test revealed significant differences between the mean 1-minute sit-up test scores between the multi-jurisdictional tactical officers and the scores of traditional law enforcement personnel (Hoffman & Collingwood, 2005), $t(20) = 16.58$, $p < 0.0001$ (Table XVII).

Table XVII

GROUP COMPARISON OF 1-MINUTE SIT-UP SCORES :
TACTICAL OFFICERS VS. LAW ENFORCEMENT OFFICERS (N=21)

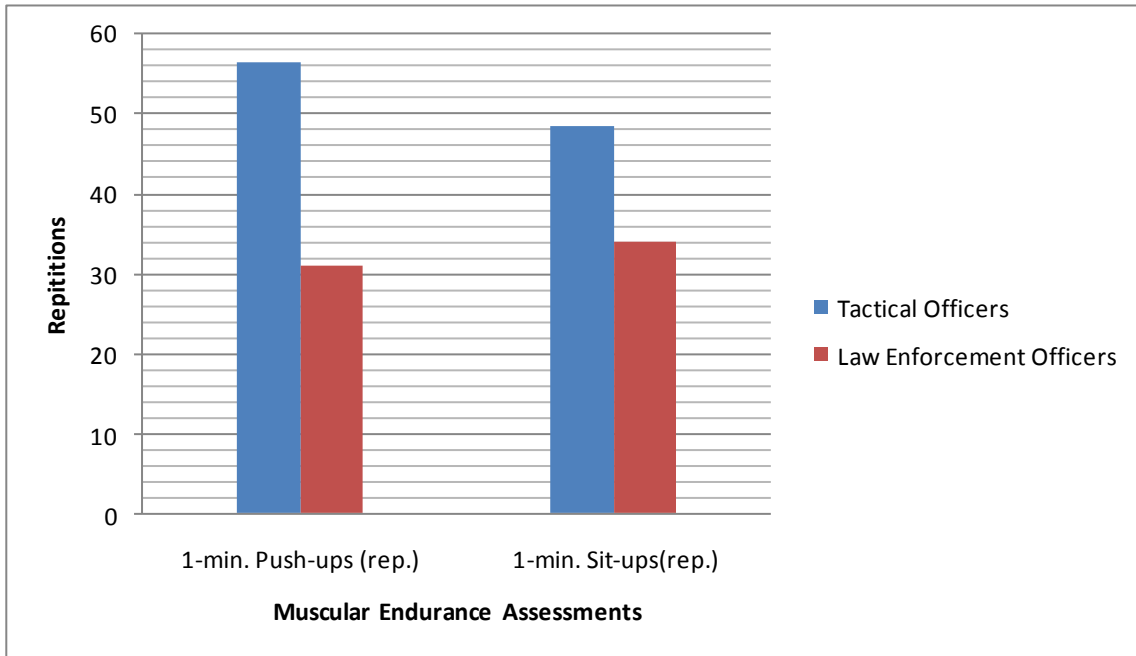
Variable	GROUP		df	t
	MJ	LE		
1-Min. Sit-ups	49.52 ± 29.30	29.3	20	17.13*

MJ = Multi-jurisdictional tactical officers

LE = Law enforcement officers

*Significance at the $p < 0.0001$

Figure: 4.4: Summary Chart of Muscular Endurance Measures for Tactical Officers vs. Law Enforcement Officers



Using a one sample t-test was significant differences in vertical jump height between the tactical officers and the 50th percentile ranking based on the CSFN for law enforcement officers were discovered , $t(27) = -13.57, p < 0.0001$. (Table XVIII).

Table XVIII

GROUP COMPARISON OF VERTICAL JUMP HEIGHT SCORES:
TACTICAL OFFICERS VS. LAW ENFORCEMENT OFFICERS (N=48)
Classification

Variable	TO	LE	DF	t
Vertical Jump	24.86 ± 4.23	17.5	48	13.57*

TO = Tactical officers

LE = Law enforcement officers

*Significance at the $p < 0.0001$

Another, one sample t-test was used to determine if mean vertical jump height scores were significantly different between full-time tactical officers and traditional law enforcement officers. The statistical analysis revealed significant differences in vertical jump height between the full-time tactical officers and the and the and the 50th percentile ranking based on the CSFN for law enforcement officers (2002), $t(27) = -13.57$, $p < 0.0001$. (Table XIX).

Table XIX

**GROUP COMPARISON OF VERTICAL JUMP HEIGHT SCORES:
FULL-TIME TACTICAL OFFICERS VS. LAW ENFORCEMENT OFFICERS (N=28)**
Group

Variable	FT	LE	DF	t
Vertical Jump	27.14 ± 3.76	17.5	27	13.57*

FT = Full-time tactical officers

LE = Law enforcement officers

*Significance at the $p < 0.0001$

A one sample t-test was used to determine if mean vertical jump height scores were significantly different between part-time tactical officers and traditional law enforcement officers. The statistical analysis revealed significant differences in vertical jump height between the part-time tactical officers and the and the 50th percentile ranking based on the CSFN for law enforcement officers (2002), $t(20) = 7.53$, $p < 0.0001$ (Table XX).

Table XX

**GROUP COMPARISON OF VERTICAL JUMP HEIGHT SCORES:
PART-TIME TACTICAL OFFICERS VS. LAW ENFORCEMENT OFFICERS (N=21)**

Variable	Group		df	t
	PT	LE		
Vertical Jump	21.81 ± 2.62	17.5	20	7.53*

PT = Part-time tactical officers

LE = Law enforcement officers

*Significance at the $p < .0001$

Statistical analysis using a one sample t-test revealed significant differences in the 300-meter run times between the tactical officers and the mean scores established by the CSFN for law enforcement officers (2002), $t(58) = -11.43$, $p < 0.0001$ (Table XXI).

Table XXI

**GROUP COMPARISON OF 300 METER RUN TIMES:
TACTICAL OFFICERS VS. LAW ENFORCEMENT OFFICERS**

(N=59)

Classification

Variable	Classification		df	t
	TO	LE		
300 Meter Run	52.96 ± 7.42	64	58	-11.43*

TO = Tactical officers

LE = Law enforcement officers

*Significance at the $p < 0.0001$

Using a one sample t-test for statistical analysis significant differences in the 300-meter run times between the tactical officers and the mean scores established by the CSFN for law enforcement officers (2002) were discovered, $t(20) = -27.12$, $p < 0.0001$ (Table XXII).

Table XXII

GROUP COMPARISON OF 300 METER RUN TIMES:
FULL-TIME TACTICAL OFFICERS VS. LAW ENFORCEMENT OFFICERS (N=21)

Variable	Group		df	t
	FT	LE		
300 Meter Run	46.83 ± 2.90	64	20	-27.12*

FT= Full-time tactical officers
LE = Law enforcement officers
*Significance at the $p < 0.0001$

A one sample t-test was utilized to determine if between group differences existed between the mean 300 meter run time scores of part-time tactical officers and law enforcement officers. This analysis revealed a significant differences in the 300-meter run times between the part-time tactical officers and the mean scores established by the CSFN for law enforcement officers (2002, $t(20) = -2.24$, $p = .004$ (Table XXIII))

Table XXIII

GROUP COMAPRISON OF 300 METER RUN TIMES:
PART-TIME TACTICAL OFFICERS VS. LAW ENFORCEMENT OFFICERS (N=21)

Variable	Group		df	t
	PT	LE		
300 Meter Run	61.57 ± 4.84	64	20	-2.24*

PT=-Part-time tactical officers
LE = Law enforcement officers
*Significance at the $p = .004$ level

A one sample t-test was utilized to determine if group differences existed between the mean 300 meter run time scores between multi-jurisdictional tactical officers and law enforcement officers. The statistical analysis revealed a significant differences in the 300-meter run times between this group of tactical officers and the mean scores established by the CSFN for law enforcement officers (2002), $t(17) = -16.61$, $p = .004$ (Table XXIV).

Table XXIV

GROUP COMPARISON OF 300 METER RUN SCORES: TACTICAL OFFICERS VS. LAW ENFORCEMENT OFFICERS (N=18)

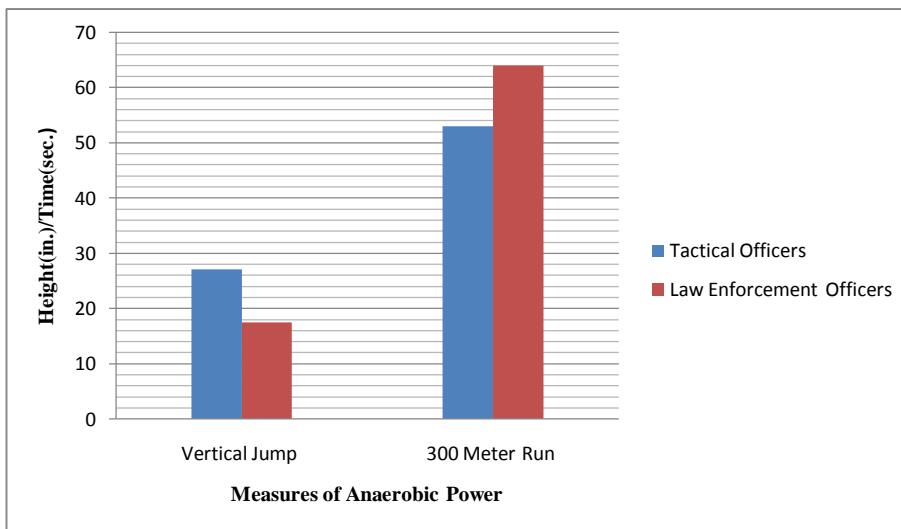
Variable	Group		df	t
	MJ	LE		
300 Meter Run	51.27 ± 4.54	64	17	-16.61*

MJ=Multi-jurisdictional tactical officers

LE = Law enforcement officers

*Significance at the p =.004

Figure 4.5: Summary Chart of Anaerobic Power Assessments for Tactical Officers vs. Law Enforcement Officers



Comparisons to Cooper Single Fitness Norms (CSFN)

The mean scores differences for the variables of BF%, bench press ratio, 1 minute push-ups and 1 minute sit-ups of tactical officers were compared to the data provided by the Cooper Single Fitness Norms (CSFN) (CIAR, 2002) using one-sample t-test for each of these measure (Table XXVI).

Table XXVI

TOTAL SAMPLE OF TACTICAL OFFICERS COMPARED TO CSFN:

Category	N	Tactical officers	CSFN
Body Fat Percentage	47	14.73 ± 5.6	22.5
1RM Bench Press Ratio	21	1.25 ± 0.17	0.72
1-min. Push-ups	21	56.50 ± 10.80	21
1-min. Sit-ups	21	48.60 ± 6.81	29.3
1.5 Mile Run	21	11.35 ± 0.62	14.46

CSFN = Cooper Single Fitness Norms at the 50th percentile

A two-tailed independent sample t-test revealed significant differences between the BF % of tactical officers and the 50th percentile ranking based on the CSFN s, $t(47) = 5.56$, $p < 0.0001$. (Table XXVII). In addition when analyzed by team, a series of one sample t-test revealed significant differences in BF % between the 50th percentile ranking based on the CSFN(2002) for full-time tactical officers, $t(24) = -22.28$, $p < 0.0001$ (Table XXVIII), as well as,

significant differences between the part-time tactical officers, $t(19) = -3.22, p = 0.004$ (Table XXIX).

Table XXVII
 GROUP COMPARISONS OF BODYFAT PERCENTAGE:
 TACTICAL OFFICERS VS. CSFN (N=47)

Variable	Group		df	t
	TO	CSFN		
Body Fat %	14.73 ± 5.6	22.5	47	5.56*

TO= Tactical officers

Figure 4.6: Summary Chart of Mean Body Fat Percentages of Tactical Officers Compared to the 50th Percentile Ranking of the CSFN

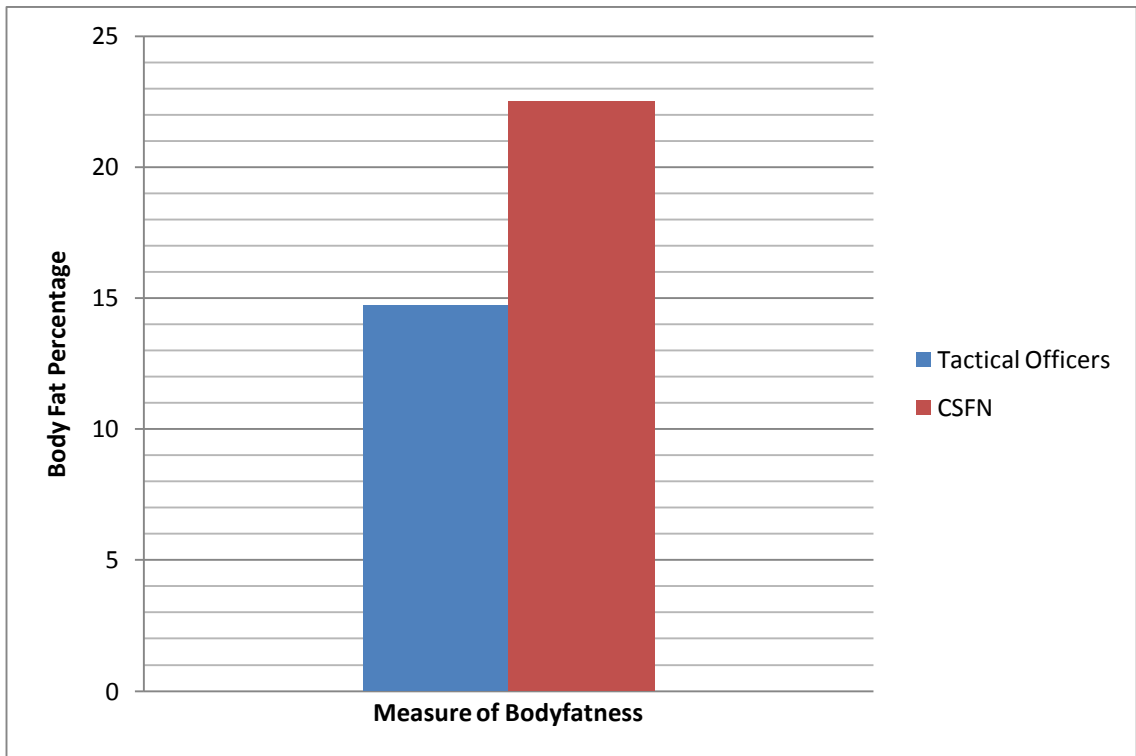


Table XXVIII

GROUP COMPARISONS OF BODYFAT PERCENTAGE:
FULL-TIME TACTICAL OFFICERS VS. CSFN (N=24)

Variable	Group		df	t
	FT	CSFN		
BF%	10.72 ± 2.64	22.5	24	22.88*

FT = Full-time tactical officers

CSFN = Cooper Single Fitness Norms at the 50th percentile

*Significance at the p<0.0001

Table XXIX

GROUP COMPARISONS OF BODYFAT PERCENTAGE:
PART-TIME TACTICAL OFFICERS VS. CSFN (N=24)

Variable	Group		df	t
	PT	CSFN		
BF%	19.50 ± 2.64	22.5	24	-3.22*

PT = Part-time tactical officers

CSFN = Cooper Single Fitness Norms at the 50th percentile

*Significance at the p = 0 .004 level

A two-tailed independent sample t-test was used to determine if mean 1 RM Bench press ratio scores were significantly different between the tactical officers and the 50th percentile ranking based on the CSFN (2002). Based on this statistical analysis it was discovered that significant differences did exist between these groups, $t(20) = 4.17$, $p < 0.0001$ (Table XXX).

Table XXX

GROUP COMPARISON OF 1RM BENCH PRESS RATIO:
TACTICAL OFFICERS VS. CSFN (N=45)

Variable	Group		df	t
	MJ	CSFN		
1-RM Bench Press Ratio	1.25 ± 0.17	0.72	20	4.17*

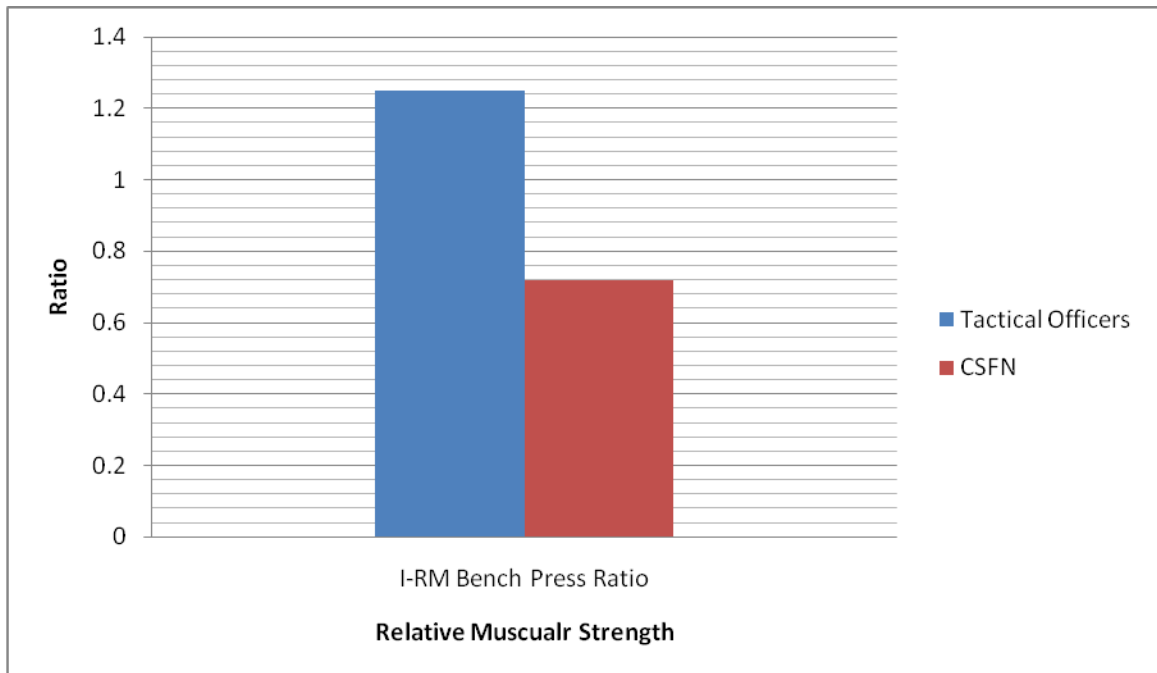
1-RM Bench Press Ratio: weight lifted/bodyweight

MJ = Multi-jurisdictional team

CSFN = Cooper Single Fitness Norms at the 50th percentile

*Significance at the p<0.0001

Figure 4.7: Summary Chart of Mean 1-RM Bench Press Ratio of Tactical Officers Compared to the 50th Percentile Ranking of the CSFN



A two-tailed independent sample t-test revealed significant differences between the 1-minute push-up test scores of multi-jurisdictional team members and the 50th percentile ranking based on the CSFN (2002), $t(20) = 4.83$, $p < 0.0001$ (Table XXXI).

Table XXXI

GROUPS COMPARISON OF 1-MINUTE PUSH-UP SCORES:
TACTICAL OFFICERS VS. CSFN (N=21)

Variable	Group		df	t
	MJ	CSFN		
1-min. Push-up	58.19 ± 7.52	21	20	4.83*

MJ = Multi-jurisdictional team

CSFN = Cooper Single Fitness Norms at the 50th percentile

*Significance at the $p < 0.0001$

A one-sample t-test revealed significant differences between the 1-minute sit-up test scores of multi-jurisdictional team members and the mean CSFN (2002), $t(20) = 17.13$, $p = .000$. (Table XXXII)

Table XXXII

GROUP COMPARISON OF 1-MINUTE SIT-UP SCORES:
TACTICAL OFFICERS VS. CSFN (N=21)

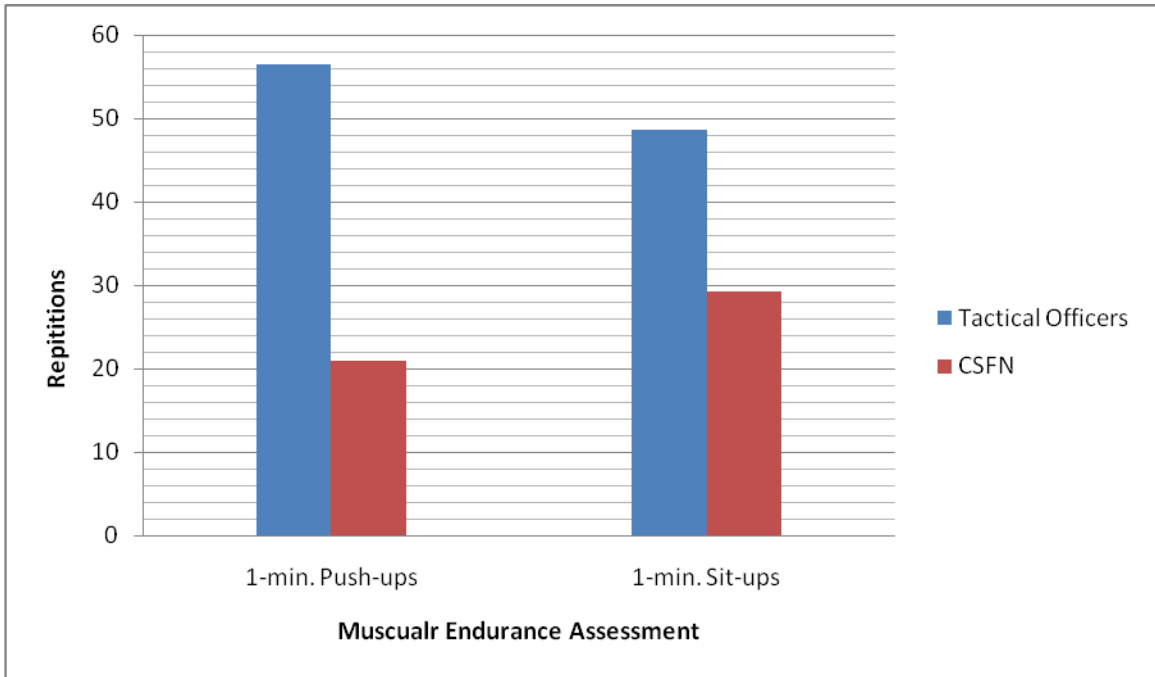
Variable	Group		df	t
	MJ	CSFN		
1-Min. Sit-ups	49.52 ± 29.30	29.3	20	17.13*

MJ = Multi-jurisdictional team

CSFN = Cooper Single Fitness Norms at the 50th percentile

*Significance at the $p < 0.0001$

Figure 4.8: Summary Chart of Mean 1-minute Push-up and 1-minute Sit-up scores of Tactical Officers Compared to the 50th Percentile Ranking of the CSFN



A one sample t-test revealed significant differences in 1.5 mile run times between the multi-jurisdictional officers and the 50th percentile ranking based on the CSFN (2002), $t(20) = -4.94$, $p < 0.001$ (Table XXXIII).

Table XXXIII

GROUP COMPARISON OF 1.5 RUN SCORES:
TACTICAL OFFICERS VS. CSFN (N=21)

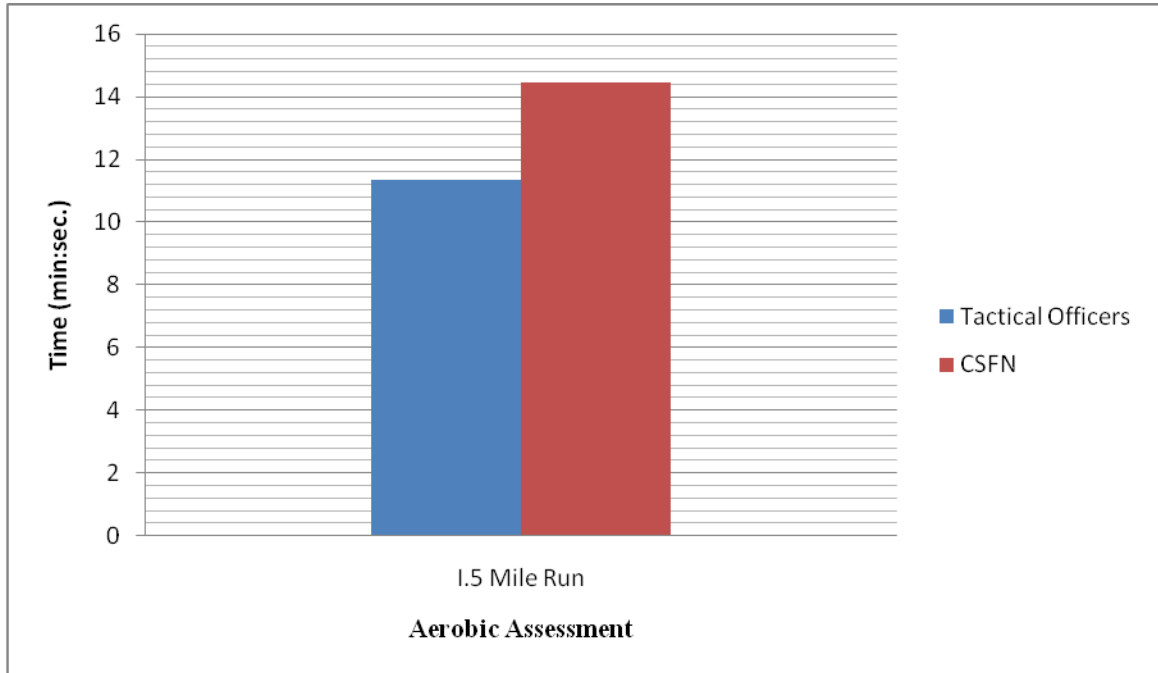
Variable	Group		df	t
	MJ	CSFN		
1.5 Mile Run	11.35 ± 0.62	14.46	20	-4.94*

MJ=Multi-jurisdictional tactical officers

LE = Law enforcement officers

*Significance at the $p \leq 0.01$

Figure 4.9: Summary Chart of Mean 1.5 Mile Run Times of Tactical Officers Compared to the 50th Percentile Ranking of the CSFN



DISCUSSION

The primary aim of this study was to examine the anthropometric and physiological characteristics of tactical officers. A detailed description of these characteristics can be found in Table I. These tactical officers were also compared to the mean percentile rankings provided by the CIAR's Physical Fitness, Tests, Standards and Programs for Public Safety, and to other law enforcement officers in several categories of fitness based on the information provided by Hoffman and Collingwood (2005). Due to the paucity of relevant and verifiable information currently found in the research and common press related to this population this research makes a significant contribution to the scientific literature. Furthermore, this study provides insight at the physiological profiles of tactical officer. It is the author's hopes that the findings of this research

may serve as a much needed reference for establishing provisional benchmarks for evaluating the minimal physical fitness standards necessary to perform the essential job-tasks of SWAT.

Demographic and Anthropometric Characteristics

Based on the information provided by each team there were no significant ($p=0.06$) difference in the age, years of SWAT experience ($p=.08$), and height ($p=0.10$) when comparing all of the tactical officers in this study. However, significant differences in mean body weights ($p=.01$) and BMI ($p<0.0001$) were found between the tactical officers that were members of full and part-time teams. A one sample t-test revealed significantly lower BF% ($p<0.0001$) for the total sample of tactical officers when compared to the mean score for the CSFN for BF%. When analyzed separately, the full ($p<0.0001$) and part-time ($p=0.004$) tactical officers also had significantly lower BF% than the mean for the CSFN. Data for BF% was not provided for members of the multi-jurisdictional team. As a result, BF% lean mass, and fat mass could not be analyzed for this group. While the BF% was considerably less than the mean percent body fat scores for the sample provided by the CIAR, it is important to remember that these percentile rankings were generated based on the general population, not law enforcement officers. Therefore, the CIAR percentile rankings may only be relevant to accessing health risks rather than performance.

Descriptive analysis of BMI for members of the three teams revealed a mean BMI of 28.23 ± 3.46 . According to the ACSM's (2010) this would classify the total sample of tactical officers as "overweight". When analyzed separately, all three teams would still be classified in the "overweight" category. Thus, in both cases this would place these tactical officers at an elevated health risk. However, when body composition was analyzed it was discovered that the mean BF% for the total sample of tactical officers was 14.73%. When analyzed separately it was found that the full-time officers had a mean BF% of 10.72%, and the part-time tactical officers

had an average BF% of 19.50% .Based on this information it appears that BMI overestimates body fatness for the tactical officer. This is consistent with the results of Kaiser et al (2008) who looked at the anthropometric characteristics of football players and found that . BMI also tended to overestimate body fatness in this population.

When analyzing the three groups separately, significant differences in BF%, and fat mass with no significant difference in the amount of lean mass between these groups were discovered. Based on the CSFN (2002) the full-time team's mean BF % score would classify these officers in the "Superior" category (95-99th percentile), while the mean BF % for the part-time teams would classify the team in the "Good" category (65-70th percentile). Based on this same percentile ranking scale the total sample of tactical officers would be classified in the "Excellent" category. Regardless, the total combined and individual team means were better than the mean CFSN for BF% (CIAR, 2002). Therefore, based on these results it appears that the tactical officer is leaner and has less body fat than the cross-section of thousands of individuals used by the CIAR to generate the percentile rankings used for comparison in this study.

While the CIAR (2006) states that BF% does not function as a significant predictor of a law enforcement officer's ability to perform essential job-tasks, and as long as aerobic power and strength are measured and are at an acceptable level a body fat measure is not needed. Furthermore, the CIAR contends that this may be considered a "red flag" for ADA litigation. However, achieving optimal body composition may have important implications for the tactical officer not just from a health, but a performance standpoint. Poor body composition may negatively impact several areas of performance for the tactical officer, such as climbing fences, walls, elevator shafts, and multiple flights of stairs, ladders, fire escapes, ropes, poles and trees to gain an objective or tactical position; crawling; functioning in crawl spaces, tunnels, vents, shafts, etc; and low and high crawling to objectives(CIAR, 2002; U.S,1988).

Boyce, Jones, Lloyd, and Boone (2008) hypothesize that heavier and obese officers may have a reduced ability to perform their job at a higher rate than their lower weight counterparts. Research conducted in athletic populations further supports the notion that performance in measures of power, speed and agility and muscular endurance may be hindered by increased body fatness (Potteiger et al., 2010; Thompson, Cain, & Jones, 2010). In addition, research conducted by Dawes et al (2011) found a negative correlation between BF%, as well as total fat mass, on muscular endurance performance in the 2-minute push-up, 2-minute sit-up and maximal pull-up to fatigue scores for part-time tactical officers. These results are similar to those reported by Esco, Olson and Wiliford (2008) who found that better performance scores in the push-up and sit-up were linked to lower subcutaneous body fat levels. Based on the significant differences seen in BF % between the full-time and part-time tactical officers in this study it is plausible that this may partially explain the differences in the mean scores observed in the 2-minute pushup and sit-up tests between the full-time and part-time tactical officers observed in this study.

Based on the results of this study it is apparent that the mean BF% for the tactical officers is significantly lower than the CSFN (2002). In addition, because these rankings were developed from the Cooper age and gender norms representing a cross-section of thousands of individuals, the applicability to the tactical officer is questionable. Therefore, body fat percentile rankings for the tactical officer at the 25th, 50th and 75th percentile have been provided in Appendix E. When comparing these BF % percentile rankings to fitness standards established for law enforcement agents with similar job tasks, such as U.S. Marshalls, it appears that the mean score attained by this sample are what one may anticipate for these specialized law enforcement agents. According to Reilly and Karlstad (2004) the fitness standard for the U.S Marshalls is 15.9% or less. Using the percentile ranking scale created for the tactical officer this standard would fall between the 40- 45th percentile. Nevertheless, these provisional percentile rankings must be viewed as a mere guide and informed reference based on the limited sample size utilized to develop this scale.

In summary, using BF% as an absolute standard would not be advised as this may make agencies more susceptible to ADA litigation. However providing this information as feedback to the tactical officer may be useful for the purpose of improving performance. Therefore, not providing this information to the officer may actually be a disservice to them and consequently may not provide them with the necessary guidance to improve their operational performance.

Muscular Fitness

While upper-body strength certainly appears to be important for performing several essential job-tasks related to SWAT it is unclear as to how much strength is necessary and how much is enough for the tactical officer. However, based on the 1RM bench press ratio scores for the multi-jurisdictional officers it appears they have impressive relative strength levels. In fact, the mean score for this group ranked well above the 99th percentile when compared to the CSFN (2002). It was also found that the absolute 1RM bench press scores for the multi-jurisdictional officers in this research were notably higher than the median ranges for over 180 federal, state and municipal agencies (FitForce™, 2007). The median scores reported ranged between 151-165 lbs, which would be approximately 70-84 lbs less than the median score (235 lbs) for the tactical officers in this investigation.

When seeking to determine the amount of strength required for the tactical officer, other physically demanding occupations with similar job tasks were considered. Compared to other law enforcement officer it is apparent that the tactical officer consistently has a greater need for physical strength to perform many of their essential job duties. In addition, when comparing the essential job-tasks of SWAT it appears that these tasks may be more similar to the demands of the firefighter than that of the traditional law enforcement officer, especially with the consideration of the additional load of their specialized gear.

Research conducted by Michaelides, et al, (2011) found significant correlations between 1RM bench press and several firefighting tasks, such as a rolled hose lift and move ($r = -.031$), a sled push (-0.41), a rescue mannequin drag (-0.31) and a charged hose advance (-0.36). This is consistent with the findings of Von Heimberg, Rasmussen, and Medbo (2006) that discovered that larger firefighters with better upper-body strength as measured by the 1RM Bench Press performed a simulated rescue of hospital patients faster than their smaller and weaker counterparts. Research by Sell (2006) found low to moderate, but significant, correlations between 1RM bench press ratios and forcible entry ($r = -0.28$), a stair climb with a hose drag ($r = -0.52$), hose drag ($r = -0.28$), ventilation exercise (-0.36), an attic crawl (-0.39) and overall time to complete the simulated firefighting tasks.

Michaelides, et al (2011) also discovered that firefighters who completed the selected physical ability tests the fastest had a mean score of 254 ± 63.76 on the 1 RM bench press. This is very similar to the mean 1 RM bench press of the tactical officers in this study (250 lbs).

At this point it is difficult to make a definitive recommendation on the amount of upper-body strength needed for the tactical officer. While relative strength is certainly important a certain amount of absolute strength is also required in many tactical situations. While more research is needed in this area, When performance of similar job tasks during firefighting simulations are considered, a good aim for the tactical officer seeking to improve performance may be in the area of 250 lbs. Based on the percentile ranking for the 1 RM bench press in Appendix E, this would correspond to the 50th percentile. Based on the limited sample size used to generate these percentiles, this scale should only be used as a general reference. In addition, it should be noted that creating an absolute standard based on this particular measure may unintentionally discriminate against protected classes especially females, due to gender differences in absolute upper-body strength levels.

Muscular endurance as measured by the 1 minute push-up and sit-up tests were significantly higher ($p < 0.0001$) than the CSFN means scores (2002) and significantly greater than the mean scores presented by Hoffman (2006) for traditional law enforcement officers. Additional information provided by Hoffman (2006) states that the standard passing scores for male police department personnel in the mean age of this sample would be 35 sit-ups and 24 push-ups until exhaustion. According to research by FitForce™ (2007) the median scores for law enforcement officers ranges from 30-38 repetitions for sit-ups, and between 25-34 repetitions for push-ups. Therefore, the tactical officers in this study scored well above law enforcement officers examined in other research.

At this time there is no data available for law enforcement personnel to compare to the tactical officer's two minute push-up and sit-up scores. Therefore other 'occupational athletes' were used to make comparisons. When evaluated in relation to the minimum standards for muscle endurance for American military personnel it was discovered that the tactical officers scored considerably higher than the standards set for the Army and Navy in all age categories (Hoffman, 2006). In fact, when compared to the physical readiness classifications for Naval personnel at the same mean age it was found that the mean score for the total sample of tactical officers in both of these. Furthermore, Findley, Brown, Whitehurst, Gilbert, and Apoid (1995) found similar mean sit-up scores (54.1 ± 17.2) to the part-time tactical officers in this study amongst a group of male firefighters ($n = 94$) between the ages of 30-39. Maximal pull-up scores for the part-time and multi-jurisdictional teams revealed significant differences between the mean scores of these teams. Since, there were no significant differences between bodyweight and BMI in these groups it appears the relative strength and endurance of the multi-jurisdictional team in the maximal pull-up test exceeded that of the part-time team. However, information related to the BF% for the multi-jurisdictional team was not provided. Therefore, it cannot be determined if BF% had an impact on the difference in scores between these groups. It should be noted that the full-time

group also performed a maximal pull-up assessment which required the officers to perform five pull-ups, from a dead hang, while wearing a 40 pound weighted vest used to simulate a tactical vest. This test was also evaluated on a pass/no pass basis. For these reasons, this test was excluded from this study. However, intuitively it may make more sense to perform similar evaluations in the future as it may be more task-specific. For example, in many cases if a tactical officer was required to lift themselves over a barrier or obstacle in an operational situation while wearing a tactical vest. The additional load of the weighted vest added an additional 40 lbs of weight the officers had to move. While the need to perform 5 repetitions of this test to successfully pass this requirement cannot be supported by the research at this time further investigation to determine the job-relatedness of this standard is warranted.

At this time there is relatively little published information related to pull-up standards and norms for law enforcement officers. According to the Federal Bureau of Investigation (FBI) (<http://www.fbijobs.gov/11133.asp>, retrieved June 11, 2011) pull-ups are not used for pass/fail purposes, rather for fitness awards. In order to achieve the minimal level of points the agent must be able to perform 2 pull-ups. To achieve the maximal level of points the agent must achieve 20 pull-ups. No additional points are awarded for individuals that are able to perform greater than 20 pull-ups. The tactical officers in this study also performed significantly better than the three repetitions required as the minimum standards utilized by the Marines in basic training. Since these soldiers have similar job-duties this may have relevance when evaluating and establishing absolute cut-scores.

Since upper-body muscular endurance has been linked to successful job-task performance for a variety of occupational athletes (Hoffman, 2006; Hoffman & Collingwood, 2005; Michaelides, et al, 2011; Sell, 2006; Von Heimberg, Rasmussen, & Medbo, 2006; 2011; Williford, Duey, Olson, Howard, & Wang, 1999) further investigation in this area is warranted to determine the level of muscular endurance needed to perform job-tasks efficiently and safely.

Moreover, the argument can be made for a higher standard for muscular endurance in the trunk than traditional law enforcement officers based on the greater load carriage task required of these officers. Percentile rankings at the 25th, 50th and 75th percentiles for these tests based on the sample of tactical officers are presented in Appendix E. As previously stated, these rankings should be used provisionally as a general reference at this time.

Anaerobic Power

According to the CIAR (2006) anaerobic power is essential in tasks that require sprinting, dodging, lifting, dragging, carrying, pushing, pulling, jumping, vaulting, and use of force. In addition, the CIAR also states that two measures of anaerobic performance, the 300 meter run and vertical jump, are highly predictive of performing job-tasks in all cases. Significantly higher scores on both of these measures were found in all cases for the tactical officer when compared to traditional law enforcement officers.

Research indicates that anaerobic power is significantly related to job-performance in a variety of physically demanding occupations (Rhea, Alvar, & Gray, 2004; Sell, 2006; Sheaff, 2009). Sell (2006) found the strongest relationship ($r = - 0.58$) between time to completion on simulated firefighting task scenarios (SFTS) was vertical jump height. In this research it was determined that firefighters that were able to achieve a vertical jump height of greater than 17 inches were more likely to achieve a passing rate (95.60%) than those that jumped less than 17 inches (46.20%). The average vertical jump for the 68 individuals in this study that achieved greater than a 17 inch vertical jump was 20.54 ± 2.74 . As previously stated, tactical officers must carry similar loads as a firefighter and perform similar job task. For this reason, a compelling argument could be made that tactical officer should have similar vertical jump performance to firefighters that are high performers on SFTS.

Research conducted by Rhea et al (2007) found that sustained anaerobic power as measured by 400 meter run time had a strong correlation ($r = 0.79$, $p \leq 0.05$) with time to completion when conducting simulated firefighting tasks. Michaelides et al (2011) found that anaerobic power as measured by a step test showed significant correlations with performance on a stair climb (-0.39 , $p < 0.01$), a rolled hose lift and move (-0.30 , $p < 0.05$) and between the vertical jump and a simulation rescue using a mannequin (-0.31).

When looking at this information this investigator would recommend the tactical athlete be able to achieve a minimum vertical jump height of 17 inches, and an ideal height of at least 20 inches. When looking at the percentile rankings for the tactical officers in this study this would correlate to a percentile ranking between the 5th and 15th percentile. When using the percentile rankings created by the CIAR (2002) for law enforcement officers this would correspond to percentile rankings between the 45th-75th percentiles.

Research by Collingwood, Hoffman and Smith (2004) found the median scores for the 300 meter run ranged between 64.3- 66 seconds. The median score for the total sample of tactical officers in this study was 48.45 seconds. When examining the percentile mean scores and percentile rankings for the tactical officers in this study the mean score for this measure was 51.27 ± 4.54 seconds. When compared to the CSFN for law enforcement (2002) the mean score would equate to an 85th percentile ranking for the total sample. When using this same ranking scale and separating times by team, the full-time team would be classified between the 90-95th percentile, the part-time group between the 55-60th percentile, and the multi-jurisdictional group in the 80-85th percentile.

Based on the essential job-tasks required of SWAT it is recommended that the tactical officer have above average anaerobic power when compared to the traditional law enforcement officer. However, more research is needed to determine the necessary level of both explosive and sustained anaerobic power required in order to maximize operational readiness. Percentile

rankings for the tactical officers in this study for the vertical jump and 300 meter run are provided in Appendix E.

Aerobic Power

Aerobic capacity has been linked to successful performance in a wide variety of occupational tasks and physical agility tests for the law enforcement officer (CIAR, 2006; Lonsway, 2008; Roberts, O’Dea, Boyce, & Mannix, 2002; Rhodes & Farenholtz, 1992; Spitler et al, 1987; Stanish, Wood & Campagna, 1999). In fact, the CIAR (2002) states that aerobic capacity is predictive of successful job performance in all cases.

Data analysis revealed significantly lower completion times for the tactical officers in this study when compared to the CSFN (2002) and the mean scores for law enforcement officers provided by Hoffman and Collingwood (2006). According to FitForce™ (2007) the median scores from the agencies surveyed IN their research revealed law enforcement officers ranged between 14:40-15:54 minutes to complete this distance. According to the CIAR (2002) this would be equivalent to an estimated VO₂ max of between approximately 32-36 mL .kg⁻¹ min⁻¹. This recommendation is consistent with those of Lilleshall consultancy Services (2010), that advocate MOE’ officers be able to achieve a predicted VO₂ Max of 35 mL .kg⁻¹ min⁻¹.

Based on the greater metabolic demands of the tactical gear and tools a higher VO₂ max than traditional law enforcement agents may be warranted for the tactical officer. Therefore, comparison to other occupationally demanding jobs that require similar load carriage tasks, such as firefighting, and military soldiers, seems more appropriate.

Research conducted by Sothman et al. (Sothman, Saupe, & Jasenof, 1990, Sothman, Landy, & Saupe 1992; Sothman, Saupe, & Jasenof, 1992) found that firefighters with a VO₂ max of 33.5 - 51.0 mL .kg⁻¹ min⁻¹ were able to successfully complete a fire suppression protocol as opposed to those scoring below 33.49 mL .kg⁻¹ min⁻¹. In a study conducted by Williams-Bell,

Villar, Sharatt and Hughson (2009) VO_2 was measured at approximately 38-40 mL \cdot kg⁻¹ min⁻¹ during a simulated stair climb while wearing an additional 34.02 kg (74.84 lbs) of gear. Similar results were found by Bilzon, Scarpelo, Smith, Ravenhill and Rayson (2001) that reported the metabolic demands of a simulated ship-board firefighting procedure consisting of several running, lifting and carrying tasks while wearing a full firefighting ensemble and a self-contained breathing apparatus (SCBA). It was found that the work demands for these tasks elicited an oxygen consumption of between 23-43 mL \cdot kg⁻¹ min⁻¹. Based on this information it was recommended that firefighters be able to achieve a minimum VO_2 max of 43 ml min mL \cdot kg⁻¹ min⁻¹ in order to withstand the physical demands of these tasks. In research by von Heimberg et al. (2006) a maximal oxygen consumption of 44 ± 5 mL \cdot kg⁻¹ min⁻¹ was achieved by firefighters during a simulated rescue exercise. Deakin et. al. (2000) found that for Canadian Special forces that VO_2 max was the most important predictor of job-performance for a variety of tasks similar to those essential to SWAT, such as the low/high crawl, land evacuation, and sandbag carry. The mean VO_2 max for the soldiers in this research was 46.40 mL \cdot kg⁻¹ min⁻¹. Based on their analysis it was determined that average observed VO_2 for the low/high crawl was 27 mL \cdot kg⁻¹ min⁻¹, 36.3 mL \cdot kg⁻¹ min⁻¹ for the land evacuation, and 35.7 mL \cdot kg⁻¹ min⁻¹ for the sandbag carry.

Based on the work demands and similar load carriage tasks, of the job-tasks discussed in the literature, the author would recommend the tactical officer strive to attain a minimum VO_2 max of 44 mL \cdot kg⁻¹ min⁻¹. This recommendation would correspond to the 90th percentile based on the CSFN (2002) and approximately the 15th percentile for the rankings created in this research for the tactical officer.

Agility

The Illinois Agility test was used by the multi-jurisdictional team as a method of assessing change of directional speed. It was found that the tactical officers in this research scored

notably better with a mean score of 15.27 seconds than the median scores (18.1 and 18.2 seconds) for law enforcement officers provided by FitForce™ (2007). When compared to athletic populations these officers would rank in the “good” category amongst male athletes (Roozen, 2004). In addition, the mean scores on the pro-agility shuttle for the part-time officers were 5.25 ± .22 seconds. At this time there is no available data to compare these officers to other tactical athletes or to law enforcement officers in this measure, however when compared to athletes it was found that this mean score was equivalent to scores the 20th percentile ranking for women’s, volleyball and basketball and the 40th percentile for women’s softball.

Relatively little published data pertaining to agility scores of law enforcement officers on standardized tests is available. In fact, at this time it appears that most measures of agility are part of a larger PAT test, which combines several different fitness components, such as aerobic fitness, muscular, endurance, speed, anaerobic power, etc, into one test. Stanish, Wood and Campagna (1999) found that performance on the Barrow zigzag agility run was significantly correlated to PARE time for both males and females. Furthermore, these researchers found that PARE success could be classified in females with an 85% accuracy using the agility test alone, and 93% accuracy using the agility test and 1.5 mile run test for aerobic fitness. The limitation of these tests is it is difficult to determine which of these underlying physical fitness components may be hindering performance. For this reason, conducting specific agility tests may better help identify if poor agility is the limiting factor to success when performing a PAT, or whether other deficits in fitness may be causing performance decrements.

Comparisons of Tactical Officers by Group

Statistical analysis of the data revealed significant differences between the full and part-time tactical officers in this study. The full-time team had significantly lower mean body

weights, BF%, and fat mass than the part-time tactical officers. In addition, it was found the full-time officers scored significantly better on the 2 minute sit-up tests, maximum pull-up scores and vertical jump height when compared to the part time officers. Furthermore, the full-time had a lower mean BMI and 300 meter run times than both the part-time and multi-jurisdictional officers and higher 2- minute push-up scores than both of these groups. There were no measures in which the part-time or multi-jurisdictional tactical officers received better mean scores than the full-time tactical officers.

A limitation of this analysis was a lack of data on several of the tests and assessments investigated in this research. Data related to BF%, fat mass, 2 minute sit-up scores, and vertical jump height was not available for the members of the multi-jurisdictional team, therefore comparisons between these groups could not be made. Data on the 1 RM Bench press raw score, 1 minute push-ups, 1 minute sit-ups and 1.5 mile run times were not provided for either the full or part-time tactical officers, thus between group comparisons could not be made on these measures.

While the between group differences in the three teams is likely multi-factorial, post analysis interviews exposed a noteworthy difference in the way these teams approached their physical conditioning. The full-time team was allowed 3-4 hours per week to train while on-duty, under the guidance of a certified strength and conditioning professional. Commanders from both the part-time and multi-jurisdictional teams said their teams were not provided with additional time by their agencies to train while on duty, and did not follow a structured team program. Rather officers in each of these groups were responsible for maintaining their physical fitness during their personal, or off-duty, time. It was also stated that many of these officers engaged in modified versions of the popular Crossfit™ training program. These factors may partially explain why the full-time team scored consistently better on all performance tests when compared to the other teams.

Underlying Fitness Component for Essential Job Tasks

Another aim of this research was to investigate the underlying physical fitness components necessary to perform the essential job tasks of SWAT as were determined by the NTOA (2008). Based on this investigation a proposed outline matching the fitness variables essential to each essential job-task was created. This chart can be found in Appendix D.

According to Haynes, Richard, and Kubany (1995) population and expert sampling is frequently recommended by psychometricians to help establish content validity of a testing item. The authors also state that “structured, open-ended interviews with persons from the targeted population and experts can increase the chance that the items and other elements are representative of and relevant to the facets of the construct” (1995). Based on this, the proposed outline was sent to several tactical officers, thought leaders and commanders to assist in validating this content. At this time the primary investigator has received communications from five of these expert sources validating the content of this outline. However, more expert opinion and discussion should be conducted before this proposed outline is considered definitive.

Conclusion

The results of this study when compared to the null hypotheses help provide a description of the similarities and differences between tactical officers belonging to three different types of SWAT teams and the differences between these officers and traditional law enforcement officers. Furthermore, the findings of this study provide a much needed analysis of the anthropometric and physical performance characteristics of the tactical officer. These findings address gaps in our understanding of the tactical officer and may be used as a first step in the development of fitness and performance norms and standards for this population. In addition these findings also serve as provisional benchmarks for evaluating the minimal physical fitness standards necessary to perform the essential job-tasks of SWAT

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND

RECOMMENDATIONS

SUMMARY

This study was designed to investigate the current physical and performance characteristics of tactical officers on full-time, part-time and multi-jurisdictional teams and to identify the underlying physical fitness components required to perform the essential job-tasks of SWAT.

The scientific literature in this area is currently lacking basic descriptive information related to this highly-specialized group of law enforcement officers. In addition, it was found that there is a lack of standardization in selection and assessment standards between agencies for SWAT team applicants and officers. This presented a significant challenge when seeking to compare these officers level of fitness in relation to any well-established norms. Therefore the investigator sought to make comparisons amongst tactical officers that were members of either a full-time, part-time or multi-jurisdictional team. The data used in this study was archival in nature. Therefore this analysis was limited based on the information provided to the primary investigator.

Officials from the National Tactical officers Association (NTOA) were contacted by email to inform them about the purpose of this study. The primary investigator requested the NTOA send an e-blast to its membership requesting SWAT team data on a range of fitness and performance based metrics (Appendix B). In addition, the primary investigator requested the Tactical Strength and Conditioning Program Director of a non-profit agency provide testing data to the primary investigator for descriptive purposes (Appendix C). The primary investigator requested that each subject be assigned an identification number prior to receiving this data in order to protect the participant's identity. All data for this research was archival in nature and collected from several different participating agencies. Testing data for a combined total of seventy-one (N=71) tactical officers, from full-time (n= 29), part-time (n=21), and multi-jurisdictional (n=21), teams between the ages of 28-56 was utilized for the purpose of data analysis. Each agency utilized different testing batteries and physical assessments for their officers. Therefore, at times throughout the analysis of this data there were variations in the amount of data collected for each measure. The data to be analyzed in this study was limited to include; anthropometric variables, such as height, weight, BMI and body composition; muscular strength and endurance; anaerobic power; aerobic power; and agility and was compared, when possible, between tactical officers on each team, the Cooper Single Fitness Norms at the 50th percentile ranking, and the mean scores for law enforcement officers provided by Hoffman and Collingwood, (2005) and Hoffman, (2006).

In addition, a provisional chart outlining the underlying physical fitness components related to the essential job tasks of SWAT was created based on personal interviews with tactical experts and the scientific literature related to several physically demanding occupations, such as law enforcement, firefighting, and military soldiers.

FINDINGS

The following hypotheses were tested at the 0.05 confidence level, and the results are indicated in the following section.

Null Hypothesis One

There will be no significant differences between the mean ages for full-time, part-time and multi-jurisdictional tactical officers.

The results of this study indicate there were no significant differences between the mean ages of fulltime, part-time and multi-jurisdictional tactical officers. Therefore, null hypothesis 1 was accepted.

Null Hypothesis Two

There will be no significant differences between the mean years of experience for part-time and multi-jurisdictional tactical officers.

The results of this study indicate were no significant differences between the mean years of experience of part-time and multi-jurisdictional tactical officers. Therefore, null hypothesis 2 was accepted.

Null Hypothesis Three

There will be no significant differences between the mean heights of full-time, part-time and multi-jurisdictional tactical officers.

The results of this study indicate were no significant differences between the mean heights of full-time, part-time and multi-jurisdictional tactical officers. Therefore, null hypothesis 3 was accepted.

Null Hypothesis Four

There will be no significant differences between the mean bodyweights of full-time, part-time and multi-jurisdictional tactical officers.

Results of this study indicate there was a significant difference between the mean bodyweights of full-time, part-time and multi-jurisdictional tactical officers. Therefore, null hypothesis 4 was rejected.

Null Hypothesis Five

There will be no significant differences between the mean Body Mass Index of full-time, part-time and multi-jurisdictional tactical officers.

Results of this study indicate there was a significant difference between the mean Body Mass Index of full-time, part-time and multi-jurisdictional tactical officers. Therefore, null hypothesis 5 was rejected.

Null Hypothesis Six

There will be no significant differences between the mean body fat percentages of full-time and part-time tactical officers.

Results of this study indicate there was a significant differences between the mean body fat percentages of full-time and part-time tactical officers. Therefore, null hypothesis 6 was rejected.

Null Hypothesis Seven

There will be no significant differences between mean body fat percentages for full-time tactical officers and the Cooper Single Fitness Norms .

The results of this study indicate there was a significant difference between mean body fat percentages for full-time tactical officers and the Cooper Single Fitness Norms. Thus, null hypothesis 7 was rejected.

Null Hypothesis Eight

There will be no significant differences between the mean body fat percentages for part-time tactical officers and the Cooper Single Fitness Norms.

Results of this study indicate there was a significant difference between the mean body fat percentages for part-time tactical officers and the Cooper Single Fitness Norms. Therefore, null hypothesis 8 was rejected.

Null Hypothesis Nine

There will be no significant differences between the mean amounts lean mass of full-time and part-time tactical officers

Results of this study indicate there was not a significant difference between the mean amounts lean mass of full-time and part-time tactical officers Therefore, null hypothesis 9 was accepted.

Null Hypothesis Ten

There will be no significant differences between the mean scores of full-time and part-time tactical officers in fat mass Results of this study indicate there was a significant differences between the mean scores of full-time and part-time tactical officers in fat mass. Thus, null hypothesis 10 was rejected.

Null Hypothesis Eleven

There will be no significant differences between the mean 1 RM bench press ratio scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms..

Results of this study indicate there was a significant difference between the mean 1 RM bench press ratio scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms.. Thus, null hypothesis 11 was rejected.

Null Hypothesis Twelve

There will be no significant differences between the mean 1-minute push-up scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms. Results of this study indicate there was a significant difference between the mean 1-minute push-up scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms. As a result, null hypothesis 12 was rejected.

Null Hypothesis Thirteen

There will be no significant differences between the mean 1-minute push-up scores of multi-jurisdictional tactical officers and the traditional law enforcement officers. Results of this study indicate there was a significant difference between the mean 1-minute push-up scores of multi-jurisdictional tactical officers and the traditional law enforcement officers. As a result, null hypothesis 13 was rejected.

Null Hypothesis Fourteen

There will be no significant differences between the mean scores of full-time, part-time and multi-jurisdictional tactical officers on 2-minute push-up scores

Results of this study indicate there was a significant difference between the mean scores of full-time, part-time and multi-jurisdictional tactical officers on 2-minute push-up scores. Thus, null hypothesis 14 was rejected.

Null Hypothesis Fifteen

There will be no significant differences between the mean 1-minute sit-up scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms.

Results of this study indicate there was a significant difference between the mean 1-minute sit-up scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms. Therefore, null hypothesis 15 was rejected.

Null Hypothesis Sixteen

There will be no significant differences between the mean 1-minute sit-up scores of multi-jurisdictional tactical officers and traditional law enforcement officers

.Results of this study indicated that there was a significant difference between the mean 1-minute sit-up scores of multi-jurisdictional tactical officers and traditional law enforcement officers Therefore, null hypothesis 16 was rejected.

Null Hypothesis Seventeen

There will be no significant differences between the mean 2-minute sit-up scores of full-time and part-time tactical officers..

Results of this study indicate there was a significant difference between the mean 2-minute sit-up scores of full-time and part-time tactical officers... As a result, null hypothesis 17 was rejected.

Null Hypothesis Eighteen

There will be no significant differences between the mean maximal pull-up scores of full-time and part-time tactical officers.

Results of this study indicate there was a significant difference between the mean maximal pull-up scores of full-time and part-time tactical officers. s. Therefore null hypothesis 18 was rejected.

Null Hypothesis Nineteen

There will be no significant differences between the mean vertical jump height scores of full-time and part-time tactical officers..

Results of this study indicate there was a significant difference between the mean vertical jump height scores of full-time and part-time tactical officers. Therefore null hypothesis 19 was rejected.

Null Hypothesis Twenty

There will be no significant differences between the mean vertical jump height scores of full-time tactical officers and traditional law enforcement officers.

Results of this study indicate there was a significant difference between the mean vertical jump height scores of full-time tactical officers and traditional law enforcement officers. As a result, null hypothesis 20 was rejected.

Null Hypothesis Twenty-One

There will be no significant differences between the mean vertical jump height scores of part-time tactical officers and traditional law enforcement officers..

Results of this study indicate there was a significant difference between the mean vertical jump height scores of part-time tactical officers and traditional law enforcement officers.. Thus, null hypothesis 21 was rejected.

Null Hypothesis Twenty-Two

There will be no significant differences between the mean 300 meter run time scores of fulltime, part-time and multi-jurisdictional tactical officers.

Results of this study indicate there was a significant difference between the mean 300 meter run time scores of fulltime, part-time and multi-jurisdictional tactical officers. .. Thus, the null hypothesis 22 was rejected.

Null Hypotheses Twenty-Three

There will be no significant differences between the mean 300 meter run times of fulltime, part-time and multi-jurisdictional tactical officers traditional law enforcement.

Results of this study indicate there was a significant difference between the mean 300 meter run time scores of fulltime, part-time and multi-jurisdictional tactical officers traditional law enforcement Therefore, null hypothesis 23 was rejected.

Null Hypothesis Twenty-Four

There will be no significant differences between the mean 1.5 mile run times scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms.

Results of this study indicate there was a significant difference between the mean 1.5 mile run times scores of multi-jurisdictional tactical officers and the Cooper Single Fitness Norms. Therefore, null hypothesis 24 was rejected.

Null Hypothesis Twenty-Five

There will be no significant differences between the mean 1.5 mile run times scores of multi-jurisdictional tactical officers and traditional law enforcement officers..

Results of this study indicate there was a significant difference between the mean 1.5 mile run times scores of multi-jurisdictional tactical officers and traditional law enforcement officers. Therefore, null hypothesis 25 was rejected.

CONCLUSIONS

The results of this research, when considered in the context of the paucity in the previous literature on this topic, lead the researcher to several conclusions. Primarily, it appears that the average tactical officer were more fit than the average law enforcement officer when examining the information provided by the Cooper Institute for Aerobic Research (2002), Hoffman and Collingswood (2006) and Hoffman, (2006). Furthermore, it appears when comparing teams the full-time team that was allowed to participate in a physical conditioning program while on duty under the supervision of a qualified strength and conditioning professional were significantly leaner and more fit than those tactical officers on a part-time and multi-jurisdictional team responsible for attaining and maintain their fitness during their off-duty times, without professional guidance.

This research also sought to identify the underlying physical fitness components necessary to perform the essential job-duties of SWAT. After a review of the literature related to several other physically demanding occupations a summary chart of these duties and the physical fitness components thought to be linked to each component was created and sent to several tactical experts for review. Five experts had responded at this time. All concurred that these proposed underlying physical components appeared to match the essential tasks listed.

Finally, based on the findings of this data provisional percentile ranking scales were created for the tactical officer. However, the researcher recognizes the limited sample these rankings were derived from and suggests these rankings serve as nothing more than mere guidelines at this point in time.

There are several limitations to this study which should be acknowledged. The results of this study are merely descriptive in nature and should not be used to determine occupational readiness or be used in the creation of absolute cut-scores. Further research is needed to validate the required level of fitness in each of the categories discussed for the tactical officer to safely and effectively perform their job-duties. Furthermore, the results of this study can only be generalized to the teams from which the study sample was provided.

The essential job-tasks of SWAT provided by the NTOA (2008) provide an excellent reference, however based on team composition and geographic variability the researcher acknowledges that other essential tasks, such as rappelling or swimming, may need to be added to this list on a case by case basis.

RECOMMENDATIONS

Currently, there is no information in the research literature that describes the physical profiles of tactical officers. For this reason, this investigation represents a preliminary step in filling this void in the research literature and there is still much work to do in this area. Though this research sought to analyze performance in job tasks related to SWAT in the context of research conducted in other physically demanding occupations there is still a need to collect data from both SWAT job-task simulations and real world tactical operations. By doing so, greater information can be collected regarding the actual, biomechanical, physiological, and metabolic demands of this occupation. These types of scientific analysis may aid in the development of an

appropriate assessment and selection criteria related to physical fitness, and in the identification of those officers fit enough to perform essential job-tasks. Furthermore, this information may also be useful in providing the tactical officer with an optimal fitness baseline to strive for.

Future research should also focus on an analysis of common injuries experienced by these specialized law enforcement officers. Based on the monetary investment in time and training agencies put into the training these specialized officers it is critical that they are injury resistant and capable of handling the rigors of the occupational tasks they must perform to protect themselves, their teammates, and the public. This information may also be valuable in the development of appropriate strength and conditioning programs to reduce the likelihood of these potential injuries, thus aiding in better operational performance.

In conclusion, there is a scarcity of information related to the anthropometric and physical fitness/performance profiles of tactical officer in the scientific literature. Currently, this investigation is the first to look at this population and develop a percentile ranking scale to serve as a provisional guideline for the tactical officer and their agencies. This research may further assist in the development of appropriate cut scores to ensure the minimum level of fitness required to meet the intense and physically demanding requirements of their occupations. This study further elucidates the need for the development of standardization of testing amongst this population so that large scale data collections can occur. This investigation also offers a rudimentary assessment of the physical demands of certain job-tasks for the tactical officer by providing comparable physiological analysis from other physically demanding occupations. This is an important preliminary step in the development of a detailed needs analysis for these occupational athletes. With this information the development of safe and effective strength and conditioning programs to meet the needs of these occupational athletes can be created..

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APPENDICES

APPENDIX A

INSTITUTIONAL REVIEW BOARD

APPROVAL FORM

Oklahoma State University Institutional Review Board

Date: Friday, May 06, 2011
IRB Application No: ED111113
Proposal Title: A Description of the Physical and Performance Characteristics of the Tactical Officer

Reviewed and Processed as: Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 5/5/2012

Principal Investigator(s):

James Jay Dawes Steven Edwards
1521 Oak Hill Dr 325U Willard
Corpus Christi, TX 78418 Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

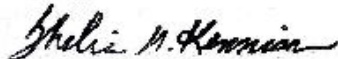
The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744 6700, both.mcternan@okstate.edu).

Sincerely,



Shelia Kennison, Chair
Institutional Review Board

APPENDIX B

NATIONAL TACTICAL OFFICERS ASSOCIATION(NTOA)

E-BLAST REQUESTING DEMOGRAPHIC INFORMATION AND TESTING DATA

From: Assistant Chief Mike Williams [mailto:williams_m@chattanooga.gov]
Sent: Friday, June 04, 2010 3:08 PM
To: corey.luby@ntoa.org
Subject: Police Related News 06-04

Your support is needed for Mr Jay Dawes who is collecting SWAT Fitness data. If you have any of this data please submit it to coachdawes@yahoo.com

I am currently in the process of collecting archival data on a variety of fitness and performance characteristics for members of both full and part-time S.W.A.T. teams for my dissertation. The purpose of this research will be three-fold. First, we will conduct a descriptive analysis of the physical attributes and characteristics of the S.W.A.T. athlete. Second, we will conduct a comparative analysis within and between groups of these athletes. Third, a comparative analysis within and between groups of these athletes will be conducted, as well as a comparison of the Tactical Athlete to other strength-power athletes.

At this time, in order to conduct the most comprehensive analysis possible, I would appreciate any assistance you could provide me in collecting this data. Attached is a sheet that details some of the measurements we are seeking to obtain. When filling out the information requested I would ask that the person recording this information assign number for each operator, rather than providing their name in order to sanitize this information and protect each individuals identity.

The following information is a few of the areas we would like to explore:

- Descriptive Information
 - o Age of the operator at time of testing.
 - o Occupational status (full or part-time)
- Anthropometric Variables
 - o Height
 - o Weight
 - o Waist to hip ratio
 - o Body Mass Index (BMI)
 - o Body Composition
 - Underwater weighing (hydrostatic weighing)
 - Bod Pod
 - DEXA
 - Bioelectrical Impedance
 - Skinfold measurements(3 site or 7 site)
- Vertical Jump Height (using one or more of the following methods)
 - o Vertec
 - o Jump mat

- o Wall (Sargent's Vertical Jump)
- o Squat jump
- o Countermovement Jump.
 - Maximum Push-Up's
 - o 1 minute
 - o 2 minutes
 - 1 Repetition Max (RM) Back Squat
 - 1 Repetition Max Bench Press
 - Maximum Pull-Up's and/or Maximum Pull-Up's with 40# weight vest
 - Maximum Curl-Up or Sit-ups
 - o 1 minute
 - o 2 minutes
 - 40 yard Sprint time
 - 300 meter Sprint time
 - 20 meter Multi-Stage Beep Test level attained
 - 1.5 mile Run time
 - Medicine Ball Chest Pass Distance(include weight of ball)
 - Pro-agility Test time
 - Agility T-Test time

Regards,

Corey Luby
NTOA

Marketing Specialist

APPENDIX C

DATA PERMISSIONS



NSCA[®]
National Strength and Conditioning Association

a nonprofit tax-exempt educational organization

Jay Dawes
3660 Arbor View Ct
Colorado Springs, CO 80918

Mr. Dawes,

6/3/2010

The NSCA Human Performance Center gives you permission to use the data collected from CSPD Tactical Enforcement Unit over the past several years. This data, while collected from several officers over several various testing dates, has been sanitized per your request in order to protect the identities and personal information of the individual officer.

The individual officers have signed off with permission to the NSCA for collection of and study of biometric and anthropometric numbers of each officer in order to compare and contrast their scores. In exchange, the NSCA would respectfully request the finished project summary of the data in order to further the knowledge of our staff and members as we attempt to better understand and serve this population in their fitness needs.

Respectfully,

Robb Rogers M.Ed., CSCS
Director Tactical Strength & Conditioning Program/Human Performance Center

MISSION STATEMENT

A the worldwide authority on strength and conditioning, we support and disseminate research-based knowledge and its practical application to improve athletic performance and fitness.

1885 Bob Johnson Drive • Colorado Springs, CO 80906 • Phone: 1-719-632-6722 or 1-800-815-6826 • Fax: 1-719-632-6367 • www.nsca-llc.org

From: Sam Todd <ssodd@neo.rr.com>

To: coachdawes@yahoo.com

Sent: Fri, July 23, 2010 7:27:33 AM

Subject: Team results

Coach

Sorry it took so long, here is what I could get from my teammates. Hope it helps I changed the names to just letters.

Sam

Sam Todd

President

Ohio Tactical Officers Assn

National Tactical Officers Assn

Central Region Director

330 620 8878

www.otoa.org

Remember

23rd Annual O.T.O.A Training Conference May 23-26, 2010 Westlake, OH

Force Science Seminar Aug 24 & 25, 2010 Cleveland, OH

OTOA Long Range Sniper Summer 2010

NTOA CNT Conference, May 18-21, 2010 Phoenix (AZ)

International Breachers Symposium, May 24-27, 2010 Tucson (AZ)

27th Annual Tactical Operations Conference, September 19-24, 2010, Pittsburgh (PA)

Sam Todd

Ohio Tactical Officers Assn

330 620 8878

ssodd@neo.rr.com

www.otoa.org

From: James Brandon [jamesbr@cctexas.com]
Sent: Thursday, January 06, 2011 1:35 PM
To: Dawes, Jay
Subject: RE: FW: Thank you

Jay,

I got your phone message from yesterday afternoon. I apologize for the delay. You may certainly use the data you gained from the team. I also don't mind speaking to the media about. We appreciate your help.

Captain James Brandon
Criminal Intelligence Unit
Corpus Christi Police Department
Office 361-826-2983
Cell 361-834-4051
Fax 361-886-2598
jamesbr@cctexas.com

Appendix D

CRITICAL PHYSICAL TASKS RELATED TO LAW
ENFORCEMENT AND THE UNDERLYING PHYSICAL
FITNESS COMPONENTS REQUIRED BY TASK

CRITICAL PHYSICAL TASKS RELATED TO LAW
ENFORCEMENT AND THE UNDERLYING PHYSICAL
FITNESS COMPONENTS REQUIRED BY TASK (CIAR, 2006)

JOB TASK	UNDERLYING FITNESS COMPONENTS
Sustained Pursuit	Aerobic Power
Sprints	Anaerobic Power
Dodging	Aerobic; Anaerobic Power; Flexibility
Lifting and carrying	Muscular Strength; Muscular Endurance; Anaerobic Power
Dragging and Pulling	Muscular Strength; Muscular Endurance; Anaerobic Power
Pushing	Muscular Strength; Muscular Endurance; Anaerobic Power
Jumping and Vaulting	Anaerobic Power; Leg Power and Strength
Crawling	Flexibility; Muscular Endurance; Body Fat Composition
Use of Force < 2min.	Anaerobic Power; Muscular Strength; Muscular Endurance
Use of Force > 2min.	Aerobic Power; Muscular Strength; Muscular Endurance

Appendix E

PROPOSED UNDERLYING PHYSICAL
FITNESS COMPONENTS REQUIRED TO
PERFORM ESSENTIAL JOB FUNCTIONS OF SWAT

PROPOSED UNDERLYING PHYSICAL FITNESS COMPONENTS REQUIRED TO
PERFORM ESSENTIAL JOB FUNCTIONS OF SWAT

ESSENTIAL JOB FUNCTIONS OF SWAT	UNDERLYING FITNESS COMPONENTS
Crawling	Agility; Flexibility; Muscular Endurance; Body Composition
Jumping over, off or across obstacles	Anaerobic Power; Leg Power and Strength
Maintaining balance while traversing a narrow object or wall	Muscular Strength; Muscular Endurance; Agility
Maintaining a tactical position for an extended period of time and remaining alert	Muscular Endurance
Climbing fences, walls, elevator shafts, and multiple flights of stairs, ladders, fire escapes, ropes, poles and trees to gain an objective or tactical position	Aerobic Power; Anaerobic Power; Muscular Strength; Muscular Endurance; Agility; Body composition
Lifting and carrying necessary equipment -rams, breaching tools, ladders, shields over rough terrain (snow) a reasonable distance (400 yards)	Muscular Strength; Muscular Endurance; Anaerobic Power ; Agility
Lifting; dragging wounded officers; citizens to safety in a reasonable time across a reasonable distance.	Agility; Aerobic Power; Anaerobic Power; Muscular Strength; Muscular Endurance
Running to escape an area of danger or to cross an open area.	Aerobic Power; Anaerobic Power; Agility
Running to pursue a suspect or rescue a hostage.	Aerobic Power; Anaerobic Power ; Agility
Functioning up on roof tops, ledges and high positions.	Agility
Functioning in crawl spaces, tunnels, vents, shafts, etc.	Agility; Flexibility; Muscular Endurance; Body Composition
Low and high crawling to objectives (100 yards)	Agility; Flexibility; Muscular Endurance; Body Composition

Sources: CIAR, 2006; Dawes et al, 2011; Hoffman and Collingwood, 1998; U.S. Marine Corp, 1988; FitForce™, 2007

Appendix F

Percentile Rankings for Tactical Officer

PERCENTILE RANKING FOR BODYFAT% FOR SAMPLE
OF TACTICAL OFFICERS(n=24)

RANK	SCORE
75 th	10.99
50 th	14.73
25 th	18.48

PERCENTILE RANKING FOR 1 RM BENCH PRESS FOR SAMPLE
OF TACTICAL OFFICERS (n=21)

RANK	SCORE
75 th	289.96
50 th	250.71
25 th	211.46

PERCENTILE RANKING FOR 1 RM BENCH PRESS RATIO FOR SAMPLE
OF TACTICAL OFFICERS (n=21)

RANK	SCORE
75 th	1.36
50 th	1.25
25 th	1.14

PERCENTILE RANKING FOR 1-MINUTE PUSH-UP SCORES FOR SAMPLE
OF TACTICAL OFFICERS (n=21)

RANK	SCORE
75 th	63.13
50 th	58.10
25 th	53.06

PERCENTILE RANKING OF 1-MINUTE SIT-UP SCORES FOR SAMPLE
OF TACTICAL OFFICERS (n=21)

RANK	SCORE
75 th	69.15
50 th	49.52
25 th	29.89

PERCENTILE RANKING OF MAXIMAL PULL-UPS SCORES FOR SAMPLE
OF TACTICAL OFFICERS (n=41)

RANK	SCORE
75 th	14.19
50 th	10.58
25 th	6.97

PERCENTILE RANKING OF 2-MINUTE PUSH-UP SCORES FOR SAMPLE
OF TACTICAL OFFICERS (n=65)

RANK	SCORE
75 th	86.45
50 th	74.46
25 th	62.47

PERCENTILE RANKING OF 2-MINUTE SIT-UPS FOR SAMPLE
OF TACTICAL OFFICERS (n=47)

RANK	SCORE
75 th	88.39
50 th	82.69
25 th	77.00

PERCENTILE RANKING OF VERTICAL JUMP HEIGHT FOR SAMPLE OF
TACTICAL OFFICERS (n=47)

RANK	SCORE
75 th	27.68
50 th	24.85
25 th	22.02

PERCENTILE RANKING OF 300 METER RUN FOR SAMPLE OF TACTICAL OFFICERS (n=59)

RANK	SCORE
75 th	47.35
50 th	52.35
25 th	57.94

PERCENTILE RANKING OF 1.5 MILE RUN TIME FOR SAMPLE OF TACTICAL OFFICERS (n=21)

RANK	SCORE	EST. VO2 MAX
75 th	10.33	49.28
50 th	11.20	46.12
25 th	11.28	45.62

PERCENTILE RANKING OF ILLINOIS AGILITY SHUTTLE TIME FOR SAMPLE OF TACTICAL OFFICERS (n=21)

RANK	SCORE
75 th	14.59
50 th	15.27
25 th	15.55

PERCENTILE RANKING OF PRO-AGILITY SHUTTLE FOR SAMPLE OF
TACTICAL OFFICERS (n=21)

RANK	SCORE
75 th	5.06
50 th	5.15
25 th	5.24

VITA

James Jay Dawes

Candidate for the Degree of

Doctor of Philosophy

Thesis: A DESCRIPTION OF THE ANTHROPOMETRIC AND PHYSIOLOGICAL
PROFILE OF TACTICAL OFFICERS

Major Field: Health, Physical Education and Leisure

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Health, Physical Education and Leisure at Oklahoma State University, Stillwater, Oklahoma in July, 2011.

Completed the requirements for the Master of Science in Health, Physical Education and Leisure at Oklahoma State University, Stillwater, Oklahoma in August, 2002.

Completed the requirements for the Bachelor of Science in Business Administration at University of Science and Arts of Oklahoma, Chickasha, Oklahoma in May 1999.

Experience: Is currently a Clinical Assistant Professor at Texas A & M University- Corpus Christi (2010-Present). Served as the Director of Education for the National Strength and Conditioning Association, in Colorado Springs, CO.(2007-2010). Was the founder/ head performance coach for the 180 Center for Health and Performance in Oklahoma City, Oklahoma

Professional Memberships: National Strength and Conditioning Association, American College of Sports Medicine, USA Weightlifting, IDEA Health and Fitness

Name: James Jay Dawes

Date of Degree: July, 2011

Institution: Oklahoma State University

Location: Stillwater, Oklahoma

Title of Study: A DESCRIPTION OF THE ANTHROPOMETRIC AND
PHYSIOLOGICAL PROFILE OF TACTICAL OFFICERS

Pages in Study: 139

Candidate for the Degree of Doctor of Philosophy

Major Field: health, Physical Education and Leisure

Scope and Method of Study:

The purpose of this study was investigate the current physical and performance characteristics of tactical officers on full-time, part-time and multi-jurisdictional teams and to identify the underlying physical fitness components required to perform the essential job-tasks of SWAT. A descriptive statistical analysis, One-way ANOVA with Tukeys' post-hocs and independent sample t-tests were used to compare differences in mean anthropometric and performance scores among three groups of tactical officers. In addition, a discriminate analysis with stepwise linear regressions was used to predict group membership. One sample t-tests were utilized to determine differences between the mean scores of the tactical officers and traditional law enforcement officers, as well as the Cooper Single Standard -Fitness Norms.

Findings and Conclusions:

The full-time tactical officers had significantly less fat mass and scored significantly better on measures of muscular endurance and anaerobic power than both the part-time and multi-jurisdictional tactical officers. In all cases the tactical officers scored significantly better on measures of body composition, muscular strength, muscular endurance, anaerobic power and aerobic power when compared to traditional law enforcement officers and the Cooper Single Fitness Norms at the 50th percentile.

ADVISER'S APPROVAL: Steven W. Edwards
