

**The Effects of Fitness Experts and Exercise Facilities on Physical Fitness in the Officer
Candidate School Population**

by

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Abstract

Introduction:

The Army recently overhauled its approach to physical fitness. A newly introduced training methodology called Holistic Health and Fitness (H2F) seeks to integrate novelties such as the use of certified fitness experts to program physical training and fully equipped training facilities. The Tactical Athlete Performance Center (TAP-C) located on Fort Benning, Georgia, provides physical training capabilities that share similarities to the H2F initiative. The Officer Candidate School (OCS) at Fort Benning, Georgia is a unit the TAP-C professionals have trained. The purpose of this study is to determine the difference between non-expert and fully resourced, expert driven physical training outcomes in the Officer Candidate School population. The results of this study may serve to inform tactical athlete organizations of considerations when establishing similar programs.

Materials and Methods:

A retrospective cohort study design was used to determine the effect of a 12-week fully resourced physical training program designed by certified fitness experts on fitness of 228 officer candidates, as compared to the traditional, less-resourced physical training plan designed and led by OCS cadre on Army Combat Fitness Test (ACFT) performance and additional TAP-C physical performance measures. Analysis of covariance (ANCOVA) was used to evaluate main effects of company on the ACFT and TAP-C physical test battery.

Results:

The comparison group performed significantly better on the overall ACFT and on the ACFT events of Hand-Release Push-Ups, Sprint-Drag-Carry, Leg Tuck, and 2-Mile Run. The intervention group performed significantly better on the 3-Repetition Maximum Deadlift and on the TAP-C physical tests of Standing Broad Jump, Mobility Assessment, and Grip Strength. There was no significant effect of either group on the performance of the Standing Power Throw or Maximum Pull-Up tests.

Conclusions:

The effects of a 12-week fully resourced physical training program designed by fitness experts varied depending on the specific physical fitness assessment. Movement quality significantly improved when officer candidates received fitness expert coaching. Officer candidates with access to strength training equipment were significantly stronger than their counterparts without access. The results of this study support the full integration of fitness experts into physical training programs to coach movement and program diversified physical training. Access to strength training equipment to optimize strength adaptations is also supported.

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List of Abbreviations

2MR, Two-mile run

ABCP, Army Body Composition Program

AC, Active Component

ACFT, Army Combat Fitness Test

ANCOVA, Analysis of Covariance

APFT, Army Physical Fitness Test

AR, Army Regulation

ARNG, Army National Guard

ATP, Army Technical Publication

BMI, Body Mass Index

CSCS, Certified Strength and Conditioning Specialist

CST, Common Soldier Tasks

CU, Chin-ups

FM, Field Manual

GS, Grip Strength

H2F, Holistic Health and Fitness

HRP, Hand Release Push-Up

IET, Initial Entry Training

LTK, Leg Tuck

MDL, Three Repetition Maximum Deadlift

MFT, Master Fitness Trainer

MS, Mobility Assessment

MSKI, Musculoskeletal Injury/ Injuries

NHIS, National Health Interview Survey

NSCA, National Strength and Conditioning Association

OCS, Officer Candidate School

RA, Regular Army

SBCT, Stryker Brigade Combat Team

SBJ, Standing Broad Jump

SDC, Sprint Drag Carry

SMCT, Soldier Manual Combat Tasks

SPRC, Soldier Performance Readiness Center

SPT, Standing Power Throw

STP, Soldier Training Publication

TAP-C, Tactical Athlete Performance Center

USAR, Army Reserve

WRC, Warrior Research Center

WTBD, Warrior Tasks and Battle Drills

Chapter 1: Introduction

Members of the United States Army are required to participate in rigorous physical activity to ensure they are prepared to meet the physical and mental demands of their job. During peace time, the physical fitness of Soldiers' is reflected in their resiliency to stress and ability to perform the physical tasks associated with their job. In combat, all the fitness measures of peace time apply but are exacerbated in that the outcome may result in failure or success of a real-world mission. Physical fitness is at the core of military service and will always be a vital component of the Army's readiness.

The Army's physical fitness training doctrine is included in Field Manual (FM) 7-22, *Holistic Health and Fitness*.¹ Doctrine in the military provides a common framework of Army accepted techniques and procedures for Soldiers to reference. Adherence to doctrine is not mandated by the military; however, it does capture and consolidate what the military finds to be the best practices in a particular area of focus. A preponderance of physical training programs across the Army are created in accordance with physical fitness doctrine by junior leaders within a unit, approved by that unit's commander, and then executed within that unit. The physical training programs are designed to first address the physical tasks that are unit specific (infantry, aviation, finance, etc.), and to second account for the varying physical training needs of each Soldier within that job field. An example of tailoring a fitness plan for individual needs would be dividing Soldiers into two groups, one group that needs to focus on muscular strength and one group that needs to improve aerobic endurance. Training plans must also account for the tumultuous Army lifestyle, including extended unit training events, deployments to foreign countries, high personnel turnover, and lengthy leave periods. Creating an effective physical training program that accounts for all of the aforementioned variables is an arduous task that is

predominantly assigned to Soldiers based on rank and duty position opposed to level of physical fitness training expertise.

The Army uses a standardized fitness test to assess the fitness level of Soldiers. The results of the fitness test are a critical component of evaluation for promotions, job positions, and career advancing military school opportunities.¹⁻³ The Army Combat Fitness Test (ACFT) became the Army's fitness test of record as of October 2020.¹⁻⁵ The ACFT replaced the Army Physical Fitness Test (APFT), which served as the Army's fitness test of record since 1980.^{1,6,7} The ACFT is designed to better assess the ability of Soldiers to conduct physical tasks associated with ground combat.^{1,4} The more comprehensive nature of the ACFT, as compared to the APFT, is apparent in both the increased number of events and in the diversity of the fitness components tested by the events.^{1,2,4,5} The APFT consists of three events designed to assess muscular endurance and aerobic endurance: push-ups, sit-ups, and two-mile run.^{1,2} The ACFT consists of six events: three-repetition maximum deadlift, standing power throw, hand release push-up, sprint-drag-carry, leg tuck, and two-mile run.^{4,5} The ACFT assesses muscular strength, explosive power, agility, balance, flexibility, and anaerobic endurance in addition to muscular endurance and aerobic endurance.^{1,4,5}

The implementation of the ACFT presents an opportune time for the Army to explore innovative physical fitness training methods and strategies that deviate from the status quo. Army leaders universally seek physical fitness programs that are effective, mitigate risk of overuse and acute injury, and maximize results for training time invested. The programs must be tailorable to address the physical capabilities and needs of a diverse Soldier population; from those in Initial Entry Training (IET) to those with multiple years in service. They must also be conducive for Soldier physical health over a career of service. It is well established in the

literature that Soldiers are more likely to develop musculoskeletal injuries (MSKI) than their non-veteran counterparts, and the onset and severity of MSKIs becomes exponentially worse with increased age.⁸⁻¹⁰ The research literature also suggests Soldiers with higher physical fitness levels are less likely to become injured.¹¹ There are two problems that are pervasive across Army physical fitness training that if corrected may contribute to improving the physical performance and health of Soldiers: 1) physical training too frequently does not optimize results for the time and resources invested; and 2) it does not best promote Soldier physical health both in the present and throughout a career of service. These problems are linked to the fact that the individuals who create and execute training programs across the Army are typically not certified physical fitness experts, and the demand for physical fitness facilities and equipment at the unit level routinely exceeds the resources available. Therefore, physical fitness training concepts that maximize training results and efficiency while minimizing injury could be of great benefit to the Army.

The Tactical Athlete Performance Center (TAP-C) offers strength and conditioning expertise and a fully equipped, state-of-the-art-facility to Army units on Fort Benning, Georgia. The purpose of the TAP-C is to “increase lethality through physical dominance;” and to “increase readiness by reducing musculoskeletal injuries in order to improve the unit’s mission capability in the operational force.”¹² It is novel because it services Army units that typically do not have access to these resources. One of these units is 3rd Battalion 11th Infantry Regiment, Officer Candidate School (OCS). Candidates who successfully matriculate through OCS are commissioned as Second Lieutenants in the United States Army. The OCS and TAP-C leadership coordinated for a portion of officer candidates to be physically trained by the TAP-C. This agreement set the conditions for the Soldiers selected for TAP-C physical training to have

their fitness programs created and implemented by fitness experts in a dedicated space free of resource competition. This training model is often sought after by leaders across the Army and shares many similar attributes of Army fitness initiatives that are conceptual or in the early stages of implementation. The resulting training effects of the TAP-C program may serve to inform invested parties of considerations as the Army shapes its future of physical fitness training. Thus, the purpose of this study was to determine the difference between non-expert and fully resourced, expert driven physical training outcomes in the Officer Candidate School population.

Specific aims:

Determine if fully resourced fitness experts influence the fitness outcomes of OCS candidates compared to traditional OCS physical training practices:

Aim 1: ACFT performance of OCS candidates.

Aim 2: Performance-oriented measures of OCS candidates: grip strength, broad jump, maximum chin-up, and mobility tests.

Hypotheses:

Hypothesis 1: An OCS company-level physical fitness intervention designed by fitness experts resourced with a dedicated fitness facility will increase the scores on all six ACFT events: 3 Repetition Maximum Deadlift, Standing Power Throw, Hand-Release Push-up, Sprint-drag-carry, and Leg Truck; and 2 mile run score.

Hypothesis 2: An OCS company-level physical fitness intervention designed by fitness experts resourced with a dedicated fitness facility will: a) improve grip strength; b) increase broad jump distance; c) increase maximum pull-up number; and d) improve mobility

Chapter 2: Literature Review

Introduction

Physical fitness in the United States Army is of paramount importance. It speaks to the readiness of Soldiers to physically and mentally endure the stressors of combat and accomplish their missions.¹³⁻¹⁵ The Army uses physical fitness as a discriminator when selecting Soldiers for promotions, competitive jobs, and military schools because it is such an integral part of the profession. A lack of physical fitness is associated with numerous problems. The biggest problem is the Army cannot best serve the Nation if Soldiers lack the ability to complete their required tasks. Soldiers that lack the fitness to do their job present a liability to their unit and mission. The successful performance of each individual job is vital to the collective success of the unit. Physically fit Soldiers perform better under combat-like stressors than those who are less physically fit.¹³⁻¹⁵ An increase in physical fitness is also associated with a decrease in musculoskeletal injury (MSKI) occurrences in tactical athlete populations.^{1,11,16-22} Soldiers who are deemed unfit to perform their job as required are considered non-deployable. Seventy percent of Soldiers classified as non-deployable in 2018 were non-deployable due to medical concerns.¹⁹ A majority of those medical concerns were MSKI or behavioral health related.¹⁹ The effects of MSKIs are not fleeting. Soldiers who experience MSKIs are at a greater risk of suffering future physical disabilities than those who suffered fewer or no MSKIs.^{23,24}

The Holistic Health and Fitness (H2F) initiative effective October 2020 reformed the Army's physical fitness program. The reformation includes transitioning from generic to individualized physical training plans; the incorporation of physical fitness experts; and the allocation of dedicated state-of-the-art fitness facilities at the unit-level. These sweeping changes arrived in conjunction with the implementation of the Army Combat Fitness Test (ACFT). The

comprehensive nature of the ACFT reinforces the momentum to modernize and integrate the H2F reforms. The H2F initiative is new to the Army, so there is little known about the effects it will have on performance at the Soldier and unit level. The Tactical Athlete Performance-Center (TAP-C) on Fort Benning, Georgia is not linked to the H2F initiative, but shares many of the same attributes. It is a fully-equipped, modern fitness facility staffed with certified fitness experts. The TAP-C is capable of supporting physical training at the unit level, while endeavoring to ensure training plans are individualized. The TAP-C also trains the same populations the H2F initiative is specifically designed to benefit, conventional and training forces. The results of the TAP-C experts training the Officer Candidacy School (OCS) candidates over a 12-week period may offer critical insights into the H2F initiative. Research examining the effects of a dedicated state-of-the-art center fully equipped and staffed with experts in the fields of human performance and exercise science on the fitness levels of tactical athletes is not yet available. This study will provide important information as many tactical organizations seek to transition to unit level physical fitness programs, designed by fitness experts, and well-resourced in both the type and quantity of equipment available with accessibility that meets the wide-range of work schedule demands.

Impacts of Physical Fitness in the Army

Physical Fitness and Career

Soldier physical fitness is inextricably linked to combat readiness in the Army because of the inherent physical demands associated with the profession.^{1,3,22} The volatile condition of the world requires Soldiers to be physically ready to accomplish their mission anywhere in the world with minimal or no notice. Both combat and realistic combat training environments often require

Soldiers to engage in prolonged physical activity while in a state of sleep deprivation and negative energy balance.²⁵⁻²⁸ The literature supports that physically fit Soldiers are able to physically and psychologically endure military assessments designed to replicate many of the stressors that accompany combat scenarios better than those who are less physically fit.¹³⁻¹⁵

The Army recognizes the relationship between Soldier fitness and performance, thus physical fitness is used as a discriminator for career progression and opportunities. The official Army physical fitness test and a body mass index (BMI) assessment is used to standardize physical fitness measurement across the force.^{1,3} Army regulation mandates that Soldiers who fail to meet the minimum established physical fitness test and BMI²² standards have all favorable career advancing actions suspended.³ Fitness test scores are also factored into rankings for merit lists for selection to attend various career enhancing military schools (Ranger, Airborne, Air Assault, etc.). A majority of the more physically rigorous military schools²⁹ and selective Army units (Rangers, Special Forces, etc.)³⁰ have additional physical tests used to provide a more comprehensive Soldier fitness assessment.

The Army culture respects high levels of fitness. Appearing and being physically fit is an expected Soldier and leader attribute.^{1,31} Routine unit physical readiness training sessions are when physical fitness reputations are informally established within the unit. That subjective reputation is often factored in by superiors when completing job performance evaluations for their subordinates. These performance evaluations are ultimately used by the Army to determine promotion potential. Therefore, physical fitness likely influences career progression beyond just performance on the established fitness tests.

Physical Fitness and Musculoskeletal Injuries

Improved physical fitness is shown to reduce the number and severity of MSKI incidents in tactical athlete and athlete populations.^{1,11,16-22} Reducing MSKIs across the force will greatly increase the Army's combat readiness. The Army Public Health Command states that MSKIs "occur when energy (physical stress) applied to bones, muscles, tendons, joints, ligaments, cartilage, or associated tissues exceeds the capacity for normal tissue function."³² Decreasing MSKIs across the Army could markedly improve the Army's overall ability to deploy and fight. Medical problems accounted for 70 percent of all active component (AC) Soldiers that were non-deployable in 2018.¹⁹ A majority of the medical problems were classified as MSKI and behavioral health related.^{19,33} Army researchers estimated that within the span of a year, 2019 to 2020, over 50 percent of AC Soldiers will experience one or more MSKI conditions.¹⁹ This statistic equates to an aggregate of 10 million days of Soldiers being medically limited in performing their duty.¹⁹ Soldiers who are medically limited both degrade combat readiness and burden the Army medical system, requiring roughly two million medical encounters to provide MSKI related care.¹⁹ It is noteworthy that 17 percent of AC Soldiers were found to be obese based on BMI data. Obesity is associated with a 48 percent and 86 percent increase in likelihood of experiencing a MSKI or becoming medically limited in ability to perform duty, respectively.¹⁹

Musculoskeletal Injuries and the Military Population

MSKIs have immediate and long-term effects. There is conclusive evidence that past MSKIs are highly predictive of future physical disability.^{23,24} The number of MSKI pain sites reported is found to be an even stronger predictor of future disability 14 years later than severity of injury or specificity of diagnoses.²³ The deleterious long-term impact of MSKI goes beyond

physical disability, as both mental health and sleep quality have been found to also decline as the number of MSKI pain sites increases.³⁴ Obesity is also found to be a predictor of increased risk of disability later in life.²⁴

The literature unequivocally supports that the most common type of MSKI in the military is associated with overuse.^{19,35-39} MSKIs resulting from overuse are described by the Army Public Health Command as collective micro-trauma caused by the repetitive application of low-intensity force over time.³² A majority of overuse MSKIs are caused by a lack of recovery time after exercise, excessive physical exertion of a particular muscle group, or excessive overall physical training volume.³⁹ It was found that 82 percent of the 743,547 MSKIs identified across the Air Force, Army, Marines, and Navy in 2006 were overuse.³⁶ In 2018, overuse injuries accounted for 71 percent of injuries within the Army.¹⁹ Load carriage and repetitive lifting were found to be the two primary MSKI risk factors associated with Soldiers from a Stryker Brigade Combat Team (SBCT) deployed to Afghanistan for 12 months.^{40,41} The researchers identified the Soldiers in the study were able to lift more weight (22.7 kg versus 36.4 kg) than their civilian counterparts before succumbing to injury,⁴¹ underscoring how physical fitness (strength in this instance) can raise the overuse injury threshold. Additionally, the authors reason that healthy Soldiers will have to do more physical work to compensate for the injured Soldiers in their unit, which in turn increases their risk of experiencing an overuse MSKI.⁴¹

Reducing MSKIs during military service will likely lessen the rate and severity of Veteran suffering in the future. The results from a study⁹ using data from the 2013 National Health Interview Survey (NHIS) indicate that Veterans will live with years of higher levels of physical pain, less mobility, and a lower quality of life than their non-veteran counterparts. The researchers posited that the disparity in wellness can be attributed to the higher number of

physical risk factors associated with military service compared to most non-military jobs.⁹ Veteran health and long-term quality of life may be improved by decreasing the number and severity of MSKIs experienced during military service through appropriate physical fitness training.

Official Army Measurement of Soldier Physical Fitness

Army Physical Fitness Testing and Body Composition Policy

Soldiers are mandated by Army Regulation (AR) 350-1 *Army Training and Leader Development*³ to take the Army's official physical fitness test. The regulation directs that Soldiers take the test twice a year with at least four months of separation between tests.³ Commanders may administer a test within the four month window to Soldiers who fail to meet the minimum test standards listed in Army Techniques Publication (ATP) 7-22.01 *Holistic Health and Fitness Testing* or require a make-up test.^{3,5} The spacing requirements by time are nested to support the Army's intent for Soldiers to be tested every six months.³ There are instances where Soldiers are unable to meet these requirements due to extenuating circumstances, such as medical reasons (e.g., fractured bone or pregnancy). Commanders make allowances for these Soldiers on a case by case basis in accordance with AR 600-8-2 *Suspension of Favorable Personnel Actions (Flag)*.⁴² Soldiers who fail the test or do not take the test because of conditions that are within their control will be "flagged," which means to have all favorable personnel actions (e.g., awards, promotions, and possibly changes in duty station) suspended.⁴² These Soldiers will be retested within 90 days of the date they failed the test.³ Repetitive physical fitness test failure will ultimately result in involuntary separation from service.

Soldiers must adhere to the Army body composition standards outlined AR 600-9 *The Army Body Composition Program*.²² The Army Body Composition Program (ABCP) provides Army leaders with a methodical framework to enforce the body composition standard.²² It also provides resources to Soldiers who need assistance achieving and maintaining the standard.²² There are individual cases where Soldiers are temporarily or permanently exempt from the ABCP regulatory requirements, such as limb amputation, pregnancy, or extended hospitalization.²² Soldiers undergo body fat screening a minimum of every six months to ensure they are within the standard.²² The screening is initiated with the measurement of bodyweight and height.²² If a Soldier's bodyweight does not exceed what is authorized for his or her age on the Army's weight for height table, no further body fat assessment is required.²² If the Soldier's bodyweight exceeds what is authorized, further body fat assessment will be conducted using the circumference-based tape method, which is the only technique authorized by the Army to estimate body fat.²² It uses the height and circumferences of specific body parts to arrive at an estimate.²² The physical fitness test and body fat screening are frequently scheduled together because they are both required every six months. Soldiers deemed by their commander to not present a proper Soldier appearance may be directed to be screened to determine if they are meeting the standard.²² Those who exceed their respective body fat standard are flagged in the same manner as Soldiers who fail to meet the physical fitness test standard, and enrolled in the ABCP.²² Soldiers in the ABCP receive exercise programming guidance from the unit physical fitness representative, counseling from a registered dietitian, and access to other fitness and wellness experts and centers when available.²² Substandard Soldiers remain in the ABCP until they meet the standard or are involuntarily separated from service for repetitive failures.²²

Army Combat Fitness Test - Army's New Official Physical Fitness Test

The ACFT became the Army's official physical fitness test effective 1 October 2020.^{4,5} The ACFT is intended to be predictive of Soldiers' ability to physically perform fundamental Soldier tasks.^{1,43} These tasks are tied to readiness for ground combat and survivability on the battlefield.^{1,44} They are referred to in the Army as Warrior Tasks and Battle Drills (WTBD) and Common Soldier Tasks (CST).^{1,44} The ACFT events were designed to be reflective of the most physically demanding aspects of all the WTBDs.^{1,43} A comprehensive list of these WTBDs can be found in Soldier Training Publication (STP) 21-1-Soldiers Manual of Common Tasks (SMCT) *Warrior Skills Level 1*.⁴⁴

The ACFT replaced the Army Physical Fitness Test (APFT).¹ The APFT served as the Army's official fitness test since 1980.^{6,7} The APFT consists of three events administered in the following order: push-ups, situ-ups, and 2-mile run.² The test must be completed within a 120 minute period.² Soldiers receive between 10 and 20 minutes of rest between each event.² A minimum aggregate score of 180 points with at least 60 points in each event is required to pass.³ The raw score for each event is adjusted to account for sex and age differences when assigned the number of points earned.² The Army ultimately replaced the APFT with the ACFT because senior military leaders wanted a physical fitness test that better measured Soldiers' ability to successfully execute all physical tasks associated with their specific job, regardless of sex or age.⁴⁵ There is not compelling evidence linking the APFT events and scores to Soldiers' performance of physically demanding WTBDs.^{1,45} Furthermore, the standardized physical performance of Soldiers is not available for ease of comparison across the Army because APFT provides scoring based on age and sex.²

Army Combat Fitness Test: Event Description, Fitness Component, Major Muscles Involved, and Linked Soldier Tasks

The physical readiness components the Army¹ uses to classify physical abilities or demands largely align with the components of athletic performance used by the National Strength and Conditioning Association (NSCA).⁴⁶ The Army components are muscular strength, hypertrophy, muscular endurance, aerobic endurance, power, and anaerobic endurance.¹ The Army¹ also details a list of foundational attributes that must be established or present before physical training can be initiated. They include agility, coordination, dynamic balance, kinesthesia, pace, load tolerance, flexibility, static balance, and body composition.¹ Many of these structural requirements coincide with physical fitness components or other fitness characteristic discussed in NSCA literature.⁴⁶ The NSCA athletic performance components are maximum muscular strength, local muscular endurance, aerobic capacity, anaerobic or maximum muscular power, anaerobic capacity, speed, agility, flexibility, balance, stability, body composition, and anthropometry.⁴⁶ The NSCA component terminology will be used during discussion in this dissertation when there is a discrepancy because it is more commonly used in the exercise science community than Army terminology. The NSCA term will have the equivalent definition of the Army term it replaced when substitution occurs.

ACFT Event 1: Three Repetition Maximum Deadlift (MDL).

Figure 1.5 Illustration of three repetition maximum deadlift



The MDL ACFT event is meant to replicate movement patterns necessary to properly lift and move heavy objects from the ground, such as carrying a litter with a casualty or lifting weighty equipment or people.^{4,5} The MDL requires a steel hexagon bar, bumper plates (steel weights covered with rubber), and bar collars (metal or plastic clamps that secure the weights on the bar) to perform.^{5,43} Soldiers execute three deadlift repetitions consecutively to meet the requirements for a MDL attempt.⁴³ The Army’s instructions for the MDL are as follows:⁵

Preparatory phase: on the command, “GET SET,” the Soldier steps inside the hex bar, feet shoulder width apart, and locates the mid-point of the hex bar handles. The Soldier bends at the knees and hips, reaches down, and grasps the center of the handles using a

closed grip. Arms are fully extended, back is flat, head aligns with the spine or is slightly extended, and heels are in contact with the ground. Each repetition begins from this position.

Upward movement phase: on the command, “GO,” the Soldier lifts the bar by straightening the hips and knees in order to reach the Straddle Stance. The hips should not rise before or above the shoulders. The back should remain straight—not rounded out or flexed. The feet remain in the same position. The Soldier and the weight must remain balanced and controlled throughout the movement.

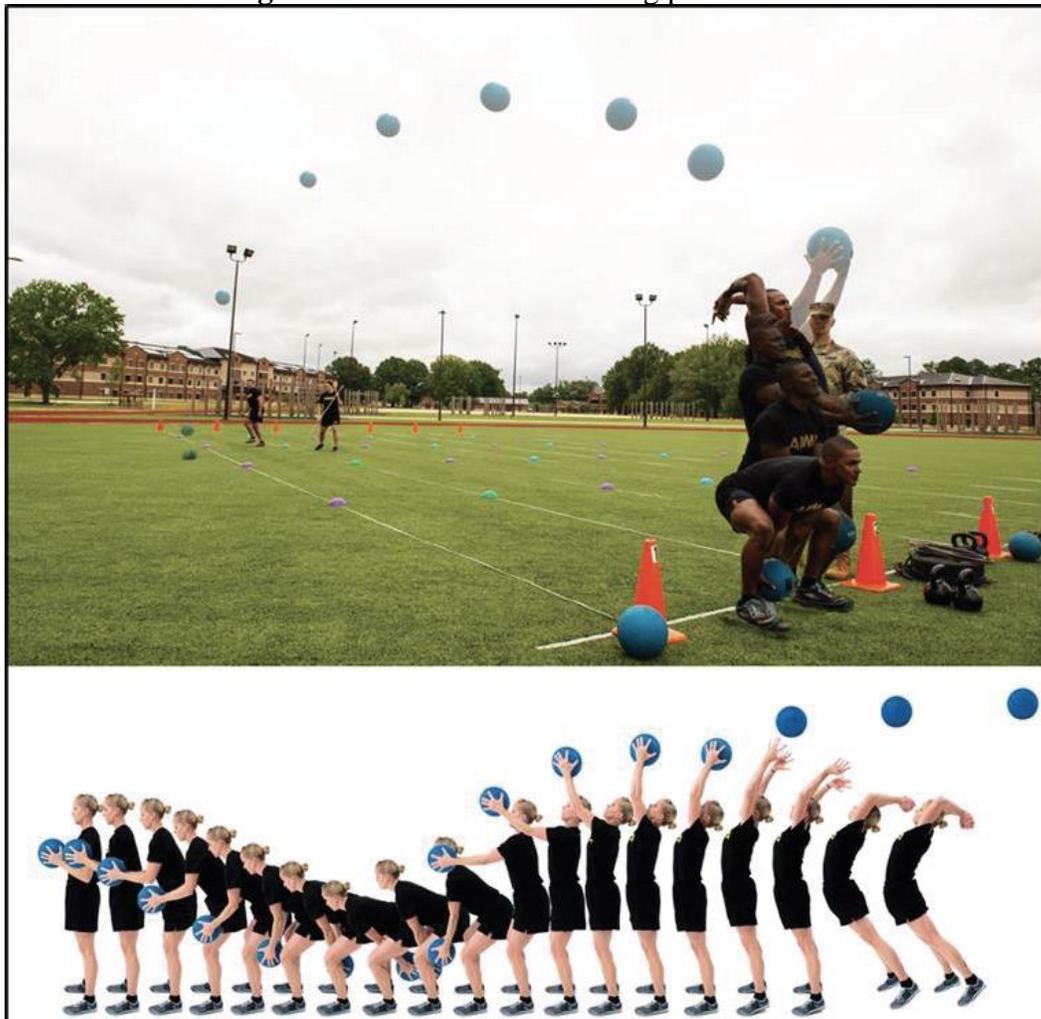
Downward movement phase: after reaching the Straddle Stance position, the Soldier lowers the bar back to the ground under control while maintaining a straight back. The bar must be placed on the ground and not dropped. The weight plates must touch the ground to complete a repetition.

The MDL measures the fitness components of maximum muscular strength, balance, and flexibility.^{4,5,46} The primary muscles involved in this event are the gluteus maximus, hamstring muscles (semimembranosus, semitendinosus, and biceps femoris), quadriceps femoris muscles (vastus lateralis, vastus intermedius, vastus medialis, and rectus femoris), and major calf muscles (gastrocnemius and soleus).⁴⁶ Activation of these muscles causes hip extension, knee extension, and ankle plantar flexion at the hip, knee, and ankle joints respectively during the concentric or “upward” movement phase of the lift.⁴⁷ The eccentric or “downward” movement phase uses the same muscle groups but with hip flexion, knee flexion, and dorsi flexion occurring at the hip, knee, and ankle joints respectively.⁴⁷ The erector spinae will also be very active to maintain a neutral spine and rigid torso during movement.^{46,47} The movement pattern for this exercise is more similar to a back squat than a barbell deadlift. The lateral grip used on the hex bar during

the MDL more naturally aligns the lifter's center of mass (weight) and base of support (ground contact) without having to compensate for an anteriorly positioned barbell.

ACFT Event 2: Standing Power Throw (SPT).

Figure 2.5 Illustration of standing power throw



The SPT ACFT event is designed to assess the explosive power required to complete common Soldier tasks such as “jumping across a ditch, executing a buddy drag, throwing equipment over an obstacle, throwing a hand grenade, assisting a buddy to climb up a wall, loading equipment, and employing progressive levels of force in hand-to-hand contact.”⁵ The

SPT requires one hard rubber medicine ball that is 10 pounds in weight and nine inches in diameter with a textured surface; a 30 meter long measuring tape with meter and centimeter increments; and a visible line marked on the ground.^{5,43} A SPT attempt is executed in accordance with the instructions listed below. The ball's point of impact on the ground is marked and measured by a grader given no faults are assessed.⁵ The Army's instructions for SPT completion are as follows by phase:⁵

Preparatory phase: The Soldier faces away from the throw line, grasps the medicine ball (10 pounds) with both hands at hip level, and stands with heels at (but not on or over) the start line. To avoid having the ball slip, the Soldier grasps firmly and as far around the sides of the ball as possible. The Soldier may grasp under the ball. The Soldier may make several preparatory movements, bending at the trunk, knees, and hips while lowering the ball almost to the ground.

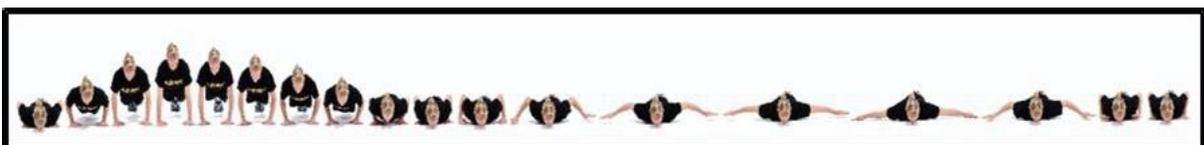
Throwing phase: After the preparatory phase, the Soldier moves quickly and powerfully to throw the ball backwards and overhead. The Soldier must be stationary prior to a throw—no hopping, stepping, or running to initiate the throw. The Soldier may jump to exert more power during the throw with one or both feet leaving the ground. If the Soldier falls or steps onto or beyond the start line, the grader records the repetition as a zero.

The SPT measures the fitness components of anaerobic power, balance, and flexibility.^{4,5,46} The primary lower body muscles involved in this event are the gluteus maximus, hamstring muscles (semimembranosus, semitendinosus, and biceps femoris), quadriceps femoris muscles (vastus lateralis, vastus intermedius, vastus medialis, and rectus femoris), and major calf muscles (gastrocnemius and soleus).⁴⁶ The concentric activation of these muscles during the

throwing phase causes hip extension, knee extension, and ankle plantar flexion during the concentric or “throwing” phase of the event.⁴⁷ The primary upper body muscles involved in the SPT are the anterior deltoid, pectoralis major, coracobrachialis, and erector spinae. The concentric activation of these muscles causes shoulder flexion and back extension and stabilization.⁴⁷

ACFT Event 3: Hand Release Push-Up – Arm Extension (HRP).

Figure 3.⁵ Illustration of hand release push-up – arm extension



The HRP ACFT event is designed to gauge the upper body muscular endurance required to sustain common Soldier tasks that require repetitive pushing, and reaching from the prone position.^{4,5} Examples of pushing tasks are to “push an opponent away during hand-to-hand contact, push a vehicle when it is stuck, and push up from the ground during evade and maneuver.”⁵ Examples of reaching tasks are “reaching out from the prone position, taking cover, or low crawling.”⁵ The HRP does not require any equipment. The starting position for the HRP is

the prone position with hands situated flat on the ground beneath the shoulders.^{4,5} The body will be rigid and in contact with the ground, and the feet will not separate more than approximately 12 inches.^{4,5,43} Once the starting position is achieved, the HRP is executed in accordance with the Army's following instructions by movement:⁵

Movement 1: On the command, "GO," the Soldier pushes the whole body up from the ground as a single unit to fully extend the elbows and move to the up position (front leaning rest).

Movement 2: After reaching the up position, the Soldier bends the elbows to lower the body to the ground. The chest, hips, and thighs touch the ground as a single unit. The head or face does not have to contact the ground.

Movement 3: The hand release. Without moving the head, body, or legs, the Soldier immediately moves both arms out to the side, straightening the elbows into the T position. The arms and hands may touch or slide along the ground during this movement.

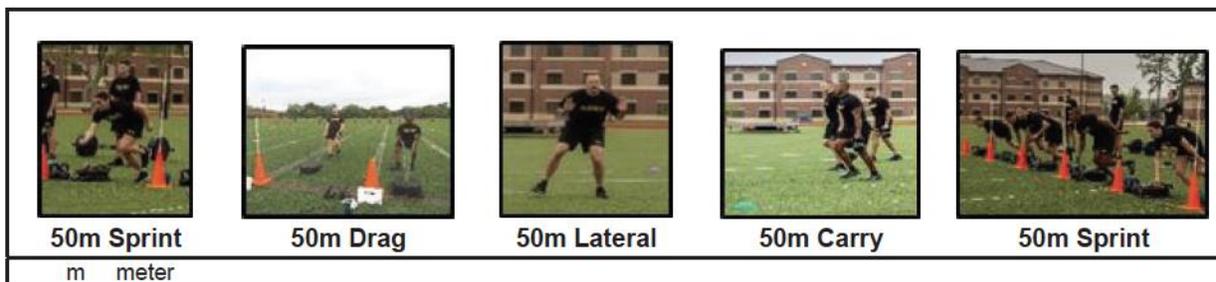
Movement 4: The Soldier makes an immediate movement to place his or her hands back on the ground to return to the starting position to complete the repetition.

The HRP ACFT measures the fitness component of local muscular endurance.^{4,5,46} The primary muscles involved in this event are the pectoralis major, anterior deltoids, triceps brachii, rectus abdominis, internal obliques, and external obliques for *Movement 1* (pushing body up) and *Movement 2* (lowering body down);⁴⁶ and rhomboids and middle trapezius for *Movement 3* and *Movement 4*.⁴⁸ Activation of the pectoralis major, anterior deltoids, and triceps brachii during the concentric phase of the HRP (pushing body up) causes horizontal shoulder adduction with flexion and elbow extension at the shoulder and elbow joints respectively.⁴⁷ The same primary

muscles are used during the eccentric phase (lowering body down) but with horizontal shoulder abduction with extension at the shoulder and elbow flexion at the shoulder and elbow joints respectively.⁴⁷ The rectus abdominis, internal obliques, and external obliques are very active in order to maintain a rigid body position when the body is being raised and lowered.⁴⁶ Movement of the hands from under the shoulders out to the T position and back to under the shoulders requires activation of the rhomboids and middle trapezius.^{47,48} The most challenging aspect of this portion of the movement (*Movement 3 and Movement 4*) is maintaining the scapular retraction required to move the hands out to the side and back. The scapular retraction will be largely isometric. There will be some scapular upward rotation but that will not be a chief scapular motion. Shoulder abduction and adduction and elbow flexion and extension during movement out and back from the T position are not overly taxing because there is minimal resistance to the hands during movement, especially if they are not in contact with the ground.

ACFT Event 4: Sprint-Drag-Carry (SDC).

Figure 4.5 Illustration of sprint-drag-carry



The SDC ACFT event is designed to measure Soldiers’ ability to accomplish tasks that are short in duration and high in intensity,^{4,5} such as “react rapidly to direct and indirect fire, build a hasty fighting position, and extract a casualty and carry them to safety.”⁵ The SDC requires two cast iron or cast steel 40-pound kettlebells, one heavy-duty nylon sled with pull

strap, two 45-pound rubber weights to place on the sled, and a visibly marked 25-meter lane on grass or artificial turf.^{4,5,43} The SDC carry is a 250-meter shuttle event completed in five 50-meter increments with each increment having an associated physical task.^{4,5} The 50-meter increments are completed in two 25-meter lengths, down and back.^{4,5} The following five tasks are completed for 50 meters during the SDC: sprint, 90-pound sled drag, lateral shuffle, 40-pound kettlebell carry, and sprint.^{4,5} The starting position for the SDC is the prone position with head fully behind the starting line.^{4,5} The SDC is executed in accordance with the Army's following instructions for each of the five physical tasks completed during the event:⁵

Sprint: On the command, "GO," move as quickly as possible from the prone position, sprint 25 meters and touch the 25-meter line with the foot and hand, turn, and sprint back to the start. If the Soldier fails to touch the 25-meter line with the hand and foot, the grader calls them back to do so.

Drag: Grasp each strap handle on the 90-pound sled and pull the sled backwards until the entire sled crosses the 25-meter line. Turn the sled and continue pulling backward until the entire sled has crossed the start line. If the Soldier fails to cross the 25-meter line, the grader calls them back to do so.

Lateral Shuffle: Perform the lateral (leading with either the right or left foot) for 25 meters, touching the 25-meter line with a foot and hand and perform the lateral leading with the opposite foot back to the start line. For example: lead out with the right foot for 25 meters, lead back with the left foot. The Soldier should always face in the same direction out and back. The Soldier's feet must not cross and must remain parallel to each other and perpendicular to the direction of travel. If the Soldier fails to touch the 25-meter line with the hand and foot, the grader calls them back to do so.

Carry: Grasp the handles of the two 40-pound kettlebells and sprint for 25 meters, touch the 25-meter line with the foot only, and return back to the start line. After crossing the start line, place the kettlebells on the ground without dropping them. If the Soldier fails to touch the 25-meter line with the foot, the grader calls them back to do so. If the Soldier drops the kettlebells at the start line, the grader calls the Soldier back to re-place them under control.

Sprint: Turn and sprint 25 meters, touch the 25-meter line with foot and hand, turn and sprint back to the start line. If the Soldier fails to touch the 25-meter line with the hand and foot, the grader calls the Soldier back to do so.

The SDC ultimately measures the fitness component of anaerobic capacity with the employment of local muscular endurance, muscular strength and agility throughout the event.^{4,5,46,49} This event is dynamic and engages many muscles throughout the body during completion. The SDC distance requirements closely corresponds with the anaerobic capacity test standards published by the NSCA, supporting its role as an anaerobic measure.⁴⁶ Physical events with moderate or higher exertion that are less than 3:00 minutes are largely driven by anaerobic mechanisms.^{1,46} Thus, it reasons that the SDC must be completed in less than 3:00 minutes to pass the Army standard.^{4,5} The primary mechanisms associated with performance of each respective SDC task (sprint, drag, lateral, and carry) are detailed below.

The sprint task at the beginning and end of the SDC heavily uses muscles that cause hip extension and flexion, knee extension and flexion, and plantar flexion.⁴⁶ The primary muscles used for hip extension are the gluteus maximus and hamstring muscles (semimembranosus, semitendinosus, and biceps femoris); for hip flexion are iliopsoas, rectus femoris, tensor fasciae latae, and sartorius; for knee extension are the quadriceps femoris muscles (rectus femoris,

vastus lateralis, vastus medialis, and vastus intermedius); for knee flexion are the hamstring muscles and gastrocnemius; and for plantar flexion are the calf muscles (gastrocnemius and soleus).^{46,47} There are numerous complex variables that influence sprint performance, including technique, neural factors, muscle structure, metabolic components, anthropometric measurements, and external factors (e.g., footwear, running surface, and weather).^{46,50-52} The body of literature supports that sprint ability is most markedly improved by engaging in maximal velocity sprint training.^{46,51} This is because other training techniques (weightlifting, plyometrics, etc.) do not provide the necessary types or amounts of stimuli necessary to holistically influence performance.^{46,51}

Performance on the drag task is predominantly determined by the lower extremity muscles that cause hip extension, knee extension, and plantar flexion. It will also require the use of the upper extremity grip (hand and forearm) and back muscles to secure the sled as it is pulled. The primary lower extremity muscles used for hip extension are the gluteus maximus and hamstring muscles; for knee extension are the quadriceps femoris muscles; and for plantar flexion are the calf muscles.⁴⁷ The primary upper body muscles used to grip the sled strap handles are the flexor digitorum profundus and flexor digitorum superficialis,^{47,53} and the primary back muscles employed are the latissimus dorsi, teres major, middle trapezius, rhomboids, posterior deltoids, and erector spinae.^{46,47}

The lateral shuffle task requires use of muscles that cause hip abduction and adduction, hip extension, knee extension, and plantar flexion. The lateral shuffle is a dynamic movement that requires substantial whole-body contributions to support the primary muscles involved. The primary lower extremity muscles used for hip abduction are the gluteus medius and gluteus minimus; for hip adduction are the pectineus, adductor brevis, adductor longus, adductor

magnus, and gracilis; for hip extension are the gluteus maximus and hamstring muscles; for knee extension are the quadriceps femoris muscles; and for plantar flexion are the calf muscles (gastrocnemius and soleus).⁴⁷

The carry task challenges the muscles needed to grip and stabilize unsteady forces over distance.^{46,54} The highly dynamic nature of a weighted carry necessitates full engagement of the musculoskeletal system.⁵⁴ Holding the weight while moving uses the muscles in the hand and forearm that facilitate gripping a handle.⁵⁴ Stabilizing the weight while moving causes a majority of muscles throughout the upper body, core, and lower body to be highly active.⁵⁴ The walking phase engages the lower body muscles that produce hip extension, knee extension, and plantar flexion.⁵⁴ There is limited information in the literature regarding the specific mechanics of this type of weight carrying task⁵⁴ and its use in strength and conditioning programs.⁴⁶ However, it can be ascertained that the primary muscles involved are the grip (hand and forearm), shoulder, back, and core muscles.^{46,54} The leg muscles contribute, but to a lesser extent than the upper body muscles for a majority of people.

ACFT Event 5: Leg Tuck (LTK).

Figure 5.5 Illustration of leg tuck



The LTK ACFT event is designed to measure “grip, shoulder, core, and hip flexor strength.”⁵ The Army asserts these muscles assist in Soldiers completing tasks such as load carriage and climbing over, onto, or across obstacles, ropes, or the ground; and assist in preventing lower and upper back injuries.^{4,5,43} The LTK requires a smooth unpainted galvanized steel bar that is between 1.25 and 1.75 inches in diameter, between 48 and 62 inches in length, and at least 86 inches in height.^{5,43} The Army’s instructions for LTK execution by part are as follows:⁵

Preparatory phase: on the command, “GET SET,” the Soldier assumes a straight-arm hang on the bar, with feet off the ground, knees bent if necessary. The grip is the alternating grip with hands no more than a fist’s width apart—as measured by the grader. The body is positioned perpendicular to the bar. The Soldier’s elbows, body, and legs are straight.

Legs and feet are not crossed. Feet cannot contact the ground or the climbing bar.

Therefore, taller Soldiers may have to bend their knees.

Upward movement phase: on the command, “GO,” the Soldier flexes at the elbows, knees, hips, and waist to bring the knees up. The elbows must flex. They cannot remain fully extended or straight. The right and left knees or front of the thighs must touch the right and left elbows or back of the upper arm respectively so they touch or are in contact with the elbows at the same time. The Army Combat Fitness Test grader must observe both knees in contact with the elbows or upper arms for the Soldier to receive credit for the repetition.

Downward movement phase: The Soldier returns under control to the straight-arm hang position to complete the repetition. If the elbows remain bent, that repetition does not count. Deliberate, active swinging of the trunk and legs to assist with the exercise is not permitted. Small, inconsequential or passive movement of the body and twisting of the trunk is permitted. The Soldier may rest in the down position.

Event Termination: The event ends when the Soldier voluntarily stops or drops from the bar. Using the ground or post to rest or push from between repetitions also terminates the event.

The LTK measures the fitness component of muscular strength and local muscular endurance.^{4,5,46} This event is dynamic and requires coordination and contribution from musculature throughout the entire body. Examining the contributions of individual muscles for this movement must be done with caution because that fails to account for the aggregate effect of the event, which is conceivably the most vital aspect. With that in mind, the primary muscle groups involved in this event are the muscles used to grip the bar; the muscles used to flex the

elbows; the muscles used to raise and rotate the upper body towards the hands; the muscles used for trunk flexion, and the muscles used for hip flexion to bring the knees to the elbows. The primary muscles involved to grip the bar are the hand and forearm muscles of flexor digitorum profundus and flexor digitorum superficialis;^{47,53} to flex the elbows are the arm muscles of brachialis, biceps brachii, and brachioradialis;^{46,47} to raise and rotate the upper body towards the hands are the back muscles of latissimus dorsi, teres major, middle trapezius, rhomboids, and posterior deltoids;^{46,47} to flex the trunk to bring the legs and elbows closer together is the abdominal muscle of rectus abdominis;^{46,47} and to flex the hips to move the knees to the elbows are the hip muscles of iliopsoas, rectus femoris, tensor fasciae latae, and sartorius.^{46,47}

ACFT Event 6: Two-Mile Run (2MR).

The 2MR event is designed to measure aerobic endurance.^{4,5} The ability to walk or run over extended distances pertains to common Soldier tasks such as “dismounted movement, ruck marching, and infiltration.”⁵ The run can be completed on an indoor or outdoor track, or on a predetermined, marked route that meets the testing requirements.^{4,5} The surface of the run route must be improved (e.g., concrete, asphalt, mulched rubber), and the course must be generally level and start and end at the same point.^{4,5} The Army’s instructions for the 2MR event are as follows:⁵

On the command, “GO,” the clock starts, and the Soldier begins running at his or her own pace, completing the 2-mile distance without receiving any physical help. The Soldier may walk or pause but cannot be picked up, pulled, or pushed in any way. The Soldier may be paced by another Soldier. Verbal encouragement is permitted. If the Soldier leaves the run course at any time or at any point before completing the 2-mile distance, the event will be terminated.

The 2MR measures the fitness component of aerobic capacity.^{4,5,46,49} Aerobic capacity is the maximal ability of the body to produce energy from calories through the use of oxidative systems.^{1,46,49} Aerobic capacity is determined by three factors: the respiratory system, the cardiovascular system, and the ability of the muscle to aerobically use energy.^{1,46,49} The limiting factor in healthy individuals is virtually always the cardiovascular system (blood flow).⁴⁹ Thus, training programs designed to develop aerobic capacity focus predominantly on cardiovascular adaptations, improved blood flow.^{46,49} There are many techniques to train the cardiovascular system but what they all have in common is a focus on maintaining an elevated heart rate for an extended amount of time.^{46,49} Army aerobic training¹ guidance reflects this methodology.

U.S. Army Physical Fitness Reformation: Holistic Health and Fitness

The Department of the Army fully overhauled its physical readiness training doctrine in October 2020 with the publication of FM 7-22 *Holistic Health and Fitness*.¹ The H2F initiative supersedes FM 7-22 *Army Physical Readiness Training*, the physical readiness training doctrine published in October 2012.^{1,2} The H2F doctrine is designed to provide a personalized approach to physical training; as opposed to the generic, massed-formation physical training methodology it replaced.^{1,55} The former physical fitness doctrine focused almost exclusively on the physical domain of Soldier readiness.² The H2F system expands to include training guidance on the nonphysical domain as well.^{1,55} The new doctrine is based around the concept that physical readiness, mental readiness, sleep readiness, nutritional readiness, and spiritual readiness all factor into overall Soldier readiness for war.^{1,55} Major General Lonnie Hibbard, the commanding general responsible for implementation of H2F, believes the holistic approach will result in a healthier force, reduced medical costs, and a more lethal Army.⁵⁵

The doctrinal updates to the physical readiness domain of the H2F system bring marked changes to the Army's longstanding way of conducting physical training.^{1,2,55} The H2F doctrine directs that fitness experts be hired and incorporated into physical fitness planning, and that state-of-the-art facilities and equipment be resourced and made readily available across the Army.^{1,55} The most notable physical training expert addition associated with H2F is the authorization of one civilian strength and conditioning specialist for every brigade-sized element (roughly 4,000 Soldiers).¹ This is monumental for the Army. Certified fitness experts have not historically been involved in the planning and execution of physical fitness training at the unit level.¹ The responsibility of planning and executing unit physical fitness was assigned based on rank and duty position, not expertise. A preponderance of individuals responsible for unit physical training were not formally educated in exercise science and held no widely-recognized fitness certification.¹ The training techniques implemented were often reflective of the Soldier's past experiences with Army physical training and preferred type of exercise (e.g., the unit ran frequently if the leader enjoyed and excelled at running). The Army's culture placed the onus of maintaining an appropriate level of physical fitness on the individual Soldier, irrespective of level of physical fitness education.¹ For example, it was normal to expect Soldiers of any rank or position who were not training with the unit because of geographical separation or operational requirements to assume full responsibility for their own physical fitness planning and execution.¹ A shortage of reliable access to physical training facilities and equipment will continue to be common place until the Army resources the facility plan detailed in the new H2F doctrine.¹ The lack of facility space is especially prevalent during designated physical fitness training blocks of time on military installations across the Army. The designated physical training times are established by senior military commanders. During these hours, all Soldiers under their

command will conduct physical training. Masses of Soldiers all physically training at the same time creates an overwhelming demand for workout equipment and space.

The H2F initiative consolidates experts and health initiatives from across the Army into an all-inclusive resource for Soldiers.^{1,55} The H2F doctrine identifies the type and number of professionals needed to support the initiative, as well as their role in promoting Soldier readiness.¹ Furthermore, it outlines an archetype facility that consolidates these resources with designated space for the experts and resources.¹ These facilities are referred to as the Soldier Performance Readiness Center (SPRC). The SPRC is a 40,000 square-foot facility that contains office space for H2F personnel, classrooms, treatment areas, counseling space, and various types of equipped physical training zones.^{1,55} Each SPRC is resourced to support a brigade-size element.¹ Figure 6 outlines the H2F specialty personnel identified as necessary to support at the brigade-level. These personnel include, but are not limited to a H2F program director, a strength and conditioning specialist, physical therapist, occupational therapist, cognitive enhancement specialist, registered dietitian, and athletic trainers.¹ The ideal SPRC has both an indoor and outdoor physical training area.¹ The indoor area has dedicated spaces and corresponding equipment for resistance training, accessory training, and work capacity and agility training¹ (Figure 7). The outdoor area includes:¹ an obstacle course, ACFT testing lanes and track, terrain running course, sheltered strength training racks, containerized strength equipment, physical training fields, and horizontal pull-up bars (Figure 8 and Figure 9). The H2F doctrine applies to the Regular Army (RA), Army National Guard (ARNG), and Army Reserve (USAR).¹ The Regular Army is scheduled to initiate construction of SPRCs in October 2023.⁵⁵ However, the ARNG and USAR implementation will be different than the RA to account for their

decentralized and part-time construct.⁵⁵ The Army has yet to arrive at a definitive resourcing solution for the ARNG and USAR.⁵⁵

Figure 6.1 Illustration of H2F personnel team structure at brigade-level

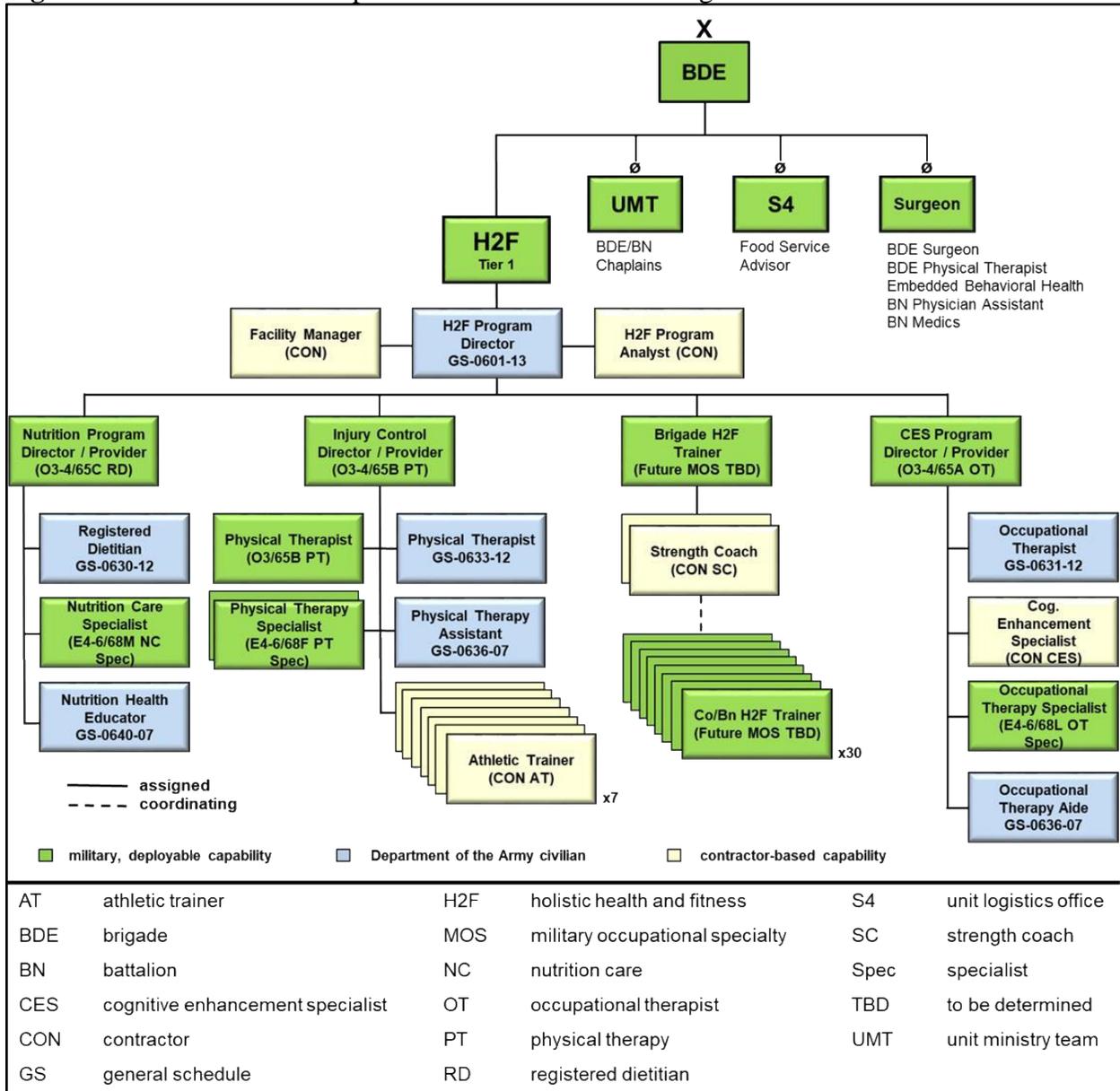


Figure 7.1 Illustration of H2F indoor facility design

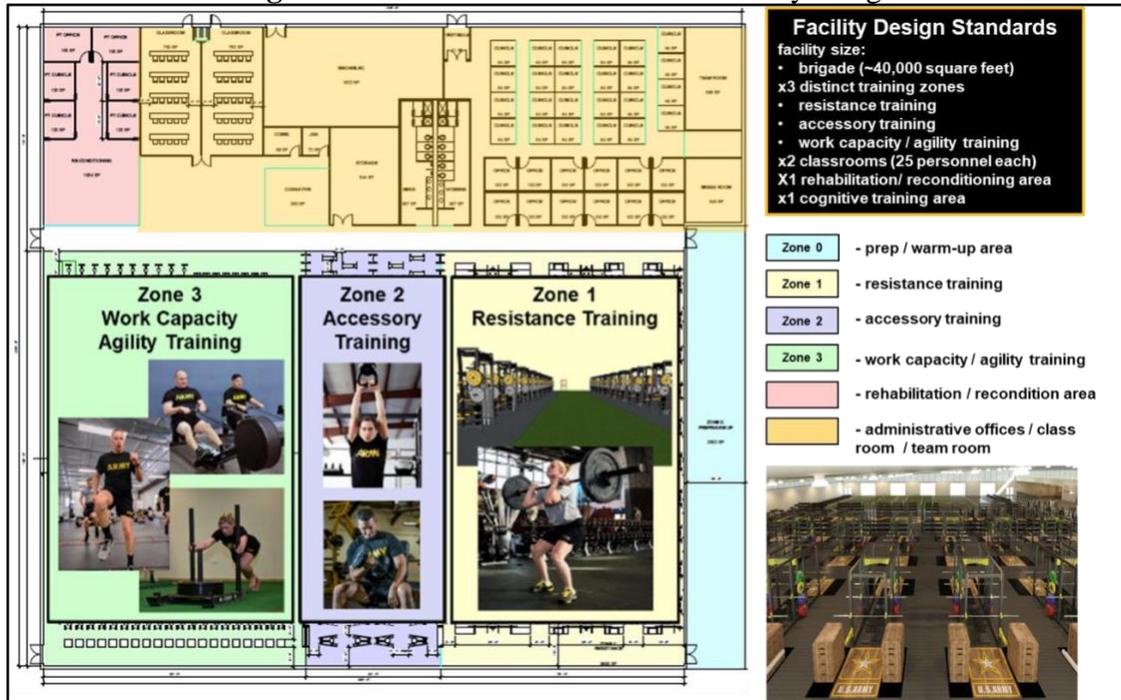


Figure 8.1 Illustration of H2F outdoor terrain run design

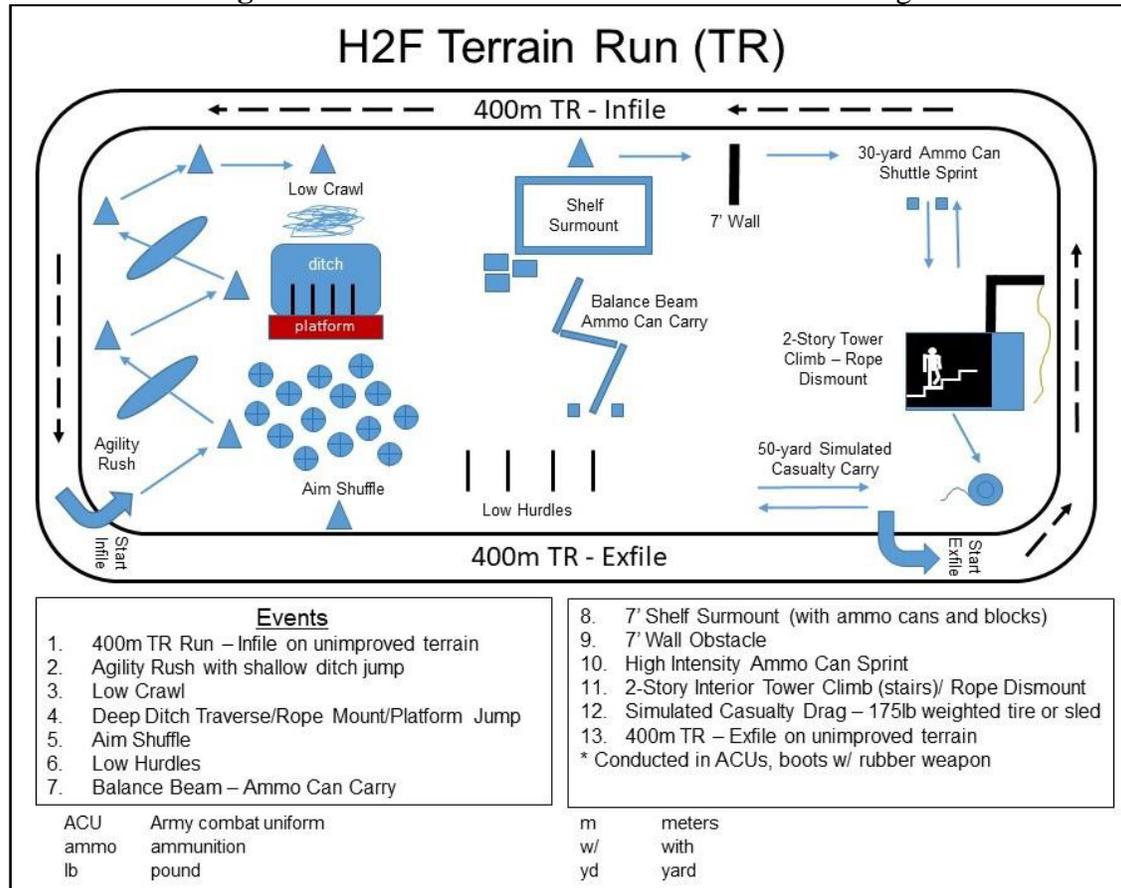
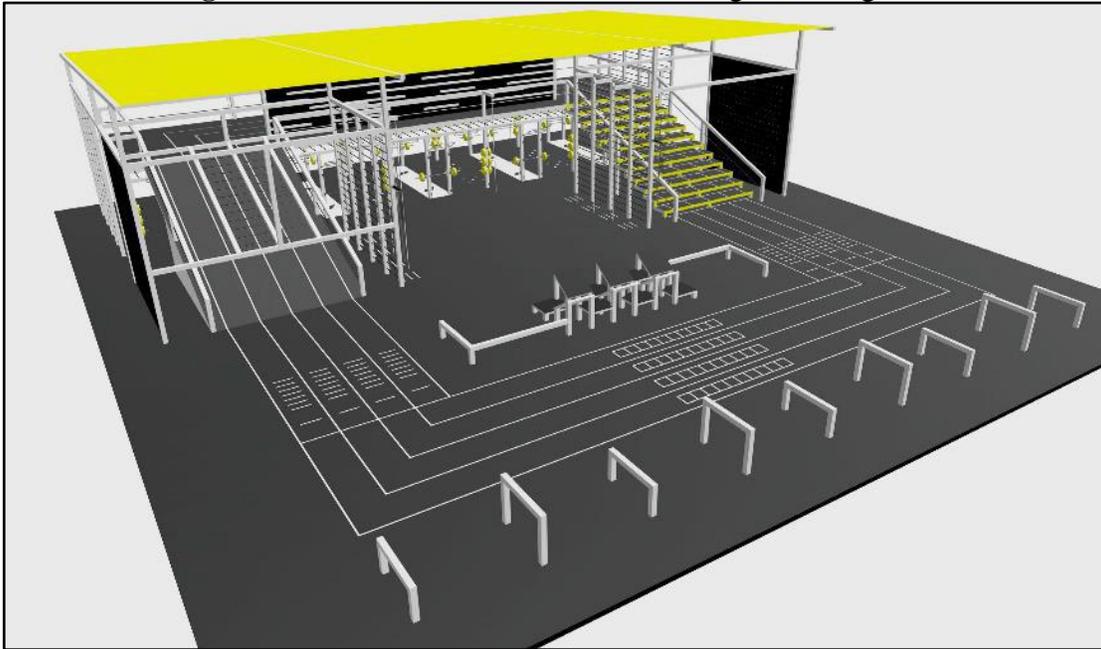


Figure 9.1 Illustration of H2F outdoor strength training area



Certified fitness experts and state-of-the-art physical training facilities

The benefits of certified physical fitness expert involvement in the design and execution of physical training are clear.⁵⁶ They are educated in exercise science and trained to practically apply their knowledge.^{46,56,57} Fitness professionals who are certified demonstrated a base level of competency in their craft by passing a rigorous certification process. One common certification is the NSCA's Certified Strength and Conditioning Specialist (CSCS). It requires a bachelor's degree or higher in an exercise science related area of study (or in the final year of the degree) to sit for the exam.⁵⁸ Only 63 percent passed the exam on their initial attempt in 2019.⁵⁸ A certification from a reputable organization validates proficiency in the fundamental skills necessary to safely and effectively physically train others.⁵⁸ It demonstrates an understanding of what factors must be considered when making a physical training plan.^{46,56,57} It shows the ability to assess and prescribe physical training to individuals in populations with a wide-range of needs.^{46,57} This includes developing a strategic, progressive, and periodized physical training

program that is tailored to the individual needs of those in the organization.^{46,57} Finally, a certification confirms they know how to coach proper body mechanics and recognize signs of overtraining, both of which will reduce injury rates.^{46,57} The ability to correct improper lifting technique during weightlifting is of utmost importance because poor technique is associated with a heightened risk of injury.^{59,60}

Essentially all highly competitive athletic organizations in the United States have their physical training program overseen by certified fitness experts. Organizations with expert involvement in the planning and execution of their physical training have increased physical fitness,^{56,61} better health, and fewer and less severe MSKIs as compared to organization without expert involvement.⁵⁶ Examples of athletic organizations who use fitness experts are professional sports teams, Olympic and National sports teams, and competitive collegiate athletic departments. Numerous organizations that are not sports oriented use fitness experts because their job performance is inextricably linked to their physical fitness. Elite military units are examples of these types of organization.

Consistent access to state-of-the-art training facilities with adequate equipment provides predictability for workout planning and increases the variety of exercises available. The literature supports that adults with perceived access to fitness facilities have a higher level of physical fitness than those without perceived access.^{62,63} The perception of access to fitness facilities and equipment speaks to people believing they can enter a known facility at a predetermined time and use the equipment that supports their exercise plan. People are likely to only include assets they perceive will be available when creating a fitness plan.^{62,63} Thus, facility and equipment availability greatly shapes the way people train. The hours that a fitness facility is open is an important factor. The chances of people exercising at a facility declines if it is closed during their

preferred exercise hours. The opportunity to exercise at a facility is nonexistent for those who are only available to exercise during times it is closed. There may also be times when the fitness facility is open but the amount of equipment does not meet the demand. This situation is common when facilities are overcrowded with users.

A diverse selection of equipment allows for greater exercise variation and potentially an increase in training specificity. Modifying exercise type, intensity, volume, and frequency is suggested to elicit greater performance adaptations.⁶⁴ Access to an expansive assortment of quality equipment exponentially expands the exercise combinations possible. Variety is important to the success of an exercise program, but specificity produces the greatest results. Specificity is one of the most basic and effective concepts required for a physical training plan.⁴⁶ The principle of specificity states exercise adaptations in individuals are directly related to the specific way they train.⁴⁶ A large selection of equipment means that individuals have more opportunities to engage in exercises that most closely replicate the tasks they are training to accomplish. Training to meet the specific demands of a task is the most efficient way to improve on that task and accomplish related fitness goals.⁴⁶

The Tactical Athlete Performance-Center on Fort Benning, Georgia

The TAP-C on Fort Benning, Georgia is a physical training facility established by Fort Benning's Maneuver Center of Excellence on 8 March 2019.¹² It is fully equipped with state-of-the-art strength training equipment and staffed by certified fitness experts.¹² Its purpose is to increase lethality through physical dominance and increase combat readiness by reducing musculoskeletal injuries.¹² The primary users of the TAP-C include conventional and training units (Officer Candidate School, Maneuver Captains Career Course, etc.) on Fort Benning. The

demographic that the TAP-C serves makes it novel. It is the only facility in the Army that provides these resources to non-special mission units.¹² The TAP-C staff is capable of physically training and educating units that have up to roughly 800 Soldiers assigned (battalion size).¹² Despite the unit level training capability of the TAP-C, exercise programs are always tailored to meet the specific needs of each Soldier.¹² The TAP-C leadership aims to modernize the Army culture of physical fitness to one that is based in exercise science via those they train and educate.¹²

The physical fitness expertise of the staff is the cornerstone of the TAP-C initiative. The staffing framework for the TAP-C includes: a head strength coach, three assistant strength coaches, master fitness trainers (MFT), facility managers, and other physical performance subject matter experts as available.¹² The head strength coach oversees the operation of the TAP-C and its training and education program design. This individual must have extensive experience coaching large groups at the collegiate, professional, and national levels; an exercise science related master's degree; and be a certified strength and conditioning specialist and personal trainer.¹² The three assistant strength coaches contribute to the program design process; overseeing and directly engaging in unit physical training and education; and assist the head strength coach as needed.¹² They must have coaching experience at the collegiate, professional, and tactical levels; and meet the same education and certification requirements outlined for the head strength coach position.¹² The MFT positions are filled by non-commissioned officers who successfully completed the Army's MFT course.¹² MFTs assist with the planning and administration of training sessions.¹² They serve under the strength coaches as additional oversight to manage large volumes of trainee throughput.¹² MFT course graduates are not credentialed strength and conditioning experts. They are trained in all aspects of the Army's

physical training doctrine and some basic exercise science concepts.⁶⁵ MFT course graduates have completed 60 academic hours of exercise science classes.⁶⁵ They have also attended a two-week course at Fort Benning where they performed practical training on all exercises and drills listed in Army physical training doctrine.⁶⁵ The facility managers are not directly involved with physical training.¹² They maintain the facility to enable the fitness experts to focus on their duties.¹² Additional physical performance experts such as athletic trainers, physical therapists, sports psychologists, and dieticians intermittently assist the TAP-C. However, these experts are not consistently available because they are not assigned to the TAP-C.

The state-of-the-art equipment in the TAP-C provides the fitness experts a reliable and expansive array of exercise options to employ when planning physical training. The Maneuver Center of Excellence spent approximately \$570,000 on fitness equipment for the TAP-C.⁶⁶ The purchase included the required equipment to create 40 fully-equipped work stations (Figure *TAP-C stations). Each station includes at minimum an adjustable squat rack with horizontal pull-up bars attached, adjustable bench, barbell, kettlebells, rubberized weights, strength bands, and dumbbells.⁶⁷ The facility has two artificial turf exercise areas that facilitate exercises such as shuttle running, reverse sled dragging, and carrying weight over distance. Other equipment available in the TAP-C includes, but is not limited to:⁶⁷ adjustable weight pulldown and low-row machine; hex shaped weightlifting bars; heavy-duty heavy ropes; large exercise inflatable balls; rowing and skiing replication machines; Jacob's Ladder (ladder climbing exercise) machines; stationary bicycles; outdoor pull-up bar stations; and a large, well-maintained outdoor grass field.

Figure 10.⁶⁸ Picture of the inside of the Tactical Athlete Performance-Center.



The TAP-C supplements the ACFT with its own battery of physical tests to obtain a more comprehensive understanding of the fitness level of those they train. The TAP-C testing battery consist of a maximum grip strength test, a standing broad jump for distance, a maximum chin-up test, and two mobility tests. The maximum grip strength test using a hand dynamometer measures the fitness component of muscular strength.⁴⁶ The primary muscles involved are the hand and forearm muscles of flexor pollicis longus, flexor digitorum profundus, and flexor digitorum superficialis.^{47,53}

The standing broad jump for distance test measures the fitness component of muscular power.⁴⁶ The standing broad jump is an explosive movement that involves numerous muscle groups. Performance on this test will be heavily determined by how fast the muscles that produce

hip extension and flexion, knee extension and flexion, and plantar flexion can contract.⁴⁶ Those muscles include the gluteus maximus, hamstring muscles (semimembranosus, semitendinosus, and biceps femoris), quadriceps femoris muscles (vastus lateralis, vastus intermedius, vastus medialis, and rectus femoris), and major calf muscles (gastrocnemius and soleus).⁴⁶

The maximum chin-up test measures the fitness component of local muscular endurance, provided the repetitions are submaximal.⁴⁶ The primary muscles involved are the grip muscles and the back and arm muscles that cause shoulder adduction, scapular retraction, and elbow flexion.⁴⁶ The grip muscles involved are the main finger flexors: flexor digitorum profundus and flexor digitorum superficialis.^{47,53} The major back muscles involved are the latissimus dorsi, teres major, middle trapezius, rhomboids, and posterior deltoids.⁴⁶ The major arm muscles involved are the brachialis, biceps brachii, and brachioradialis.^{46,47} The major back muscles involved are the latissimus dorsi, teres major, middle trapezius, rhomboids, and posterior deltoids.⁴⁶ The posterior deltoid shoulder muscle also contributes to the shoulder extension movement.⁴⁷

The TAP-C mobility tests measure the fitness component of flexibility.⁴⁶ The tests are the overhead squat test and the shin box test. Both tests are largely considered movement competency screens.⁴⁶ They assess flexibility, mobility, and overall movement control of the body.⁴⁶ The results of these screens inform fitness experts of the readiness of their clients to work underload and engage in more advanced exercises.

The Army's H2F initiative and TAP-C initiative share many of the same characteristics. They both place a premium on having fitness experts involved in the planning and execution of unit level physical training. Each initiative asserts that exercise programs must be tailored to meet individual needs, not indiscriminately applied to the masses. Both initiatives emphasize that

having access to dedicated state-of-the-art facilities is required to optimize physical training outcomes. They agree that Soldier physical performance is a product of more factors than just physical training. These factors include sleep, nutrition, mental readiness, and injury prevention and management. The H2F initiative includes approved positions for a range of professionals on staff to ensure the diverse fitness needs of the Soldiers are addressed. The TAP-C is not able to carry an array of professionals on staff because money is not available to pay their wages. However, the TAP-C leadership values a holistic support network. They resource outside organizations to provide Soldiers the expertise required. Perhaps the greatest similarity is both initiatives are designed to serve conventional and training forces.

The Officer Candidate School on Fort Benning, Georgia

Officer Candidate School, 3rd Battalion 11th Infantry Regiment, is an Army officer commissioning source located on Fort Benning, Georgia. The mission of OCS is to train, educate, and commission officers to serve in the Army as leaders of character who live by the Army Ethic.⁶⁹ Candidates who successfully matriculate through OCS are commissioned as Second Lieutenants in the United States Army.⁶⁹ The branch (job) they are assigned when they graduate will largely be determined by their OCS class ranking and branches the Army has available.⁶⁹ There are three, 12-week OCS classes per year. An OCS class consists of five companies, each with up to 160 candidates. Individuals seeking to attend OCS must apply through the U.S. Army Human Resources Command. The Army publishes a comprehensive list of the criteria that must be met to be eligible for OCS.⁷⁰ The following are some highlights of criteria required to attend OCS:⁷⁰ possess a baccalaureate degree; not have a criminal record; be 33 years of age or less or receive a waiver if older; do well on a cognitive test (general technical

score of above 110); be a U.S. citizen; and be physically and mentally fit. RA, ARNG, USAR, and civilians may apply to OCS. Basic combat training must be completed before attending OCS.

The OCS program is physically demanding. Candidates must pass an ACFT; a 6, 9, and 12 mile foot march; and a 4 mile timed run to graduate the course.⁶⁹ Candidates conduct physical training sessions five to six times per week.⁶⁹ The exercise bout for the day is typically delegated to a candidate to plan and execute. The candidate charged with leading the physical training session changes regularly to distribute practice opportunities. There are physically demanding tasks inherent to the OCS curriculum that are completed as part of normal Army competency training. Candidates are required to complete events such as obstacle courses, land navigation courses, WTBD rehearsal and testing, and squad combat training exercises.⁶⁹

Conclusions and Purpose Statement

Physical fitness is tied to the Army's ability to fight and win the Nation's wars. The most up-to-date, science-based physical fitness training methods must be employed when training Soldiers to optimize outcomes. The Army recognized its physical training doctrine needed to be modernized to keep pace with the evolving strength and conditioning practices. The H2F publications capture the changes the Army made to its physical training paradigm. Two novel changes the H2F initiative brings is the use of fitness experts to design and oversee unit-level physical training, and the availability of state-of-the-art facilities for use by conventional and training units. The effects of these changes on unit-level physical fitness are unknown as a consequence of the recent H2F implementation. Furthermore, there are a lack of studies in the literature that serve to inform the potential effects of fitness experts and dedicated training

facilities on unit-level physical fitness. The physical training program the TAP-C conducted with OCS is not associated with the Army's H2F program, and does not aim to validate any aspect of the H2F program. However, the Army and other tactical athlete organizations may benefit from study outcomes examining the impact of fitness experts and dedicated fitness facilities on unit-level training. Thus, the purpose of this study was to add novel information to the literature for use by tactical athlete organizations who are integrating or seeking to integrate unit-level physical training programs.

Chapter 3: Methodology

Study Design

A retrospective cohort study design was used to determine the effect of a 12-week fully resourced physical training program designed by certified fitness experts on the officer candidate school population, as compared to the conventional Army doctrine based Physical Readiness Training (PRT) program designed and led by OCS cadre. The collected data covered a 12-week training period. The independent variables are group with two levels (comparison and intervention) and time with two levels (pre-measurements and post-measurements). The dependent variables are aggregate Army Combat Fitness Test (ACFT) score, individual event ACFT scores, combined mobility test score, grip strength, broad jump distance, and maximum chin-up number.

Participants

The Auburn University Institutional Review Board (protocol number: 20-090 EP 2006) approved all procedures of this study. The data were collected between 28 October 2019 and 21 February 2020. All participants were between 21 and 37 years of age and enrolled in OCS during data collection. They were all healthy, physically active service members who met the criteria required by the Army to attend OCS. This included passing a physical fitness test, a cognitive test, and a medical wellness examination. The data of 228 (179 male [26.74 ± 3.78 years] and 49 female [26.55 ± 4.18 years]) officer candidates were analyzed. The data of 170 of the 228 officer candidates (148 male [26.44 ± 3.72 years] and 22 female [25.77 ± 4.05 years]) were used to examine additional TAP-C physical performance measures. The 58 (31 male [28.16 ± 3.76 years] and 27 female [27.19 ± 4.26 years]) officer candidates who did not participate in

the TAP-C data collection were not available because of various non-disclosed conflicting requirements. The data for 18 (9 male and 9 female) officer candidates were excluded from analysis because of incompleteness.

Data Sources

Data for this study were preexisting and maintained at either Officer Candidacy School (OCS) or the Tactical Athlete Performance-Center (TAP-C). The Army's Center for Initial Military Training authorized the data to be used in this study. Members from the research team coordinated with the respective OCS and TAP-C staff to acquire the data. The participants' ACFT scores and demographic information was maintained at OCS. The OCS personnel consolidated the data and gave it to the WRC researchers. The participants' results on the grip strength test, broad jump, maximum chin-up test, and combined mobility test were stored at the TAP-C. The TAP-C leadership consolidated the data and provided it to the Warrior Research Center (WRC) researchers.

Study Procedures

Two OCS companies were randomly assigned to participate in a 12-week long physical fitness training program. The 12-week training program start dates were offset by 21 days because the companies had staggered start dates. Charlie Company (n = 112; 86 male and 26 female) served as the intervention group, and Delta Company (n = 116; 93 male and 23 female) served as the comparison group. The intervention group's physical training was planned, resourced, and implemented by the TAP-C certified fitness experts. The comparison group conducted physical training led by OCS cadre. Both groups completed an ACFT, grip strength

test, broad jump test, maximum chin-up test, and combined mobility test at the beginning and end of the 12-week training period. The United State Army Center for Initial Military Training and the Auburn University Institutional Review Board approved the study protocol.

WRC researchers worked with the OCS and TAP-C personnel to acquire the data and gain an exhaustive understanding of any circumstances or procedures that may have influenced the study outcomes. This included gathering information on factors such as the assignment of candidates to OCS companies; the selection of the intervention company and comparison company; and any events that disrupted physical training. The research team had a general understanding of the methods used to collect data on each measure being examined, but worked with the parties responsible for data collection to get more fidelity. All measures described below were collected a total of two times during the study, once at the beginning of the participants' OCS class and once after 12 weeks of training.

ACFT: The OCS cadre administered all four ACFTs to the candidates at Fort Benning, GA. The cadre responsible for administering the ACFT are trained and certified to do so by the U. S. Army. The WRC researchers completed the training and certification process to further their understanding of the ACFT testing procedures. However, they were not involved in administering the ACFTs to the OCS candidates. The exact standards used by the cadre to establish the ACFT testing site and grade the six events are listed in Army Technical Publication (ATP) 7-22.01 *Holistic Health and Fitness Testing*.⁵

Grip Strength: Participants completed the hand grip strength tests using a Baseline hydraulic hand dynamometer (Fabrication Enterprises Inc., Irvington, NY, USA). The participants initiated the test standing upright with both arms generally straight and down by their side. They grasped the hand dynamometer between the fingers and the palm, at the base of

the thumb in the hand being tested. When ready, they gripped the dynamometer as hard as possible while simultaneously raising their arm from their side to directly out in front of them until parallel with the ground. The participants were told to raise the hand dynamometer as if they were aiming a pistol. They were not directed to maintain a straight elbow at any point. This process was completed once for the right and once for the left hand.

Standing Broad Jump: Participants initiated the standing broad jump by standing with both toes behind a marked line on the ground and feet approximately shoulder width apart. Once in position, a member of the TAP-C staff instructed them to jump forward as far as possible when ready. Upon completion of the jump, TAP-C staff member marked where the participants landed by placing a cylindrical piece of plastic piping behind their heels. The distance of the jump was measured from the line of departure to the pipe. If the participants fell backwards and touched the ground with their hand and or took a step forward or backward after landing, the attempt was invalidated. Participants were permitted to fall forward and touch the ground with their hand and return to the standing position as long as their feet did not move from the initial landing positions. Participants all received three test attempts, with the longest jump recorded.

Maximum Chin-Up: The participants conducted the chin-up test at the exercise stations in the TAP-C. The test was administered by a member of the TAP-C staff. The participants suspended themselves, arms with extended, from handles mounted on the work station rack apparatuses. The palms of their hands were oriented towards their body. When ready, participants pulled themselves up in a controlled manner until their chin was parallel or above their knuckles and then lowered their body in a controlled manner back down to the fully-extended hanging position. Excessive swinging was considered uncontrolled movement and was not authorized. Movement from the fully-extended hanging position and back constituted one

repetition. Repetitions that did not meet the standard were not counted. Participants completed as many repetitions as possible. The test was terminated upon release of the pull-up bar.

Combined Mobility Assessment: Participants completed two movement assessments, the overhead squat assessment and the shin box assessment. These evaluations were selected by fitness experts at the TAP-C and at the U.S. Army Physical Fitness School. The same strength and conditioning coach assessed all candidates on each respective assessment to standardize scoring. Both mobility assessments were scored similarly. A maximum score of six points between the two assessments was possible, three points per assessment. Participants that received a score of three points displayed no movement deficiencies during the assessment. The only participants that received a score of zero were ones that experienced pain during the assessment.

Statistical Analysis

All data received from the TAP-C and OCS personnel were consolidated on a secure hard drive that can only be accessed by WRC researchers. The data were moved from the source document and consolidated into a single Microsoft Excel (Microsoft Excel for Macintosh 2018, Version 16.16.27 Redmond, WA, USA: Microsoft) file. Once consolidated, the WRC researchers assessed the Excel file to assess completeness of data. Listwise deletion was used to address the missing data for 18 officer candidates.

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS Statistics for Macintosh, Version 27.0. Armonk, NY, USA: IBM Corp) statistical software. Analysis of covariance (ANCOVA) was used to compare differences of main effects of company on ACFT measures for the groups of 228 and 170 officer candidates. The covariates of pretest score differences, sex, and prior participation in collegiate athletics were controlled for

during main effect testing. An *a priori* alpha level of 0.05 was used to determine statistical significance of effects. Bonferroni post-hoc analysis was conducted on all significant main effect findings. Partial Eta-Squared (η^2) effect sizes were calculated for each outcome variable. Effect sizes were classified as the commonly accepted approximations of small (.01), medium (.06), and large (.14).⁷¹ The data failed tests of normality and homogeneity of variance; however, these violations are negligible with the large sample size and generally equal sized groups. The covariates violated the homogeneity of regression slopes assumption on instances of main effect testing; however, the statistical model was robust to these violations.

Chapter 4: The Effects of Fitness Experts and Exercise Facilities on Physical Fitness in the Officer Candidate School Population

Introduction

Members of the United States Army participate in rigorous physical activity to cultivate the physical lethality and mental fortitude required to successfully fight and win anywhere in the world with little to no notice.⁷² The Army universally seeks to improve physical training programs to reduce risk of overuse and acute injury, and optimize results for training time invested. The programs must be tailorable to address the needs of a diverse Soldier population, ranging from new recruits to those approaching retirement. Finally, adequate fitness facilities equipped with cutting-edge equipment must be available and accessible at all times to meet a wide-range of work schedule demands.

Certified fitness experts have not historically been involved in the Army's physical fitness training.¹ Rather, the planning and executing of unit physical fitness is often delegated to junior leaders based on their rank and duty position, not expertise. A preponderance of individuals responsible for unit physical training are not formally educated in exercise science and hold no widely-recognized fitness certification.¹ Physical training plans are based on the most up-to-date physical fitness doctrine published by the Army. The onus of maintaining an appropriate level of physical fitness is on the individual Soldier, irrespective of level of physical fitness knowledge.¹ Additionally, the demand for physical fitness facilities and equipment routinely exceeds the resources available on most major Army posts. Soldiers on an installation typically conduct physical training during similar times and compete for space and equipment in a limited number of communal gyms.

The Army revolutionized its longstanding physical training approach with its publication of the Holistic Health and Fitness (H2F)¹ doctrine in October 2020.^{1,2,55} The doctrine directs that

fitness experts be hired and incorporated into physical fitness training, and state-of-the-art facilities and equipment be resourced and made readily available.^{1,55} The most notable change regarding fitness experts is the authorization of one civilian strength and conditioning specialist for every brigade-sized element (roughly 4,000 Soldiers).¹ The benefits of fitness experts are irrefutable. Organizations with fitness experts in charge of their physical training have increased physical fitness,^{56,61} better health, and fewer and less severe musculoskeletal injuries as compared to organization without expert involvement.⁵⁶

The Tactical Athlete Performance-Center (TAP-C) on Fort Benning, Georgia is a state-of-the-art physical training facility established by Fort Benning's Maneuver Center of Excellence on 8 March 2019.¹² It is fully equipped with contemporary strength training equipment and staffed by certified fitness experts.¹² Its mission is to increase lethality through physical dominance and increase combat readiness by reducing musculoskeletal injuries.¹² The TAP-C is novel because it is the only facility in the Army with its combination of expertise and equipment to service conventional Army units.¹² The TAP-C staff is capable of physically training and educating units of up to 800 Soldiers (battalion size).¹² TAP-C exercise programs are tailored to meet the specific needs of the individual Soldier while also training large groups of Soldiers.¹²

The Officer Candidate School (OCS) on Fort Benning is one of the units using the TAP-C resource. The mission of OCS is to train, educate, and commission officers to serve in the Army.⁶⁹ Candidates who successfully matriculate through OCS are commissioned as Second Lieutenants in the United States Army.⁶⁹ There are three, 12-week OCS classes per year. An OCS class consists of five companies, each with up to 160 candidates. The OCS and TAP-C leadership coordinated for a company of officer candidates to participate in the TAP-C physical training program as an intervention group, and another company to serve as a comparison group.

The intervention company had their fitness programs created and implemented by the TAP-C fitness experts, and they were trained in a dedicated space free of resource competition. The comparison company conducted physical training as is usual for OCS. This training model does not aim to validate the Army's H2F program. However, the training effects of the TAP-C program may inform considerations as the Army and other tactical athlete organizations shape the future of unit-level physical training. Thus, the purpose of this study was to determine the difference in training effects of a 12-week fully resourced physical training program designed by certified fitness experts on officer candidates, as compared to the more traditional, less-resourced physical training plan designed and led by OCS cadre.

Methods

Participants

The data of 228 (179 male [26.74 ± 3.78 years] and 49 female [26.55 ± 4.18 years]) officer candidates enrolled in OCS at Fort Benning, Georgia were analyzed in this study. The data of all 228 officer candidates were used to examine Army Combat Fitness Test (ACFT) performance. The data of 170 of the 228 officer candidates (148 male [26.44 ± 3.72 years] and 22 female [25.77 ± 4.05 years]) were used to examine additional TAP-C physical performance measures. The 58 (31 male [28.16 ± 3.76 years] and 27 female [27.19 ± 4.26 years]) officer candidates who did not participate in the TAP-C data collection were not available because of various non-disclosed conflicting requirements. The data for 18 (9 male and 9 female) officer candidates were excluded from analysis because of incompleteness. The United State Army Center for Initial Military Training and the Auburn University Institutional Review Board approved the study protocol.

Study Design

A retrospective cohort study design was used to determine the effect of a 12-week fully resourced physical training program designed by certified fitness experts on officer candidates, as compared to the traditional, less-resourced physical training plan designed and led by OCS cadre. All data in this study was collected and maintained by the OCS or the TAP-C personnel, and then provided to the researchers for analysis.

Procedures

Two OCS companies were randomly assigned to participate in a 12-week long physical fitness training program. One company was assigned as the intervention group and the other company assigned as the comparison group. The intervention group consisted of 112 (86 male and 26 female) participants, and the comparison group consisted of 116 (93 male and 23 female) participants. The intervention group's physical training was planned, resourced, and implemented by the TAP-C certified fitness experts. The comparison group conducted physical training led by OCS cadre. The training program start dates for the two groups were offset by 21 days. Both groups received 25 exercise sessions over the 12 weeks that were specific to their assigned group. Sessions associated with standardized OCS physical requirements and common to both groups (foot marches, unit runs, field training, and land navigation) were not counted. The ACFT and TAP-C physical test battery (combined mobility assessment, grip strength, standing broad jump, and maximum pull-ups) were selected to measure physical fitness adaptations because they collectively provide a comprehensive assessment of participant fitness.

Both groups completed a pre- and post-test for all physical performance measures. The specific components of fitness each event assesses is outlined below.

Physical Performance Measures

ACFT: The OCS cadre administered the Army Combat Fitness Test (ACFT) to participants in accordance with the standards codified in ATP 7-22.01 *Holistic Health and Fitness Testing*.⁵ The ACFT consist of a 3-repetition maximum deadlift (MDL), 10-pound medicine ball standing power throw (SPT), hand-release push-ups (HRP), 250-meter shuttle-run (SDC), hanging leg tuck to elbows (LTK), and 2-mile run (2MR).^{4,5} The ACFT assesses muscular strength, explosive power, agility, balance, flexibility, anaerobic endurance, muscular endurance, and aerobic endurance.^{1,4,5} A maximum of 100 points per event can be earned. The final ACFT score is the sum of the points earned for the six events.

Mobility Assessment: Participants completed the overhead squat and shin box mobility assessments to evaluate movement competency.⁴⁶ They assess flexibility, mobility, and overall movement comparison of the body.⁴⁶ The results of these screens inform fitness experts on readiness of their clients to work under load safely, as poor technique is associated with a heightened risk of injury.^{59,60} The same strength and conditioning coach assessed all candidates on each respective assessment to standardize scoring. A maximum score of six points between the two assessments was possible, three points per mobility assessment. Participants that displayed no movement deficiencies earned three points, and those experiencing physical pain received zero points.

Grip Strength: Participants completed the hand grip strength tests using a Baseline hydraulic hand dynamometer (Fabrication Enterprises Inc., Irvington, NY, USA). This test

measures the fitness component of muscular strength.⁴⁶ They grasped the hand dynamometer between the fingers and the palm, at the base of the thumb in the hand being tested. When ready, they gripped the dynamometer as hard as possible while simultaneously raising their arm from their side to directly out in front of them until parallel with the ground. This process was completed once for the right and once for the hand.

Standing Broad Jump: Participants jumped forward as far as possible from behind a line. This test measures the fitness component of muscular power.⁴⁶ The distance of the jump was measured by a member of the TAP-C cadre. If the participants fell backwards and touched the ground with their hand and or took a step forward or backward after landing, the attempt was invalidated. Participants all received three test attempts, with the longest jump recorded.

Maximum Chin-Ups: Participants conducted the pull-up test at the exercise stations in the TAP-C. This test measures the fitness component of local muscular endurance, provided the repetitions are submaximal.⁴⁶ The test was administered by a member of the TAP-C staff. The participants suspended themselves, arms with extended, from handles mounted on the workstation rack apparatuses. The palms of their hands were oriented away from their body. When ready, participants pulled themselves up in a controlled manner until their chin was parallel or above their knuckles and then lowered their body in a controlled manner back down to the fully extended hanging position. Movement from the fully extended hanging position and back constituted one repetition. Participants completed as many repetitions as possible.

Statistical Analyses

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) for Macintosh Version 27 (IBM Corporation, Armonk, New York, NY) and Microsoft

Excel 2018 (Microsoft, Redmond, WA). Analysis of covariance (ANCOVA) was used to evaluate main effects of company on the ACFT and TAP-C physical test battery. ANCOVA was used to compare differences of main effects of company on ACFT measures for the groups of 228 and 170 officer candidates. The covariates of pretest score differences, sex, and prior participation in collegiate athletics were controlled for during main effect testing. An *a priori* alpha level of 0.05 was used to determine statistical significance of effects. Bonferroni post-hoc analysis was conducted on all significant main effect findings. Partial Eta-Squared (η^2) effect sizes were calculated for each outcome variable. Effect sizes were classified as the commonly accepted approximations of small (.01), medium (.06), and large (.14)⁷¹ The data failed tests of normality and homogeneity of variance; however, these violations are negligible with the large sample size and generally equal sized groups.⁷³ The covariates violated the homogeneity of regression slopes assumption on instances of main effect testing; however, the statistical model was robust to these violations.

Results

There was a significant effect of group on ACFT overall performance ($N=228$), $F(1, 223) = 12.8$, $p < .001$. The effect size for this analysis ($\eta^2 = .054$) was medium. There was also a significant effect of group on the performance of five of the six ACFT events: MDL, $F(1, 223) = 5.44$, $p = .021$; HRP, $F(1, 223) = 11.67$, $p < .001$; SDC, $F(1, 223) = 20.06$, $p < .001$; LTK, $F(1, 223) = 16.95$, $p < .001$; and 2MR, $F(1, 223) = 23.76$, $p < .001$. The effect size for MDL ($\eta^2 = .024$) was small. The effect sizes for HRP ($\eta^2 = .050$) and LTK ($\eta^2 = .071$) were medium. The effect sizes for SDC ($\eta^2 = .083$) and 2MR ($\eta^2 = .096$) were medium to large. There was no significant effect of group on SPT performance, $F(1, 223) = .067$, $p = .80$. Post-hoc analyses

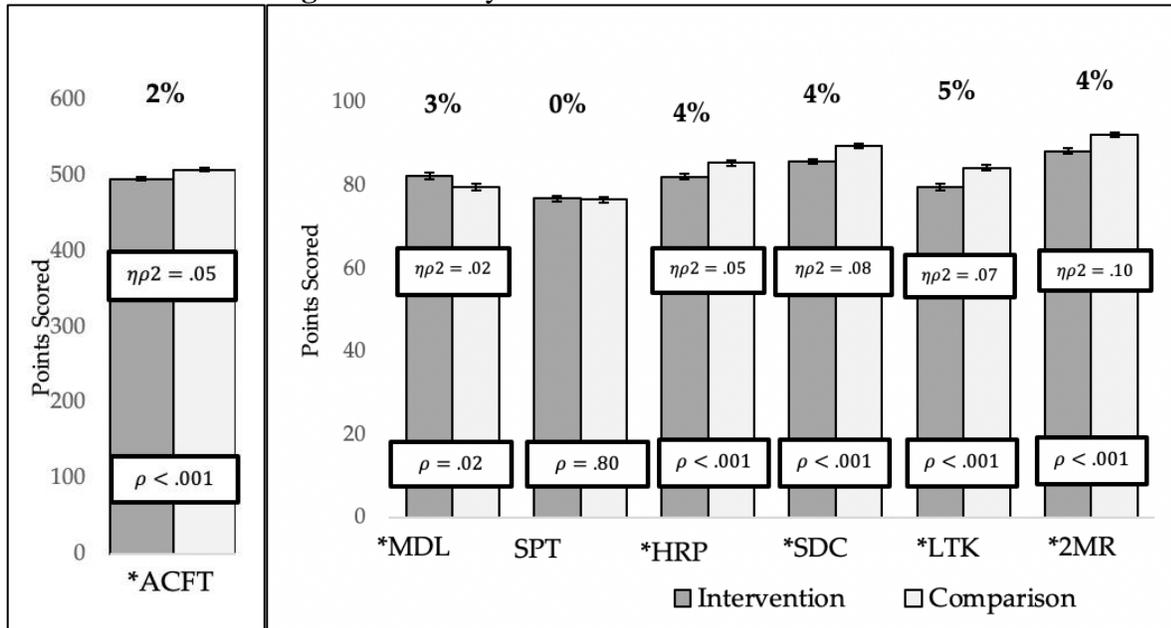
indicated the comparison group performed significantly better on the ACFT, HRP, SDC, LTK, and 2MR, and the intervention group performed significantly better on the MDL (Table I and Figure 11).

TABLE I. Army Combat Fitness Test Posttest Results

	N	Posttest Score (points: 0-100)				Posttest Score (raw)			
		Mean	SD	Adjusted Mean	SE	Mean	SD	Adjusted Mean	SE
*ACFT									
Intervention	116	494.23	54.34	496.32	2.40	–	–	–	–
Comparison	112	510.37	54.08	508.36	2.35	–	–	–	–
*MDL									
						Pounds		Pounds	
Intervention	116	80.53	13.7	82.47	0.79	249.82	67.33	259.53	3.33
Comparison	112	81.71	13.69	79.83	0.78	255.17	67.13	245.8	3.27
SPT									
						Meters		Meters	
Intervention	116	77.20	11.90	76.99	0.66	8.93	2.28	8.82	0.09
Comparison	112	76.55	11.32	76.75	0.64	8.78	2.28	8.89	0.09
*HRP									
						Repetitions		Repetitions	
Intervention	116	82.35	10.07	82.3	0.69	42.12	10.88	41.81	0.72
Comparison	112	85.54	9.73	85.59	0.68	45.56	10.70	45.85	0.71
*SDC									
						Time (minute:second)		Time (minute:second)	
Intervention	116	85.92	11.45	86	0.58	01:54	00:17	01:54	00:03
Comparison	112	89.70	11.03	89.62	0.57	01:51	00:42	01:51	00:03
*LTK									
						Repetitions		Repetitions	
Intervention	116	79.90	11.86	79.87	0.79	10.11	5.78	10.40	0.31
Comparison	112	84.43	12.84	84.46	0.78	12.32	6.30	12.03	0.30
*2MR									
						Time (minute:second)		Time (minute:second)	
Intervention	116	88.34	8.63	88.48	0.56	15:09	01:26	15:06	00:06
Comparison	112	92.44	8.01	92.3	0.55	14:24	01:30	14:27	00:06

*Indicates statistically significant ($p < .05$) difference between Intervention Group and Comparison Group. Abbreviations: ACFT, Army Combat Fitness Test; MDL, 3-Repetition Maximum Deadlift; SPT, Standing Power Throw; HRP, Hand-Release Push-Up; SDC, Sprint- Drag-Carry; LTK, Leg Tuck; 2MR, 2-Mile Run; SD, Standard Deviation; SE, Standard Error.

Figure 11. Army Combat Fitness Test Posttest Results



*Indicates statistically significant ($p < .05$) difference between Intervention Group and Comparison Group. Values and depictions on the chart reflect adjusted mean and standard error of the mean. Abbreviations: ACFT, Army Combat Fitness Test; MDL, 3-Repetition Maximum Deadlift; SPT, Standing Power Throw; HRP, Hand-Release Push-Up; SDC, Sprint-Drag-Carry; LTK, Leg Tuck; 2MR, 2-Mile Run.

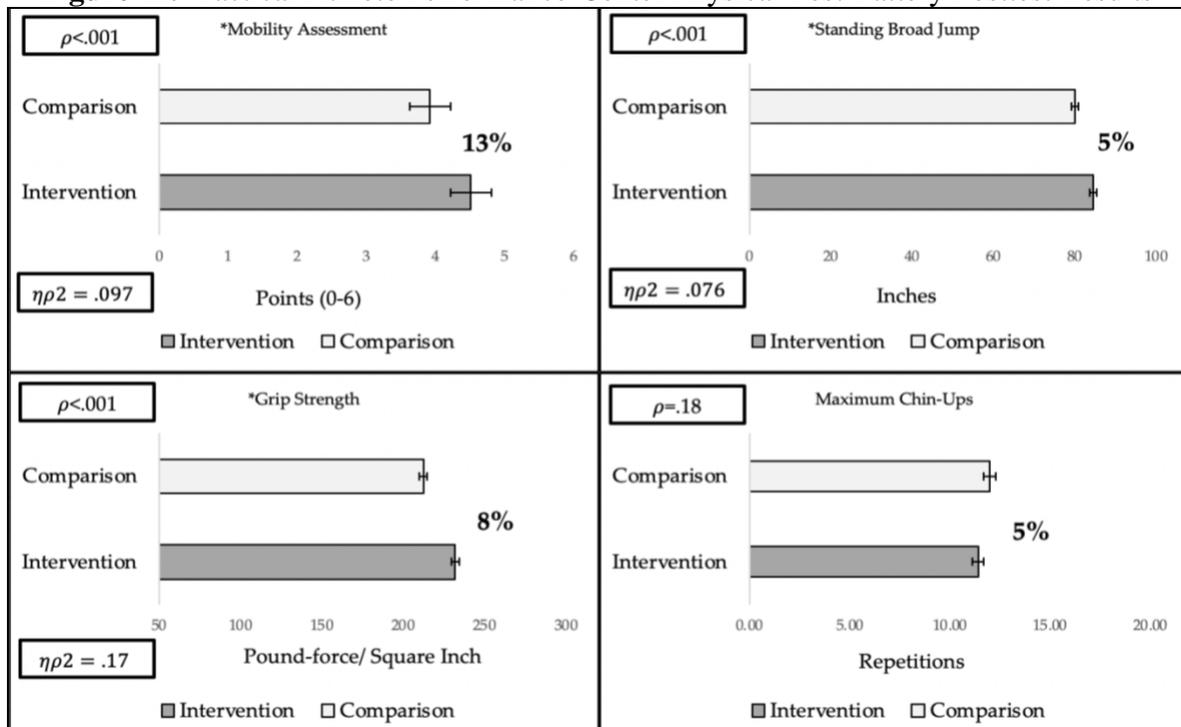
There was a significant main effect of group on the performance of three of the four TAP-C physical tests: mobility assessment (MS), $F(1, 165) = 17.77, p < .001$; grip strength (GS), $F(1, 165) = 33.52, p < .001$; and standing broad jump (SBJ), $F(1, 165) = 13.65, p < .001$. The effect size for MS ($\eta^2 = .097$) and SBJ ($\eta^2 = .076$) was between medium and large. The effect size for GS ($\eta^2 = .17$) was large. There was no significant effect of group on maximum chin-ups (CU) performance, $F(1, 165) = 1.82, p = .18$. Post-hoc analyses indicated the intervention group performed significantly better on the SBJ, MS, and GS (Table II and Figure 12).

TABLE II. Tactical Athlete Performance-Center Physical Test Battery Posttest Results

	N	Posttest Score			
		Mean	SD	Adjusted Mean	SE
*Mobility Assessment		Points (0-6)		Points (0-6)	
Intervention	90	4.46	1.04	4.51	0.10
Comparison	80	3.97	1.04	3.92	0.10
*Grip Strength		Pound-force/Square Inch		Pound-force/Square Inch	
Intervention	90	230.44	43.50	231.88	2.31
Comparison	80	214.00	45.84	212.39	2.45
*Standing Broad Jump		Inches		Inches	
Intervention	90	84.51	12.82	84.55	0.85
Comparison	80	80.00	11.11	79.96	0.90
Maximum Chin-Ups		Repetitions		Repetitions	
Intervention	90	11.74	5.44	11.40	0.30
Comparison	80	11.59	5.56	11.98	0.31

*Indicates significant ($p < .05$) difference between Intervention Group and Comparison Group. Abbreviations: SD, Standard Deviation; SE, Standard Error.

Figure 12. Tactical Athlete Performance-Center Physical Test Battery Posttest Results



*Indicates significant ($p < .05$) difference between Intervention Group and Comparison Group. Values and depictions on the chart reflect adjusted mean and standard error of the mean.

The data for the group of officer candidates who took the ACFT was compared to the group of officer candidates who took both the ACFT and TAP-C physical test battery. The analysis found no significant ($p < .05$) difference of main effects or post-hoc results between groups.

Discussion

The purpose of this study was to determine the training effects of a 12-week fully resourced physical training program designed by certified fitness experts on officer candidate fitness, as compared to the traditional, less-resourced physical training plan designed and led by OCS cadre. The training effects of the two programs were measured by the ACFT and TAP-C physical test battery.

The findings varied by group. The comparison group performed significantly better on the ACFT events of hand-release push-ups, 250-meter shuttle-run, hanging leg tuck to elbows, and 2-mile run. The intervention group performed significantly better on the 3-repetition maximum deadlift. There was no significant performance difference between groups for the 10-pound medicine ball standing power throw. The intervention group performed significantly better on the TAP-C physical tests of mobility assessment, grip strength, and standing broad jump. There was no significant performance difference between groups for the maximum pull-up test.

Previous research suggests the intervention group's physical training program may influence long-term physical health attributed to fitness experts deliberately controlling the intervention group's exercise technique^{46,56} and running volume.⁷⁴ The comparison group did not control either of these variables. The participants in the intervention group received coaching to

improve their weightlifting and running technique. The fitness experts did not allow participants in the intervention group to increase exercise weight until they demonstrated proper weightlifting technique.⁶⁸ Proper movement technique is associated with a reduced risk of injury, especially during weightlifting.^{59,60} Coaching proper technique is a core fitness expert skill. They are trained and certified in their ability to recognize movement deficiencies and implement corrective prescriptions.⁴⁶ The TAP-C experts allocated time to educate the candidates on the science behind the exercise and to teach correct movement and lifting technique in conjunction with the scheduled training sessions.⁷⁵ Officer candidates were assigned to tiered training groups based on technique quality and strength. Those assigned to the group requiring more technique training conducted modified exercises that carried a lower risk of injury but also produced lower training effects during the study timeline. The focus on form most likely resulted in reduced training effects over the 12-week period for participants training with less weight or volume as compared to their comparison group counterparts whose progress was not restrained by proper technique requirements. It is also likely the focus on form that decreased various performance scores resulted in the intervention group performing better on the movement assessment. The intervention group received coaching on running form as well as lifting technique. A dedicated portion of every scheduled running day was spent on running form improvement. The link between proper running technique and injury is not as clear in the literature as the link between weightlifting technique and injury. However, research does suggest running form improvement may have long-term health benefits.⁷⁶

The intervention group's physical training program controlled for running volume to prevent overuse injury. The literature unequivocally supports the most common type of musculoskeletal injury in the military is associated with overuse.^{14,19,35,36,38,77} A majority of

overuse injuries are caused by a lack of recovery time after exercise, excessive physical exertion of a particular muscle group, or excessive overall physical training volume.³⁹ The intervention group dedicated seven of the 25 physical training sessions to training speed and running,⁷⁵ as compared to the 12 of 25 physical training sessions the comparison group conducted.⁷⁸ The intervention also committed four of 25 physical training sessions to completing field-based active recovery during times of more physically demanding military training being conducted by OCS.⁷⁵ These sessions were low impact and designed to expedite recovery of the body to prepare for future physical demands. The intervention group did not run further than 200 meters during the running sessions to avoid overuse injuries by reducing the number of times the foot struck the ground. Overall, the intervention group ran less distance on fewer occasions and had longer amounts of time between running sessions than the comparison group. The lower running volume and extended rest time of the intervention group likely explains why the comparison group performed better on the ACFT 2-mile run event. However, it is also probable that the comparison group would experience considerably more injuries over time than the intervention group if each group continued its training methodology. This is important because there is conclusive evidence that past injuries are highly predictive of future physical disability.^{24,34} The deleterious long-term impact of injuries goes beyond physical disability, as both mental health and sleep quality have been found to also decline as the number of musculoskeletal pain sites increases.³⁴ Similarly, individuals with poor form who forgo progression will likely temporarily outperform those taking the time to learn proper technique; however, it is likely the individuals with proper form will not only be at lower risk of long-term injury but will eventually perform better for a longer period of time.

The intervention group's unimpeded access to training with the TAP-C's strength and conditioning equipment was another considerable difference between the two groups. This capability allowed the intervention group to resistance train for 10 of the 25 physical training sessions.⁷⁵ The comparison group did not resistance train because they did not have the resources available. They did not have access to an indoor facility, and only had items such as medicine balls, large tires, kettlebells, and sparse amount of weights at their disposal. The availability and use of strength training resources likely accounted for the intervention group outperforming the comparison group on the ACFT MDL event and the grip strength test, which both measure muscular strength. The standing broad jump results are likely a product of the intervention group prioritizing strength training and explosive training over aerobic training.

The intervention group's physical training goal was to improve overall physical fitness while preventing injury.¹² Conversely, the comparison group's physical training plan was deliberately designed to improve ACFT performance. The OCS cadre member⁷⁹ responsible for creating the plan stated that was his goal, and it is evidenced throughout the comparison group's training plan design.⁷⁸ This cadre member was likely more effective than his peers at programming physical training because he received extensive training from the TAP-C experts before being assigned to work at OCS.⁷⁹ He disclosed that he integrated physical training techniques and theories learned from the TAP-C experts into his training plans and briefs.⁷⁹ He also stated that he encouraged the members of the comparison group to train to outperform the intervention group in the spirit of competition.⁷⁹ This added motivation may have permeated throughout the group and influenced performance.

The comparison group conducted tactical circuit training for 13 of the 25 physical training sessions.⁷⁸ Ten different circuit training plans were created to use in rotation on circuit

training days.⁷⁸ Eight of the 10 plans directly incorporated one or more of the ACFT events as an exercise station.⁷⁸ The remaining 12 sessions were running focused to develop aerobic and anaerobic endurance necessary to succeed on the ACFT.⁷⁸ The physical training principle of specificity states exercise adaptations in individuals are directly related to the specific way they train.⁴⁶ The comparison group specifically trained for the ACFT and likely performed better on a majority of the events as a result. There is also a possibility that repetitively training the specific ACFT events over the course of 12-weeks resulted in an unknown amount of score improvement because of technique refinement, disassociated with physical fitness adaptations. The intervention group dedicated four of 25 sessions to tactical circuits.

The intervention group's tactical circuits were very similar to the 13 completed by the comparison group; however, the exercises targeted overall fitness improvement as opposed to specific ACFT event improvement. It is not optimal to overly dedicate physical training time to improving performance on an event-specific physical test when the true goal is to achieve overall fitness that can be functionally applied to combat related physical tasks. However, the ACFT was designed to assess a broad range of physical fitness components. Specifically training for the ACFT likely produces a broad training effect that translates into functional combat performance. This highlights the value of a comprehensive physical fitness test because it results in diversification of training to achieve the desired performance on each event

Limitations

There are several limitations associated with this study. The comparison group received more ACFT event technique practice than the intervention group. This likely resulted in some score increase due to improved technique. Another limitation was a 2-week exodus of the officer candidates from OCS for the holidays that occurred within the 12-week training period. The

individual physical training choices the officer candidates made during their time away from OCS may have influenced the study training results. Body composition and musculoskeletal injury data would have benefited this study. Tracking body composition changes over time could have provided valuable information regarding the training program that may not have been revealed via purely physical performance tests. This data could also have helped explain some of the observed physical tests outcomes. The musculoskeletal injury data may have informed of long-term and immediate health effects associated with the training programs.

Conclusions and Recommendations

The effects of a 12-week fully resourced physical training program designed by fitness experts varied regarding performance on physical fitness assessments in officer candidates. Movement quality significantly improved when officer candidates received fitness expert coaching. Officer candidates with access to strength training equipment were significantly stronger than their counterparts without access. Our work suggests that there may be long-term health and performance benefits associated with fitness expert involvement. OCS units without the oversight of fitness experts are likely to train specifically for ACFT improvement. The results of this study support that fitness experts should be fully integrated into physical training programs to coach proper movement. Additionally, the findings support that fitness experts should be involved in the programming of physical training to ensure the plan is goal oriented and diverse. Finally, they support that officer candidates need to have access to strength training equipment to optimize strength adaptations. Future research could examine the long-term health and performance effects of incorporation of fitness experts and strength training resources into conventional US Army physical training.

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