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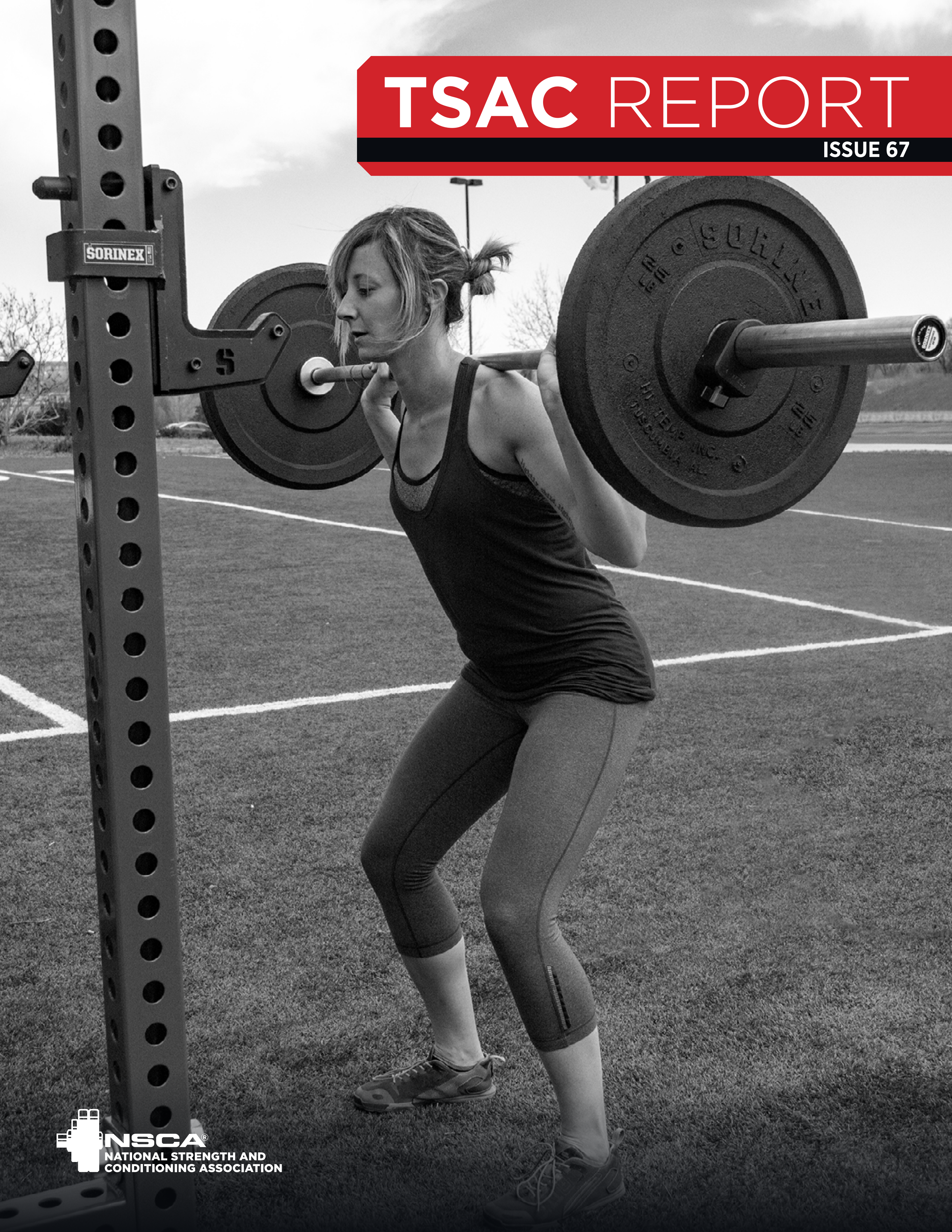

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IMPLEMENTING A TIME-EFFICIENT OCCUPATIONAL TRAINING PROGRAM FOR LAW ENFORCEMENT PERSONNEL

Present day law enforcement officers (LEOs) perform a variety of physical tasks including pushing, pulling, lifting, foot pursuits, use of physical force, victim/body drag, and obstacle clearance (10,22,24,30). On-duty shifts for LEOs can range from 8 – 12 hr or longer and may occur during morning, afternoon, and night hours (13,27). In addition to varied time of day and hours worked while on-duty, LEOs are consistently faced with the possibility of having their sedentary work time interrupted by unpredictable job tasks of a physically demanding nature (11). The need to be able to perform physically demanding tasks on a moment's notice requires sufficient levels of physical fitness that should be consistently developed during the LEO's employment.

However, there can be many obstacles that stop a LEO from achieving this. Not having a dedicated workout facility in the law enforcement agency, limited equipment, and time limitations or restrictions are just a few of the obstacles that may prohibit LEOs from attaining necessary levels of fitness to effectively perform their required job duties (20,22). Moreover, a lack of confidence in executing prescribed movements without qualified supervision may also predispose LEOs from maintaining optimal physical fitness levels (23).

Accompanying the previously mentioned limitations LEOs face in achieving optimal levels of physical fitness is decreased levels of physical activity. Decreases in physical activity levels have been reported due to an increased amount of service to an agency. Possible causes of decreased physical activity levels include time spent working in jails and detention centers, increasing LEO age, and lack of mandates on maintaining physical fitness levels after graduating from academy (11,22,25). Decreased levels of physical activity could lead to increases in occurrence of musculoskeletal injury and an increase in the number of days of service missed due to injuries sustained (11,40). To combat both decreased physical activity levels and increases in musculoskeletal injuries, a recent preliminary investigation evaluated the effectiveness of a time-efficient occupationally specific training program to improve performance in qualities related to physically demanding tactical tasks (4). This involved analyzing the effects a 15-min post-shift program would have on improving lower-body strength and speed. Separate investigations by Orr et al. suggested lower-body strength shows a direct relationship with performance in victim drags and loaded carrying (32,33). Furthermore, individual LEO speed may be improved by way of increases in lower-body power to aid in foot pursuits, sprinting, lifting, carrying heavy loads, and climbing stairs (32,33). The four-week training intervention by Bonder et al. was chosen based on convenience of the LEOs and the agency and utilized a small sample size of male LEOs (N=7) (4). This study provided a preliminary understanding of how time-efficient training can be implemented within the confines of a small agency (4). The results revealed statistically significant improvements in lower-body strength for the hex bar deadlift three-repetition maximum (HBD 3RM) ($p<0.001$). Specifically, an average increase of 4.5% weight lifted equating to 336.43 + 77.98 lb in the initial assessment and 352.14 + 74.32 lb in the final assessment. The HBD 3RM test was utilized due to previously observed correlation ($r=-0.477$ to -0.666) in relation to performance of victim/body drag capabilities and reduced horizontal bar displacement to decrease pressure on the low back (21,39).

The preceding study from Bonder et al. yielded an average decrease of 0.04 seconds in improvement of 20-m sprint performance (4). Minimal improvements in sprint capabilities could have been due to: 1) lack of cueing during 20-m sprints; 2) 20-m sprints performed on carpet; and 3) lack of time to yield larger improvements. A previous study from Gil et al. reported a 3% overall improvement in 20-m sprint times over the course of six-weeks (12). Furthermore, Pareja-Blanco et al. observed improvement in 20-m sprint times (measured in seconds) with the use of light-sled tow exercises, over the course of eight weeks (pre=3.15 + 0.13 vs. post 3.10 + 0.11) (35). Nonetheless, the training intervention utilized by Bonder et al. may be used as a guide to time-efficient training program design (4).

SEDENTARY TIME

LEOs face the prospect of being sedentary for much of their time on-shift. The average activity level observed by LEOs is an average of 1.6 metabolic equivalents (METs), which is comparable to common activities of sitting, standing, ironing, or holding a baby (36). Furthermore, as much as 80 – 90% of a LEOs shift is filled with sedentary time (42). Additionally, as many as six hours of a 12-hr shift is spent sitting in their vehicle while on-duty (13). Included in the six hours is nearly three hours dedicated to working on their mobile data terminal (13). Use of a mobile data terminal has led to observations of injury and discomfort specific to the low-back and right shoulder because of unnatural postural deviations (29). Injuries related to the low-back may be a direct effect of the decrease in physical activity levels among LEOs. Depressed levels of physical activity may lead to decreases in physical fitness, with a potential downstream effect of loss in proficiency of tactical tasks associated with law enforcement duties (22).

Concurrent with mobile data terminal use and time spent sitting in a police car, 25% of present-day LEOs are considered "prolonged drivers," logging upwards of 25,000 km traveled per year (7). Perhaps, not coincidentally, 18% of those LEOs considered prolonged drivers also experienced pain centralized to the low back while driving (7). Additional factors of sedentary time leading to negative performance outcomes include amount of time spent working in jails and detention centers, irregular work hours and conditions leading to poor food choices, and an observed inverse relationship between body fat percentage and physical fitness levels in male and female LEOs (25,28,41).

The amount of sedentary time LEOs encounter throughout their shift and the unique injuries and negative performance outcomes experienced as a result of their downtime should be factored in when designing time-efficient programs for the law enforcement community.

INJURY STATISTICS AND COMMON INJURY SITES

LEOs are at risk of incurring large costs related to injury in addition to facing the potential of numerous days of missed service. Data from Lyons et al. reported injury costs ranging from $2,500 up to $12,000 (USD) depending on the injury sustained (26). A separate analysis from Violanti et al. utilizing data spanning 16 years, noted that LEOs miss approximately 15 days of work per year on average due to injuries sustained on duty (40). The prior statistics on injury cost and extensive work time missed due to injury highlight the need to have a trained tactical practitioner on-staff at all agencies.

Owing to persistent and excessive lumbar flexion, LEOs are susceptible to acute and chronic low-back pain. Lyons et al. lists a range of 240-2,500 injuries per 1,000 law enforcement personnel per year with the torso and back being the most common site of injury (26). A cross-sectional study conducted with the Quebec Police Department revealed nearly 70% of respondents to an online survey had the perception their low-back pain was directly related to work on the police force (3). Burton et al. observed an increased length of service to an agency was related to more frequent and recurrent episodes of low-back pain (6). Cardoso et al. noted injuries to the low back as a result of wearing a duty belt and lack of lumbar support (7). Furthermore, in a large cross-sectional study (n=4,185), Larsen et al. reported a 41.3% prevalence of multi-site musculoskeletal pain occurring at least one day per week for the previous three months (19). Specifically, the low-back was reported to be the most often injured site (43.2%). Lastly, other common injury sites requiring appropriate attention in training programs include the shoulder, waist, and neck (9).

TIME-EFFICIENT TRAINING PROGRAM DESIGN PRINCIPLES

As stated by Lockie et al., most LEOs do not have time allotted during their day to follow traditionally programmed and periodized training routines (22). For this reason, the program outlined in Table 2 is recommended to limit rest times to as long as a LEO needs to recover, but not to exceed two minutes between sets. Furthermore, the program may be broken into separate 15 – 20 min components while still yielding improvements in musculoskeletal fitness (15,18). When designing time-efficient training programs for LEOs, numerous variables must be considered: primary tactical task being developed, amount of equipment and space provided by the agency, past and current injury history, amount of instruction necessary, and, perhaps most importantly, exercise selection based on available equipment and space. As mentioned earlier, policing requires LEOs to perform various physical tasks all having different fitness qualities. Necessary physiological traits include lower-body power and speed to aid in foot pursuits and obstacle clearance, strength-endurance for sustained physical force application, absolute and relative strength to assist with victim/body drag capabilities, and a focus on proper joint mobility and stability to reduce chance of injury (10,22,32,33). Each quality mentioned requires specific training methods, programming, and sufficient rest periods to achieve the desired training outcomes (37). The amount of equipment and space provided by the agency will dictate the types of movements that can be trained and common movements that may need to be modified. In turn, the equipment and space available will partially dictate the programming capabilities.

Each program should begin after the LEOs have signed a liability waiver for the agency. Additionally, completing a needs analysis with a Certified Strength and Conditioning Specialist® (CSCS®) or Tactical Strength and Conditioning Facilitator® (TSAC-F®) to determine unique individual needs, especially in regard to current and past injury history, is essential. If a qualified practitioner is not available, the following tables will provide choices for various exercises and movement patterns that can be self-selected to improve physical qualities related to tactical tasks. Lastly, the amount of technical instruction needed for each movement must be considered when planning time-efficient tactical programs.

The time-efficient training intervention outlined in Table 2 provides a unique approach to tactical training and injury reduction strategies. The movements referenced in both Table 1 and Table 2 may be found in the *Essentials of Strength Training and Conditioning (4th ed.)* chapters 14 – 16 or in *Strength Training (2nd ed.)* from the National Strength and Conditioning Association (NSCA) (5,8,14,17). Additionally, readers are directed to utilize the video collection on the NSCA website (NSCA.com) for further reference on selected exercises and proper technique.

Beginning with the warm-up, movements should be specific to the performance component being trained and improve muscular contractions by way of reduced muscular viscous resistance (1,34). The dynamic stretches and warm-up movement patterns provided mimic neuromuscular patterns often seen in common tactical tasks. Table 1 provides LEOs with several options for dynamic stretches and movement patterns that may be selected as part of the warm-up routine. Warm-up choices should be based on the main movement(s) to be performed during the training session and prepare the LEOs accordingly. Warm-up stretches and movements are provided based on the biomechanics of commonly encountered tactical tasks. For example, walking knee lift, straight-leg marches, walking over and under, and hurdle or box jumps can be used to prepare LEOs for sprinting/foot-pursuits and obstacle clearance. Furthermore, the exercises included in Table 1 and Table 2 have been shown to stimulate improvements in musculature related to improved postural and balance capabilities, as demonstrated by Shim et al. (38). Additionally, push-up plus, banded rows, and jumping jacks can prepare LEOs for pushing and pulling patterns encountered during training and while on-duty. To improve general flexibility, both dynamic stretches and warm-up movements should gradually progress throughout the set to be performed through larger ranges of motion (17). Dynamic stretch and movement selections can be altered as needed based on agency population, individual training needs, equipment and space availability, and individual time constraints.

The warm-up and training program provided can be tailored, and should be periodically adjusted, to meet the needs of the population of the law enforcement agency and the individual. Programming can be provided to focus on improving muscular strength, power, endurance, mobility, and stability. The preceding physiological improvements may then lead to improved performance in occupational tasks including sprinting, pushing, pulling, dragging, and lifting. Additionally, training may need to be focused on reducing the occurrence of common injuries and discomfort frequently experienced by LEOs. Exercise selection should include compound, multi- joint movements with appropriate intensity and rest period prescriptions to achieve desired training outcomes in relation to the tactical task being trained for. Remember, this is a time-efficient training program for LEOs with limited time in their day dedicated to training, making single-joint, isolation movements a low priority.

Table 2 provides a sample, five-day per week time-efficient training program that focuses on several performance components related to daily LEO tasks. Rest periods between sets and exercises will be as long as a LEO needs to recover, not to exceed two minutes (16). Each day of the five-day program includes a warm-up that may be modified as needed using Table 1. Monday and Friday have a focus on improving performance in foot pursuit and obstacle clearance. Tuesday and Thursday are designed to improve the power and capacity of the aerobic system, necessary for sustained cardiovascular endurance and recovery from physically demanding tasks. Wednesday is focused on strength and power development vital for improving performance in common tactical tasks.

Each day of the program may be adjusted to be a 20 – 50 min program, depending on time availability. Both the Monday/Friday and Tuesday/Thursday programs can be lengthened, as time allows, by adding repetitions or rounds to each of the drills. Wednesday's program may be lengthened by adding more repetitions and sets as fitness levels improve. Additionally, tactical

TABLE 1. WARM-UP ROUTINE OPTIONS

DYNAMIC STRETCHES	SETS / REPS	MOVEMENTS	SETS / REPS
Upper Body	**1 / 10**	**Upper Body**	**1 / 10**
Arm Swing		Push-Up Plus	
Inchworm		Bodyweight Rows	
Supine T-Spine Rotation (5 each side)		Banded Rows	
Banded Rows		Cook Squat	
Lower Body	**1 / 10 (each leg)**	**Lower Body**	**1 / 10**
Walking Knee Lift		Squats (BW)	
Heel-to-Toe-Walk		Jumping Jack	
Walking Over and Under		Walking Lunge (10 each leg)	
Inverted Hamstring		Side Lunge (10 each leg)	
Straight Leg March		5 Min Walk/Slow Cycle	
Quad Pull		Hurdle Jumps/Box Jump (12"+ Height)	
Leg Swing (Forward and Backward)			

(BW = bodyweight)

facilitators may decide to increase focus on strength and power development while minimizing focus on drills. In this example, the Wednesday program would be performed 2 – 3 days per week, allowing at least 48 hr of recovery between workouts, at which time the Monday/Friday and Tuesday/Thursday program could be performed once each. Following the recommendations of Sheppard and Triplett, power movements should take priority in workouts, followed by strength movements and finishing with assistance exercises (37). Dumbbells, kettlebells, and barbells can be substituted for use in strength and power movements as needed. Distance for drills and intervals may be modified based on space and cardio equipment availability.

PRACTICAL APPLICATIONS

Present day LEOs face the possibility of experiencing excessive amounts of sedentary time, along with unpredictable bouts of high-intensity physical activity. The physical stress of unpredictable physical activity coupled with sedentary time spent sitting in uncomfortable positions expose LEOs to various injuries related to the low back, neck, shoulders, waist, trunk, and knees. While injury risk can never be eliminated completely, effective programming can serve as a positive mode of injury reduction due to improved mobility, stability, and strength of muscle and connective tissue (tendons and ligaments). Despite the positive influence an effectively designed tactical training program can have on the tactical performance of LEOs, time constraints are always present. Limited time dedicated to training can lead to

TABLE 2. SAMPLE TIME-EFFICIENT TRAINING PROGRAM

MONDAY AND FRIDAY (SPEED, AGILITY, AND QUICKNESS FOCUS)	
Warm-Up	Push-ups + BW squats + leg swings (forwards and backwards) + side lunging + jumping jacks = 10 reps each
Main Body (Rest Periods between Reps Not to Exceed 2 min)	*From two-point starting stance* Jogging 10 – 30 yards (x3) Sprint 10 yard to half-kneel position (x2) Sprint 20 – 30 yards (x2) T-drill (x2) 5-10-5 (pro-agility) (x4) (2xL + 2xR)
Cooldown	Seated hamstrings, lying side quadriceps, supine glute-piriformis, foam roll IT band
TUESDAY AND THURSDAY (AEROBIC POWER AND CAPACITY FOCUS)	
Warm-Up	Rhythmic toe touch + inverted hamstring stretch + straight-leg kicks + Spiderman crawl + forward lunge with elbow to instep + walking knee lift + heel-toe walk = 10 total reps of each 5 min walking or slow cycling
Main Body	10 min interval running or cycling (5 s maximum effort/55 s recovery)
Cooldown	Core work for 5 min
WEDNESDAY (STRENGTH AND POWER FOCUS)	
Warm-Up	Push-ups + BW squats + leg swings (forwards and backwards) + side lunging + jumping jacks = 10 reps each
Main Body	Barbell complex (RDL + front squat + push press) bar or 25% of 1RM 2x5 each exercise Overhead medicine ball toss (each toss for maximum height) 4x5 Depth falls (height 12”+) 4x4 total reps Hurdle jumps (height 12”+) 4x3 Backward over shoulder medicine ball throws (8 – 30 lb) x 10 Hex bar deadlifts 2x5 at 75 – 85% 1RM
Cooldown	Cook squat, shoulder dislocates with stick, cat-cow, warrior pose

declining physical fitness and increases in musculoskeletal injury due to excessive stress and overuse (2). Considerations to take into account when designing a time-efficient tactical training program include the following:

1. Common tactical tasks encountered while on-duty: Common LEO tasks include, but are not limited to pushing, pulling, lifting, foot pursuits, use of physical force, victim/body drag, and obstacle clearance. Possible exercises to utilize in training to address these movement patterns include: upper-body pushing and pulling exercises such as close-grip bench press and single-arm dumbbell rows, sled pushes, tows, HBD, sprints of various distances, and depth falls to accustom the LEOs to forces associated with proper landing from obstacle clearance.

2. LEO equipment and space limitations: Training programs must account for both equipment and space limitations of individual LEOs. Movements may need to be modified to account for limitations.

3. Amount of sedentary time: Many LEOs spend, on average, half of an 8- to 12-hr shift in a seated position. Excessive sitting and contorting in uncomfortable positions to work on a mobile data terminal could lead to prolonged lumbar flexion and injuries to the right shoulder and low back. Referring to the exercises listed in Table 1 and Table 2, they may additionally be implemented as a corrective exercise method to improve low-back and shoulder pain as suggested by Bonder et al. and Niederbracht et al. (4,31).

4. Common injuries: Knowledge of common injuries sustained by LEOs can guide proper exercise prescription and selection to promote injury reduction.

5. Time constraints: Many LEOs work long shifts, leading to limited time to dedicate to training. Time-efficient training programs of varying time and focus can be designed to best suit the needs of LEOs. Table 1 provides movement options to prioritize for the warm-up. Table 2 is a sample of a weekly training program that could be used by an agency and adjusted based on equipment/space availability. Take into account rest periods and prioritize compound, multi-joint, and full-body movements.

Time-efficient training programs can be useful to combat declines in physical fitness that accompany long service to a law enforcement agency. Additionally, a time-efficient training program is a viable option to work around time constraints often faced by LEOs. Lastly, time-efficient training programs can be tailored to suit the needs of LEOs leading to sustained performance in tactical tasks, reduced chance of musculoskeletal injury, decreased number of workdays missed, and money spent due to injury.

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CORRELATING SEX-SPECIFIC MILITARY PERFORMANCE TRAINING TO COLLEGIATE LACROSSE

Disclaimers: The opinions or assertions contained herein are the private views of the author, and are not to be construed as official, or as reflecting true views of the Department of the Army or the Department of Defense.

WHY COLLEGIATE LACROSSE CAN TRANSLATE TO MILITARY TALENT MANAGEMENT

The Special Forces community has historically leveraged principles and practices of professional teams in the National Football League (NFL) and the Olympic Training Center to develop its human performance optimization programs (9). Aligned with these efforts, we gathered data from two historically successful and nationally ranked collegiate men's and women's lacrosse programs to extend reach from Special Forces to the conventional United States Army. Lacrosse was our desired sport of choice because several parallels can be drawn between the high physically-demanding tasks required for Soldiers such as for light infantry/airborne units and those of lacrosse players: agility, balance, coordination, power, speed, strength, and endurance.

In 2015, a task force of experts in military performance reached a consensus that the current Army Physical Fitness Test (APFT) used to evaluate physical fitness of conventional United States Soldiers did not have cross-functionality to military operational specialties (MOS) (4,8). Specifically, the APFT did not sufficiently address: 1) skill (a combination of agility, balance, coordination, power, reaction time, and speed), or 2) integration of strength and conditioning domains (strength, power, and endurance). Thus, there was a need for new testing criteria that could better predict military performance, specifically for high-physically demanding and life-saving tasks (e.g., evacuating a casualty and breeching a 10-ft wall with body armor).

As a result, Army leadership began to champion a new physical fitness test, termed the "Army Combat Fitness Test" (ACFT). The ACFT was designed to biannually test skill, strength, power, endurance, and have cross-functionality to a Soldier's military operational specialty. Soldiers from units with operational responsibilities requiring a greater number of high physically-demanding military tasks and drills would be required to score higher on the ACFT. There are six events selected for the ACFT, compared to three events for the APFT. Each event is worth up to 100 points and has a sliding scale of performance. The highest score that could be earned is 600 points. Initially, the ACFT was designed to be sex and age neutral (i.e., not weighted based on sex or age) and standardized for military operational specialties. That is, a Soldier was required to achieve a minimal score in one of three ability groups based solely on their military operational specialty.

For example, a judicial officer (male or female) may be required to achieve a score for the easiest ability group (silver or moderate) (Figure 1), whereas a light infantry/airborne officer (male or female) may be required to meet the minimum score for the most difficult ability group (black or heavy) (Figure 1). However, several years of analysis across multiple military units revealed that a sex and age neutral standard would drastically limit talent management and job capabilities while increasing attrition. The primary concern was that women assigned to light infantry and other combat arms units would be unable to meet the minimum score on the ACFT (6). This led to the development of sex- and age-specific scoring criteria, comparable to the APFT.

WHY SEX-MATCHED TRAINING MATTERS

Given the agreement towards sex-matched performance standards for the ACFT, this also means that strength and conditioning approaches to training for the ACFT ought to be sex-matched. In fact, there are noted sex differences in overall athletic performance. In general, men generate greater power during upper and lower body exercises and velocity during the execution of Olympic lifts compared to women (5,10,12,13). Women, on the other hand, have greater flexibility compared to men due to architectural differences in muscle fiber thickness and length (5,10). The broad impact of these sex differences in overall athletic performance is that it takes a minimum of six months for an age-matched female athlete following a strength and conditioning program to develop strength and power comparable to an age-matched untrained male, especially for a military performance test (7). Therefore, accelerated timelines of increasing percent working weight (% load) in a strength and conditioning program could place a female at greater risk for injury (2). To date, it is well known that musculoskeletal injuries (MSKI) is the number one reason for a decrease in military readiness, impacting career progression, training output, and deployment status in military personnel (11). Prevailing risk factors for MSKI in the military are also holistic in nature with female sex being the greatest non-modifiable risk factor (11).

The military has traditionally overlooked sex-specific strength and conditioning programs due, in part, to a lack of sufficient resources. The military is designed to physically condition a minimum of 60 Soldiers (company-sized unit) at once. Barriers include inadequate space, a low cadre to Soldier ratio, and limited knowledge of gold-standard strength and conditioning principles and practices in the formation to effectively implement inter-individualized and sex-specific programming. There has also never been any formalized Army-written doctrine that has focused on military performance optimization based on sex. Another confounding factor is scheduling. Units often fight to occupy the limited number of resources devoted for strength and conditioning as well as duty day/mission requirements, leading to inconsistency in time of training, duration of training, and focus (goal-setting) of training. In recent years, the Army has made concerted efforts to address these challenges through the implementation of the Holistic Health and Fitness (H2F) program. H2F is centered around Soldier optimization through inter-individualized programs. H2F is also intended to model inter-individualized programs of elite collegiate and professional athletic programs to the extent that H2F has even effectively employed strength conditioning coaches, athletic trainers, dieticians, and sports psychologists from these collegiate and professional programs.

LESSONS LEARNED FROM MEN'S AND WOMEN'S NATIONALLY RANKED LACROSSE PROGRAMS

While the issue of sex-specific strength and conditioning programs has been addressed previously, the military, with its mindset of "winning matters," often refers to best practices of athletic programs (8). Therefore, our overall intent was to identify a historically successful collegiate program that has integrated a sex-matched pre-season strength and conditioning training regimen to provide real-world principles and practices back to the military. We used the same ideology of the Special Forces community, which has leveraged principles and practices of professional teams in the NFL, National Hockey League (NHL), and the Olympic Training Center to develop their human performance optimization programs. We aimed to use quantitative data collection and analysis to capture how these winning collegiate teams approach strength and conditioning from the perspective of sex. In recent years, our team has worked with one university that fields both National Collegiate Athletic Association (NCAA) Division I men's and women's lacrosse teams that were nationally ranked (2017 – 2019). Lacrosse was our desired sport of choice because several parallels can be drawn between the high physically-demanding tasks required for Soldiers such as for light infantry/airborne units and those of lacrosse players: agility, balance, coordination, power, speed, strength, and endurance. Second, the age of collegiate play and military service overlap (mean+/- SD: age: 19.6 +/- 1.7 years; range: 18 – 23 years).

From our initial assessment of pre-season strength and conditioning programs (n=46, men; n=33, women), we discovered that the men's lacrosse program had two strength cycles of periodization for each of the three foundational lifts: back squat, deadlift, and bench press (Figure 2A). These two cycles were followed by a two-week de-loading phase (coinciding with the Thanksgiving holiday). The men's strength program exhibited three key trends: a) the first cycle was 11 weeks and the second cycle was four weeks; b) the starting working weight for each cycle was no greater than 60% (relative to an athlete's historical one-repetition maximum [1RM]) for each lift with the percent working weight increasing by 5% weekly; and c) the first cycle built up to a maxing week at 95% effort or greater for each lift. The second cycle was more for strength maintenance as it immediately preceded the competition season. It should be noted that maximal strength is not the most important athletic performance attribute, but rather one scalable and measurable attribute of those required for Soldiers to execute high physically-demanding tasks. Other attributes include speed, power, cardiovascular endurance, balance, and coordination.

In contrast, the women's lacrosse program had three strength cycles of periodization for back squat, deadlift, and bench (Figure 2B). There was a rest week between each cycle (coinciding with holiday breaks). Three key trends for the women's program that differed from the men's program were: a) all cycles were four weeks; b) the starting working weight for each cycle was +/- 5% of 70% (relative to an athlete's historical 1RM) for each lift with the percent working weight increasing by 5% weekly; and c) each cycle built up to a maxing week at 80% effort for back squat, 75% for deadlift, and 90% for bench press. For all lifts during a single strength cycle, women were at 45% working weight (on average) of men for back squat, deadlift, and bench press. Men, on average, exhibited a 45-lb increase for back squat, deadlift, and bench across a strength cycle, whereas women had less than a 15-lb increase for each lift.

FINAL THOUGHTS AND WAY AHEAD

It is important to note these data simply provide a one-year "snap-shot" of the average training loads and progressions for one sex-comparable sport and therefore may not account for individual differences in training volume based on training age and playing status. For instance, strength and conditioning coaches for these teams presently implement training programs of higher volume and longer duration for athletes with less training experience (which traditionally aligns with chronological age) as well as those who see less playing time during competition. In contrast, programming for more experienced athletes (i.e., higher training age and those seeing more field action) is centered on shorter periodized cycles that allow for a greater variation of training stress (e.g., exercise selection, sets, repetitions, and intensity schemes) to avoid training accommodation.

For these reasons, these data can be used to develop data-informed recommendations and refine current approaches towards training men and women part of military and tactical training programs. These data can be leveraged by H2F as well as Preservation of the Force and Family (POTFF) to optimize readiness, talent management, and reduce attrition. Today's military force is no longer a "one size fits all" model. Although resources and scheduling are still problematic, the military is working towards a solution of implementing inter-individualized and sex-specific programs of strength and conditioning. Through the availability of "winning" case studies presented here, military leaders are equipped with additional knowledge and models for how to implement sex-specific programs. Moreover, as more women continue to join traditionally male tactical units (e.g., combat arms) and as military organizations become increasingly pressured to reduce the sex gap, knowledge, models, and implementations of sex-specific strength and conditioning programs will become more critical.

Points	MDL	SPT	HRP	SDC	LTK	2MR	
70	200	8.0	30	2:10	5	18:00	HVY
69		7.8	28	2:14		18:12	
68	190	7.5	26	2:18	4	18:24	
67		7.1	24	2:22		18:36	
66		6.8	22	2:26		18:48	
65	180	6.5	20	2:30	3	19:00	SIG
64	170	6.2	18	2:35		19:24	
63	160	5.8	16	2:40		19:48	
62	150	5.4	14	2:45	2	20:12	
61		4.9	12	2:50		20:36	
60	140	4.5	10	3:00	1	21:00	MOD

FIGURE 1. SNAPSHOT OF MINIMUM AND/OR MAXIMUM PERFORMANCE REQUIREMENTS DURING THE ERA OF AGE- AND GENDER-NEUTRAL STANDARDS (INITIAL CONCEPT; 2019 – 2021) FOR EACH MOVEMENT AND CATEGORY OF THE ARMY COMBAT FITNESS TEST (ACFT)
Adapted from Headquarters, Department of the Army, Field Manual 7-22, October 2020.

HVY = heavy category (black); SIG = significant (gold); MOD = moderate (silver); MDL = pounds lifted for heaviest set of three "touch and go" trap bar deadlifts given two attempts; SPT = meters traveled for farthest backward toss of a 10-lb medicine ball given three attempts; HRP = number of hand-release pushups completed in a two-minute time frame; SDC = time to complete a sprint, drag, carry event requiring a 90-lb sled, two 40-pound kettlebell weights, and 25 m of lane space; LTK = number of leg tucks completed on a pull-up bar (recently changed to a plank hold for time); and 2MR = time to complete a two-mile run.

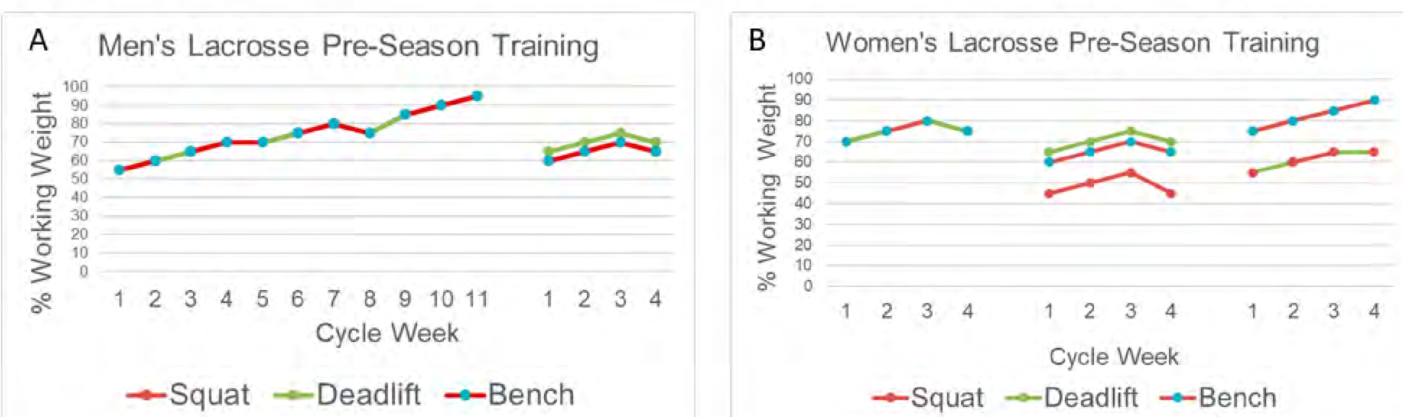

FIGURE 2. A CASE STUDY OF TRAINING OUTCOMES SHOULD BE SENSITIVE TO SEX
Training cycles and percentage working weights plotted across time for back squat, deadlift, and bench during the pre-season for two nationally ranked men's [left; A] and women's [right; B] lacrosse teams. Color overlap indicates equal percent working weights for each of the three foundational lifts.

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TSAC RESEARCH COLUMN—JULY 2022

FUNCTIONAL MOVEMENT QUALITY OF FIREFIGHTER RECRUITS: LONGITUDINAL CHANGES FROM THE ACADEMY TO ACTIVE-DUTY STATUS. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH* 18(7): 3656, 2021.

CORNELL, DJ, GNACINSKI, SL, AND EBERSOLE, KT.

Maintaining a healthy body composition has many benefits for tactical populations. Recently, researchers examined how body composition may impact functional movement quality for 38 weeks in firefighters. Twenty-six firefighter recruits (age: 30 ± 4 years, height: 179.8 ± 4.7 cm, weight: 87.6 ± 9.7 kg) participated in the data collection.

Body composition and Functional Movement Screening (FMS) data were collected three times during the study. Data were collected at the start of the firefighter training academy (W1), the end of the 16-week training (W14), and after recruits completed their 22-week probationary period as active-duty firefighters (W38). Body fat percentage was estimated using a three-site skin fold measurement performed by an experienced researcher. Functional movement screening was scored on a scale of 1 – 3 (worst to best.) Recruits completed the following movements for score: deep squat, hurdle-step, in-line lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability test. After a five-minute warm-up, recruits performed the FMS tests three times, with the highest score recorded.

During the training academy, recruits completed eight hours of training five days a week. One to two hours each day was dedicated to physical activity to develop the skills required to be a firefighter (e.g., ladder raising, victim rescue, etc.). After completing the training academy, recruits transitioned into a 22-week probationary period, where they worked 24-hr shifts on a rotating three-shift schedule.

Data showed recruits lost a significant amount of body fat (W1: 17.8 ± 4.1%, W14: 12.3 ± 3.2%) with no significant change in body mass index (W1: 27.1 ± 3.0, W14: 26.7 ± 2.3 kg/m2). There were no significant body composition changes after the probationary period. Total FMS scores also significantly increased from W1 (12 ± 2) to W14 (14 ± 2) and from W14 to W38 (15 ± 1). Additionally, when controlling for body composition, only estimated body fat ($p < 0.01$) and not body mass index (BMI) ($p = 0.09$) influenced the improvement of FMS scores. These findings indicate that decreasing body fat may help to improve functional movement. While the improvements to FMS cannot exclusively be attributed to a decrease in body fat, it did have a significant influence, whereas BMI did not. These findings indicate that maintaining a healthy BMI by decreasing body fat and increasing lean body mass can improve functional movement. Based on the data and the author citing multiple studies showing an increased risk of musculoskeletal injury when functional movement is low, tactical human performance professionals may want to monitor firefighter's body fat and FMS score during training. While maintaining an optimal individual body fat level may require consulting a Registered Dietitian Nutritionist (RDN), functional movement can be improved by increasing flexibility.

ONE OUT OF FOUR RECRUITS DROPS OUT FROM ELITE MILITARY TRAINING DUE TO MUSCULOSKELETAL INJURIES IN THE NETHERLANDS ARMED FORCES. *BMJ MILITARY HEALTH* 168(2): 136-140, 2022.

DIJKSMA, I, ZIMMERMANN, WO, HERTENBERG, EJ, LUCAS, C, AND STUIVER, MM.

Musculoskeletal injuries (MSI) impact most occupations that require heavy physical activity. This physical demand may have an even greater impact on job performance and attrition among tactical populations. Researchers in the Netherlands recently examined how MSI may impact dropout rates among recruits from elite military training.

Dropout and injury rates were collected from 482 recruits to the Royal Netherlands Marine Corps (RNMC) and 703 recruits to the Airmobile Brigade (AMB) who attended training between January 1, 2015, and December 31, 2017. The dropout rate for recruits to the RNMC was 53.9%, with the dropout rate due to MSI being 23%. Among all recruits, 68% reported suffering from MSI during training, with the most affected areas being the feet, knees, and legs. Airmobile Brigade data showed a similar rate, with the dropout rate being 52.6%, 25% due to MSI, and 44% of all recruits reported MSI during training. The MSI most commonly affecting recruits to the AMB were the back, knees, and legs.

With close to one in four recruits dropping out due to MSI, preparing military recruits before entering training is crucial to help reduce MSI injury rates. Considering the data indicated the lower body was the most affected during training, tactical human performance professionals should ensure their military athlete's lower body is well trained. Strengthening the lower body muscles can help support the commonly injured joints (knees and ankles) and decrease the effort needed for specific tasks. Utilizing the back squat to build both strength and build muscle can help to support the knee joint. Using 8 – 12 repetitions for 2 – 4 sets will focus on building both muscle mass and strength. Properly monitoring training volume and intensity will also lower the risk of injury due to overtraining. Decreasing training volume 2 – 4 weeks before military training may help reduce overtraining symptoms when the athlete is outside of the tactical human performance professional's control.

THE RELATIONSHIP BETWEEN STRENGTH MEASURES AND TASK PERFORMANCE IN SPECIALIST TACTICAL POLICE. *JOURNAL OF STRENGTH AND CONDITIONING RESEARCH* 36(3): 757-762, 2022.

ORR, RM, ROBINSON, J, HASANKI, K, TALABER, KA, SCHRAM, B, AND ROBERTS, A.

Tactical populations are responsible for carrying external loads up to and possibly exceeding 30 kg, with specialist forces usually at the higher end. Lean muscle mass can increase strength but can also increase total body mass. Researchers recently examined the relationship between absolute and relative strength among specialist tactical police officers performing occupational tasks.

Data from 47 male specialists (weight: 89.0 ± 8.6 kg) in an elite Australian police unit were analyzed. Strength was measured using a one-repetition max (1RM) test for the bench press, squat, trap bar deadlift, and pull-up. For the 1RM pull-up, officers wore a weight belt with plates hanging between their legs. Occupational tasks included a victim drag and a five-kilometer pack march. The victim drag included dragging an 85-kg dummy through a 50-m long course while wearing their tactical uniform. Participants drug the dummy for 10-s followed by a 20-s rest where they dropped the dummy. This sequence was repeated six times, recording the total distance covered. The officer's tactical uniform consisted of boots, body armor, and a helmet totaling around 15 kg. During the five-kilometer march, participants wore a 25-kg backpack in addition to their tactical uniform.

All absolute strength tests had a significant and strong correlation to victim drag performance, with relative strength showing significant but moderate correlations. The absolute deadlift strength had the highest correlation to the victim drag, accounting for 56% of the variance. Correlations to the pack march were significant, but weak to moderate associations with relative bench press, squat, and pull-up. Only absolute squat and pull-up showed a statistically significant, yet weak, correlation to the pack march. The authors noted that absolute deadlift strength may have played a more important role in lifting the dummy off the ground, while the actual movement of the dummy was more reliant on relative strength. Tactical human performance professionals working with law enforcement, especially those serving on specialist forces, may benefit from increasing trap bar deadlift strength. Increasing absolute strength may make loads easier to lift and move, but if they struggle to move those loads over long distances, their relative strength may be the issue. Decreasing body mass while maintaining strength levels will increase relative strength, which may lead to better performance carrying loads over long distances. If absolute strength and body mass are both high, a proper diet may be the best change to make to decrease body fat while maintaining strength through their regular training. Improving endurance may also assist in improving longer duration activities. Including both strength and endurance (e.g., circuit training, split sets, etc.) may be a better option than traditional long duration cardio.

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PRESCRIPTION EXERCISE PROGRAMMING IN PREPARATION FOR THE ARMY COMBAT FITNESS TEST

Having qualified fitness professionals oversee dedicated strength training and high-intensity training programs helps ensure Soldiers meet physical readiness while potentially lowering their risk of injury. This article highlights the measurable improvements of prescribed exercise programming through high-intensity training and resistance exercises. Each of these to be used by United States Army Soldiers to improve their overall physical readiness and performance testing scores. Using random acts of fitness does not provide Soldiers with the training, periodized loads, or skill-specific tasks for success on performance tests. What is needed are deliberate exercise prescriptions, facilitation, and execution to create measurable fitness improvements on the Army Combat Fitness Test (ACFT), while also reducing the occurrence of musculoskeletal injuries.

INTRODUCTION

US Army Special Operations Forces (ARSOF) are provided access to numerous allied health care professionals and state-of-the-art facilities, much like professional athletes, to ensure proper training, injury prevention, and rehabilitation (36). While ARSOF make up only 3.4% of the active Army, National Guard, and Army Reserve, approximately 35,000 Soldiers, the remaining 96.6%, 973,373 Soldiers, are left without the same resources (33,34). ARSOF has direct access to facilities that support human performance missions and incorporates the latest training and rehabilitation protocols to increase their combat performance, prevent injuries, and decrease recovery time (36). Additionally, ARSOF receives on-staff professional strength coaches to ensure these Soldiers are in peak condition for their mission set (36). These advancements in care and guidance can be traced back to the creation of the Tactical Human Optimization, Rapid Rehabilitation and Reconditioning program (THOR3) by the US Army Special Operations Command (19).

The purpose of THOR3 was to create programs for special operations personnel by using professional sports-quality staff to provide coaching in strength and conditioning, physical therapy, dietetics, and cognitive enhancement (19,31). The THOR3 program differs from other Army fitness programs in several important ways. Most importantly, THOR3 uses a holistic approach to improve physical and mental performance by focusing on individual and unit needs and through reliance on a professional staff of program coordinators, strength and conditioning coaches, physical therapists, dietitians, and cognitive enhancement specialists that deliver training and rehabilitation services on par with professional sports teams (19).

With this amassed set of resources, a great divide in training and opportunity is evident between ARSOF and the remaining Army Soldier population. There is currently no evidence that the same level of facilities, resources, and professionals are readily available to the remaining 973,373 Soldiers of the US Army.

Without qualified professionals and deliberate exercise prescription, most of the Army is responsible for their own (and other's) physical training (PT) programming, leaving thousands of Soldiers at a disadvantage and susceptible to unplanned and unorganized training sessions. Zummo found that poorly planned and executed PT sessions with no focus and poor technique were more common in the Army than effective PT sessions with a strength component and some conditioning (37). Aside from the very small percentage of Special Operations Forces, US Army Soldiers have not been prescribed deliberate exercise programming or resistance training guidelines during daily PT, resulting in a lack of preparation for the biannual ACFT. Careful planning and execution of resources have been provided to the Army's best Soldiers, yet modern wars and field training exercises do not fall solely on the shoulders of that population.

NEEDS OF THE ARMY

The purpose of the Army is to deploy, fight and win our nation's wars by providing ready, prompt, and sustained land dominance, crossing the full spectrum of conflict as part of the joint force. Today's Soldiers must be physically ready to face and overcome unforeseeable challenges during field training exercises and combat deployments. The Army Physical Fitness Test does not adequately evaluate Soldiers for their combative environments like the occupationally driven ACFT does. By comparison, the ACFT predicts with 80 percent accuracy whether a Soldier will be effective in combat, compared with 40% accuracy for the APFT (28). The Army Physical Fitness Test (APFT) has been the Army's fitness test of record since 1980, resulting in commanders and Soldiers focusing their physical training efforts on performance for the APFT and not for combat (28). Today's field training exercises and deployments demand a Soldier be fit for battle and duty in a more complex and powerful way.

The ACFT, which relies heavily on high-intensity functional fitness, replaces the APFT with six separately scored events. Comparatively, the ACFT necessitates proficiency in skill-specific strength, power, speed, and endurance movements. The ACFT is designed to reduce injuries while increasing physical fitness across multiple activity domains: muscular strength, endurance, power, speed, agility, cardiorespiratory endurance, balance, flexibility, coordination, and reaction time (20). The older APFT evaluates two activity domains: cardiorespiratory endurance and muscular endurance.

The six events from the ACFT are designed to simulate movements under fire, loading heavy weaponry, and dragging casualties to safety, to name a few. The six scored events on the ACFT are executed in the following order: three-repetition maximum (3RM) deadlift, standing power throw, hand release push-up, sprint-drag-carry, plank, and a two-mile run. Even though the US Army requires a high level of physical readiness via the biannual ACFT, Soldiers are not typically provided, instructed, or led through an adequate exercise training program during mandatory company PT sessions. To mitigate this problem, military personnel must move away from unplanned and unorganized fitness events or training sessions and use more deliberate programming to maximize efficacy and reduce injury (37). Since the Army estimates it spends about $55,000 – $74,000 to bring an individual into the service and prepare them to join their first unit, it does not strategically or financially make sense to train an expensive asset inadequately or improperly (20).

Additionally, Zummo states that PT from a battalion commander's perspective was random in execution and loosely supervised with no deliberate prescription or plan (37). Continual operational commitments amongst Soldiers and units only help to prevent the implementation of a universal training program within the military. However, casual workouts with no connection from one workout to the next workout or training event are detrimental to Soldier physical readiness. Moreover, a deliberate exercise program comprised of strength training, ACFT skill training, and constantly varied high-intensity functional training would help provide Soldiers with sufficient exposure across several fitness domains. It is recommended that programming is inclusive of high-intensity functional training. This type of training, which involves a combination of cardiovascular activities (e.g., running, rowing, and cycling), weightlifting/powerlifting exercises (e.g., clean and jerk, squat, deadlift, push press, bench press, and power clean), and elements of gymnastic exercises (e.g., pull-ups and hanging knee raises), should be performed in a timed and/or circuit format with little to no rest periods (14,17,35).

INJURY PREVALENCE

According to the Defense Medical Surveillance System, over 1.3 million medical encounters related to injury in 2013 affected over 300,000 US Army Soldiers (1). Musculoskeletal injuries are the most common reason military service members cannot perform their military duties, accounting for more than 80% of all injuries among US Soldiers in 2016 and were the primary reason for a medical non-deployment status among US Soldiers as of early 2019 (30). As of March 2019, more than 19,000 medically non-deployable US Soldiers were victims of musculoskeletal injuries, equating to approximately four US Army brigade combat teams (30). In addition to the importance of musculoskeletal injuries to a Soldier's deployment status, these injuries also accounted for 59% of all limited duty days in the US Army (30). In mid-2018, 22.9% of non-deployable Soldiers could not perform their duties due to being on a limited-duty profile lasting more than 14 days (4).

The ebb and flow of military training plays a direct role in a soldier's level of physical fitness. This is because adequate equipment, time, and venue may not be readily available during the intensified periods of training or deployments, which can be associated with an increased risk of injury (7). It is imperative that trainees and Soldiers adequately develop and maintain physical readiness to accomplish the task-specific demands of their career. It was shown in a study of 105 Soldiers who reported to medical screening because of injury or to pass fitness assessments, 72% (76) were considered having physical restrictions that limited their ability to fully participate in any training (7). Which is why Allied Healthcare Professionals can play an important role in the overall success of military personnel. Another study found that by implementing physical therapists to U.S. Army Ranger battalions, the overall unit readiness increased from 88% to 95% (27).

Physically demanding military occupational specialties (MOSs), particularly those with high strength demands, have been associated with an increased risk of musculoskeletal injury (5). As injuries increase overall military readiness and national security can be compromised (30). Depending on a Soldier's MOS, they may be in a perpetual cycle of train, deploy, redeploy, train, etc. This constant cycle can meaningfully affect a Soldier's overall physical readiness and ability to train. Exercise programs created by a strength and conditioning coach and tailored to a unit's training and deployment schedule, could help to improve readiness and reduce injuries. Evans states that regimented and prescribed exercise training from fitness professionals can decrease injuries and increase flight performance in fighter pilots (10).

BENEFITS

The benefits of resistance training and high-intensity functional movements typically outweigh the uncommon and infrequent risks of injury during these types of training. Recent systematic reviews showed that the injury ratio for high-intensity functional movements is similar to other forms of high-intensity training, but still lower than some sports like soccer or rugby (25,29). Another study found that the reported incidences of injuries associated with high-intensity functional training programs were comparable to or lower than rates of injury in Olympic weightlifting, distance running, track and field, rugby, or gymnastics (21). A separate study found that Soldiers who participated in extreme conditioning programs (i.e., high-intensity functional fitness-like programs) had a decreased risk of injury than those participating in typical exercise programs (14). Finally, a different study found that high-intensity training, performed for eight weeks, had a positive impact on cardiorespiratory fitness, muscle endurance, maximum upper-body strength, and vertical jump without inducing muscle damage or inflammation (29).

While the chance of injury is a risk with almost any sport or exercise, injuries related to high-intensity functional training seem to have a common denominator from the research of overtraining, poor technique, or training loads higher than the capabilities of the athletes (2). However, the most important risk factor for injuries in high-intensity functional training is the presence of previous injuries. Research shows athletes with a previous injury are up to 3.75 times more likely to sustain a new injury compared to athletes who have not suffered any previous injuries (2). From a military perspective, Gutierrez states that common musculoskeletal injuries can result from inappropriate Army Physical Readiness Training programming and subsequent overloading of tissues (15). A well-planned and properly executed exercise training program is critical to US Army Soldier physical readiness.

Meyer state that high-intensity functional training can lead to various health improvements for those who practice it (25). Functional exercises are considered compound movements (e.g., multi-joint) requiring universal motor recruitment patterns (12). The physical demands of the Army, or any branch of the military, require warfighters to be in excellent physical condition, meaning evidence-based exercise prescription and execution are necessary for Soldiers to meet the demands of today's battlefields and training operations. General increases in strength, bone density, cardiorespiratory endurance, and weight management are just a few benefits from resistance training and high-intensity movement programming (6). Research states that the practical benefits to high-intensity functional training exercise programs include shorter training times and volumes, exercises which simulate combat tasks, lower equipment costs, reduced potential for boredom and adaptation because of constant variation, less injury potential compared to high-volume endurance training, and scalability to all fitness levels and rehabilitation needs (16).

While the benefits of exercise are well known, the benefits of a deliberate unit-specific training program will provide commanders and leaders the opportunity to increase physical readiness and decrease the incidence of injury. Performance improvements have been seen on all aspects of performance testing measures with participation in a standardized training program, which elicits short-term skeletal muscle adaptations such as improved neuromuscular efficiency (24). Research shows that in athletes with high-intensity functional training experience of greater than one year, a higher amount of weekly training (greater than 10 hr per week) is associated with better body composition (6). This is especially prevalent in terms of lean mass and upper limb bone density, as well as better performance in a typical high-intensity functional training workout, like the events on the ACFT (6).

The research presented in this article shows that the benefits of deliberately prescribed exercise programming offer a high return on investment. Additionally, a prescribed exercise prescription plan allows Soldiers in leadership roles during PT and ACFT events to train fellow Soldiers to the highest degree. It also takes the guesswork out of planning workouts, periodization timing, scaling options, modifications, variability, and more. Research suggests that strength and conditioning for tactical athletes will probably increase G-tolerance, decrease injuries, and decrease healthcare costs for active duty and retired fighter aviators (10). Like those in basic training, incoming tactical personnel may come from a K – 12 experience with more state-mandated physical education or from areas where less emphasis was placed on physical education and sport (9). If Soldiers are entering the Army from a place of fitness and exercise inexperience, a deliberate exercise program designed to enhance physical readiness can assist them in implementing and executing ACFT preparatory movements.

EXERCISE TRAINING

A Soldier who is misguided during mandatory company PT is at a disadvantage regarding the physical demands of field training exercises, deployments, ACFT performance, and potentially, their MOS. To meet the demands of their MOS and help avoid overuse injuries, a training program for Soldiers should include mobility, strength, endurance, power, speed, and agility components (13). The *Army Physical Readiness Training Manual* gives an extensive list of mobility movements and individual training exercises; however, it fails to provide specific workouts to improve performance testing scores (24). The *Army Physical Readiness Training Manual* would likely benefit from a systematic approach to produce optimal development and performance (24). Research found that high-intensity functional training in a physical training program at military schools has a positive effect on the level of physical fitness of cadets by increasing motivation for physical education and sports activities, contributing to mastering the knowledge of modern approaches to the organization of physical training and skills; and by increasing the skills of physical training (23).

Research recommends methods of high-intensity functional training programs for use in the training activities of athletes of combat sports (23). Gagestein suggests a training program design that incorporates five separate sections to each training day: warm-up (mobility and stability); strength, power, and agility; ACFT-specific movements; task-specific; and recovery/regeneration (13). The strength, power, and agility section of a daily workout session should include varied amounts and frequency of plyometrics, snatches, cleans, deadlifts, squats, split squats, weighted pull-ups, bench presses, and overhead presses (13). These movements are consistently found in conjunction with high-intensity functional training programming. The Army may benefit from the implementation of a high-intensity functional training program because it is open to changes in terms of the exercise progression and intensity, which allows a large population with different levels of physical conditioning to perform them safely and effectively (8,11,24,25). Kolomiitseva found that after the application of a 12-week targeted high-intensity functional training program, an increase in the studied parameters (sit-ups, push-ups, burpees, jumping rope, and kettlebell squats) can be tracked by students and cadets (23). Kliszczewicz found that high-intensity functional training displayed rapid physiological improvements in strength and aerobic and anaerobic capacity following a four-week intervention in physically active participants (22).

The importance of a dedicated fitness professional to program, instruct, and coach high-intensity functional training movements cannot be understated. Weisenthal found that injuries decreased in gyms where high-intensity functional training was implemented (35). Cavendon found that greater than six hours per week of high-intensity functional training determines a better body composition profile (i.e., higher lean mass and lower fat mass) compared to age-matched and body mass index-matched physically active controls (6). This guidance correlates well with the 7.5 hr per week available to most Soldiers for PT.

CONCLUSION

In conclusion, this article iterates the importance and need of a qualified fitness professional overseeing a dedicated strength training program with complimentary high-intensity functional training. Having a qualified fitness professional ensures Soldier physical readiness and lowers the risks of injury. US Army Soldiers benefit from deliberate exercise programming, especially if it is tailored to the demands and schedule of their unit's training cycle. Qualified fitness professionals, in turn, should remember to lead an adaptation or introductory period for Soldiers who are new to exercise or high-intensity functional training. This introduction will to help establish sound movement patterns and decrease the risk of injury. Soldiers and other military personnel typically have a limited amount of time available for daily PT sessions, so what time they have must be utilized efficiently. The research, as stated above, shows high-intensity functional training typically aligns with the amount of time most Soldiers have available during a weeklong PT session. Haddock recommends that these programs become the standard for military physical training as high-intensity functional training programs provide an impressive range of health benefits, such as the promotion of metabolic conditioning and muscular strength and less systemic inflammation or oxidative damage compared to sustained aerobic activity thereby promoting general physical preparedness for the unpredictable physical demands of combat (16). As the ACFT is a young performance test for the US Army, time and data collection will show the needs of unit physical training. Moreover, more studies need to be completed to clarify the relationship between injury rates and the time of training experience for high-intensity functional training (3).

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LOAD CARRIAGE—PROGRAMMING FOR SPECIAL OPERATIONS FORCES

INTRODUCTION

Special Operations Forces (SOF) require an advanced level of physical fitness to accomplish occupational tasks. When SOF are not in hostile combat zones, they are training various skills to increase operational readiness and task efficiency. Typical tasks associated with SOF training are rucking, marksmanship, obstacle courses, land/sea travel in gear, movement under fire, casualty drag, explosive movements (e.g., jumping, sprinting, lifting, throwing), and weapons/ammunition transferring (3,11). Most, if not all, of these tasks require the use of a rucksack or load carrying on the torso. These loads can range from 22 – 55 kg with the heavier loads being more prevalent (12,13). Research suggests that adding any amount of weight substantially decreases performance by an average of 1% per 1 kg and increases the likelihood of injury with loads 26 – 50% bodyweight (2,8,9,13,16).

Research analyzing maneuverability tasks with 16 kg or more of added load demonstrated notable decreases in agility and power, with a 13 – 27% decline in vertical jump scores compared to no load (9). During a 12-month deployment, 45% of United States combat forces suffered from a musculoskeletal injury related to load carriage and external variables (e.g., obstacles, terrain, occupational tasks) (8,13). Load carriage reduced endurance time and increased the energy expenditure of walking/running by 5 – 6% with altered gate kinematics and biomechanical responses (1,13). Loads carried on the extremities (e.g., boots, rifle) increases energy expenditure by an additional 7 – 10%/kg of weight added (1). There is no current "standard" for SOF fitness training as it applies to load carriage, which may be due to the varying missions, individual roles, and physiological differences. Although there are mixed recommendations on concurrent resistance and endurance training, research shows that it is the most effective method to optimize physical readiness in SOF (5,11,18). Further reinforcing resistance training with plyometrics and agility performance in task-simulated movement patterns could increase combat readiness (5). Regular exposure to complex occupational tasks with a range of loads could also improve performance (3). Therefore, this narrative review will focus on the research related to tactical load carriage and on a program recommendation to maximize strength and endurance adaptations in SOF.

AEROBIC CONSIDERATIONS

Maximal aerobic performance is critical to military units due to prolonged foot marches and travel under loaded conditions. Although foot marches and running are often required among all healthy active duty and reserve military, SOF are expected to perform at an elite level with heavier loads of upward 55 kg or more (12). This would require SOF to have superior aerobic fitness to reach maximal performance. While carrying loads for prolonged marches, an individual's weight distribution is altered (compared to unloaded marches), exacerbating the effects of terrain on performance and reduces the speed of movement; this can increase cardiorespiratory, metabolic, and neuromuscular demands of the Soldiers (17). When using critical speed and a three-minutes all-out exercise test to evaluate tactical performance, loaded conditions decreased completion time significantly (2). Occupational tasks, such as marksmanship, are negatively affected by about 16% after loaded exercise due to the increase in heart rate, breathing rate, and muscle tremors (8).

Research on body armor weighing about 10 kg reported thoracic restriction and increased pulmonary ventilation at 75% of the participant's VO_{2max} (1). Since body armor is a non-negotiable and variable piece of equipment, prolonged activity with this load requires a higher VO_{2max} to increase tactical performance. Load carriage performance can be predicted using the Load-Speed Index, where a higher VO_{2max} increased maximal walking speed with load (1). Research on the Load-Speed Index predicted individual maximal walking speeds at an aerobic output of about 45% of their VO_{2max} to delay fatigue (1). This indicates those with higher VO_{2max} can walk faster at about 45% VO_{2max} and should be able to maintain maximal walking speeds with load for a prolonged period compared to those who are less aerobically fit. Research findings also suggest that there is a correlation between increased maximal absolute oxygen uptake and load carriage performance with loads 20 – 45 kg (17).

Notably, Soldiers who have a lower VO_{2max} tend to score lower on the Functional Movement Screen™ (FMS™) by a variance of ±8, which likely leads to an increase in injury prevalence (7). Lower running and marching volumes, with and without load, are associated with reduced injury incidence and/or equivalent physical performance changes when compared to higher-volume groups (13,17). Therefore, it could be postulated that endurance training at high relative intensities should be incorporated into SOF training programs to increase VO_{2max} and reduce run/march volume.

ANAEROBIC CONSIDERATIONS

Muscular strength and endurance are important characteristics for optimal tactical performance, especially load carriage. Physical fitness aspects of SOF include muscular strength and endurance, flexibility, mobility, power, and agility (5,16). Increasing strength through resistance training has been shown to improve neural input and motor control for performance (16). Load carriage can reduce efficiency and speed during combat movements or obstacles, which increases exposure to enemy gunfire (9). Maneuver Under Fire (MANUF) time trials performed with US

Marines showed a 100 s or more increase in completion time when comparing no load to loads at 30% and 45% bodyweight (8). Power and agility movements are frequently incorporated in tactical occupational tasks, but performance decreases by 13 – 42% with loads of about 10 kg or more (9). Resistance training protocols should increase physical development while avoiding plateaus in adaptations and overtraining (5). Explosive movements using anaerobic energy systems should be trained to withstand deployed conditions, such as reduced sleep and nutrient intake. Wearing body armor and/or a ruck sack during resistance training drills could improve overall performance when proper recovery is included.

Maneuverability skills and other scenario-specific task performance appear to decrease with added load, but challenging these skills in a training environment increases performance (3). Research supports field training a variety of activities such as plyometrics, agility, manual material handling, and sandbag lifts to improve load carriage performance (17). However, programming should include plenty of rest and an appropriate balance between resistance training and task-specific training. Preparing for combat conditions through resistance training with and without load carriage training may reduce performance detriments. Tactical performance improvements can be expected when training power and agility to mimic factors of a combat environment.

Furthermore, load carriage increases demands placed upon the lumbopelvic hip complex and lower extremities (10,18). Postural stability using scalar parameters (e.g., sway variability, sway path, sway velocity) is altered by adding load during occupational tasks (10). Interrupting an individual's postural stability can change center of mass and base of support, resulting in reduced performance (10). Of the reported musculoskeletal injuries in SOF personnel, 76.9% are considered preventable (18). A potential solution to decrease injury prevalence from load carriage is concurrently training whole body strength and conditioning (15,17,18). This suggests resistance training for increasing strength can aid in the reduction of load carriage detriments and preventable injuries in combat. Along with general resistance training, functional/task specific drills should be incorporated routinely in SOF programming.

STRESS INOCULATION TRAINING

Responding to stress as an elite tactical unit is imperative to the success of the mission. Several stressors, such as noise, thermal stress, and fatigue, negatively affect military performance (15). Regulating the individual's ability to withstand these types of stressors can decrease the decrements associated with stress; fatigue from load carriage might decrease reaction time, decision making, and memory (15). Incorporating stress inoculation training could be an effective strategy within a strength and conditioning program to improve operational readiness in SOF units. Tactical units should focus on training problem solving, decision making, responsiveness, and knowledge/understanding while in a working state. For example, one could place a maze style problem on the wall with various colors and themes. The individuals would then perform a high-intensity movement or circuit to increase heart rate and respiratory rate but attempt to solve the maze as fast as possible. This could mimic a SOF unit calling for a nine-line medical evacuation, reporting mission critical information, or even reacting to enemy gunfire. Consideration of stress inoculation training has the potential to favorably impact cognitive functions related to combat scenarios, while not directly performing them. This may avoid learning adaptations from repetitive military simulation training. Further research should be done to provide more information on stress inoculation training (15).

PROGRAM RECOMMENDATIONS

Focusing on the small population of SOF, a general program recommendation can be made to increase operational readiness. Assuming the SOF individual is already a trained athlete, increasing VO_{2max} requires vigorous aerobic training. Interval sprinting, rowing, swimming, skiing, or cycling at about 95% of the individual's maximum heart rate 3 – 5 times a week should increase aerobic capacity (4). High-intensity interval training (HIIT) circuits can be an additional method to challenging the aerobic system (4,5). HIIT is considered the more effective method to increase aerobic capacity compared to endurance training when performed at 90 – 95% of VO_{2max} (4,6). Baseline analysis of aerobic capacity could be accomplished through the 1.5-mile run VO_{2max} prediction test (4). Loaded foot marches should be performed 2 – 4 times a month, while gradually increasing in distance until military requirements are met (12,14). Marching with varying submaximal loads might induce training adaptations through specificity, while reducing load on the musculoskeletal system (12). Incorporating stress inoculation training could challenge cognitive function while performing these aerobic and anaerobic exercises.

Plyometrics, agility training, and power training should be emphasized when resistance training for load carriage and tactical performance. Increasing the individual's ability to perform these drills while unloaded should improve combat performance in loaded conditions. Typically, when explosiveness and agility are required during a tactical scenario, tactical athletes are not standing in an anatomical/bilateral stance. Unilateral/split stance movements and speed drills could mimic real life demands when these Soldiers are on uneven terrain and might experience an unexpected combat escalation. An example exercise might be an elevated front foot lunge with a one-second eccentric, one-second hold, and an explosive concentric. Partnered mirror drills for forward and lateral agility movements could also increase maneuverability and reaction time in tactical athletes. Exercises like split stance cable chops that progress into single-leg lateral lunge chops, could improve rotational trunk control under explosive demands that mimic tactical performance. A staggered single-arm landmine press may also provide additional unilateral trunk control while increasing upper extremity strength. See Table 1 and Figures 1 – 4 for a sample protocol.

CONCLUSION

In summary, overall strength and muscle mass, along with aerobic conditioning, are key when addressing load carriage performance. Maintenance of strength and size should be considered alongside plyometrics and agility skill work for load carriage performance and injury prevention. Various exercises can be used to improve SOF performance, and some of the aforementioned movement patterns in this article may be useful for practitioners working with SOF units. These exercises can be utilized with different parameters to focus on strength goals. For example, movement patterns can be performed with a longer time under tension factor and/or by additional load. Furthermore, combining both multi-joint and single-joint movements into a training program can incorporate the upper and lower body through complex exercises that challenge the trunk and extremities. Importantly, practitioners should understand the demands imposed on their SOF unit to develop training programs for optimizing performance.

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TABLE 1. LOAD CARRIAGE PERFORMANCE PROTOCOL

EXERCISE	GOAL	ENERGY SYSTEM/ INTENSITY	WORK INTERVAL (S)	REST INTERVAL (S)
Partnered Mirror Drills	Improve reaction time	Phosphagen/high	15	180
Single-Leg Chop with Lateral Lunge*	Unilateral trunk control under load	Glycolytic/high	30	60
Toe/Heel Elevated Front Foot Lunge*	Unilateral control with load on uneven terrain	Glycolytic/mod	30	60
Single-Arm Landmine Press in Split Stance*	Overhead task efficiency	Glycolytic/mod	30	60
High-Intensity Interval Training (HIIT)	Increase aerobic capacity for load carriage performance	Oxidative/90 – 95% max HR	240	240

**See Figures*

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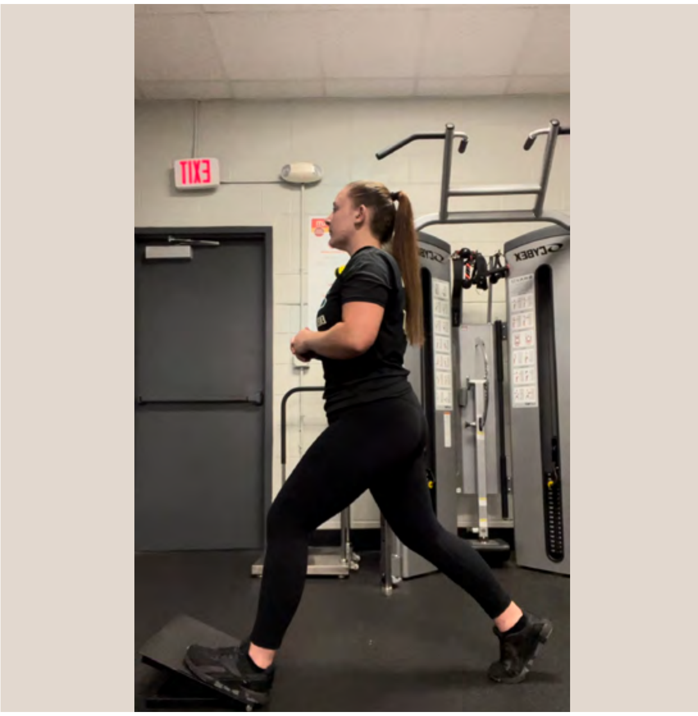

FIGURE 1A. FRONT FOOT TOE ELEVATED LUNGE

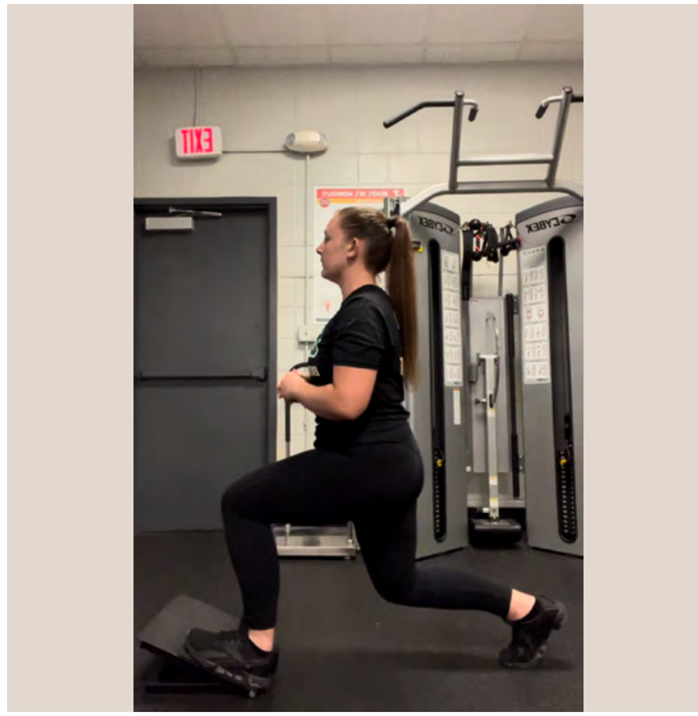

FIGURE 1B. FRONT FOOT TOE ELEVATED LUNGE

While standing in a lunge position, the individual will have the toes of the front foot elevated on a slant board. They will then descend into a lunge until the back knee is close to or touches the floor. This is a stationary lunge where the individual ascends and descends without having to move forward and backwards.

FIGURE 2A. FRONT FOOT HEEL ELEVATED LUNGE

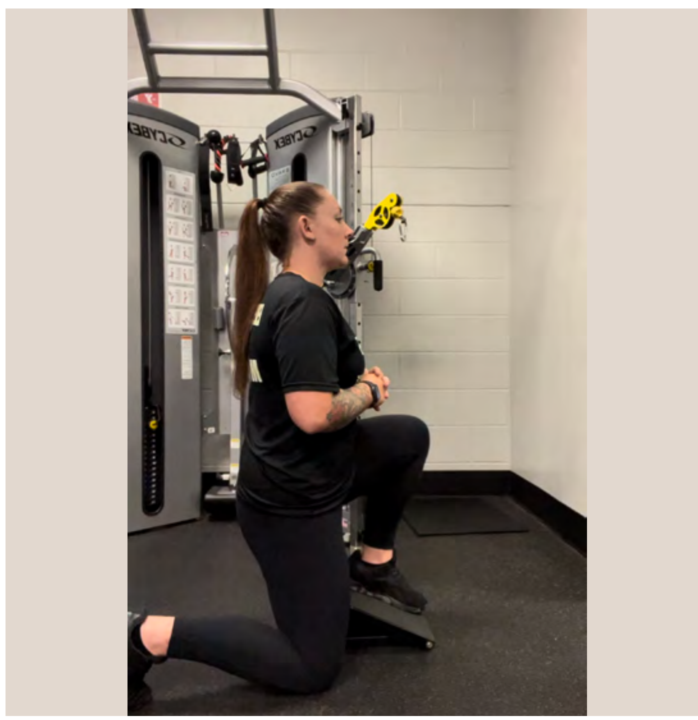

FIGURE 2B. FRONT FOOT HEEL ELEVATED LUNGE

While standing in a lunge position, the individual will have the heel of the front foot elevated on a slant board. They will then descend into a lunge until the back knee is close to or touches the floor. This is a stationary lunge where the individual ascends and descends without having to move forward and backwards.

FIGURE 3A. SINGLE-LEG CHOP WITH LATERAL LUNGE

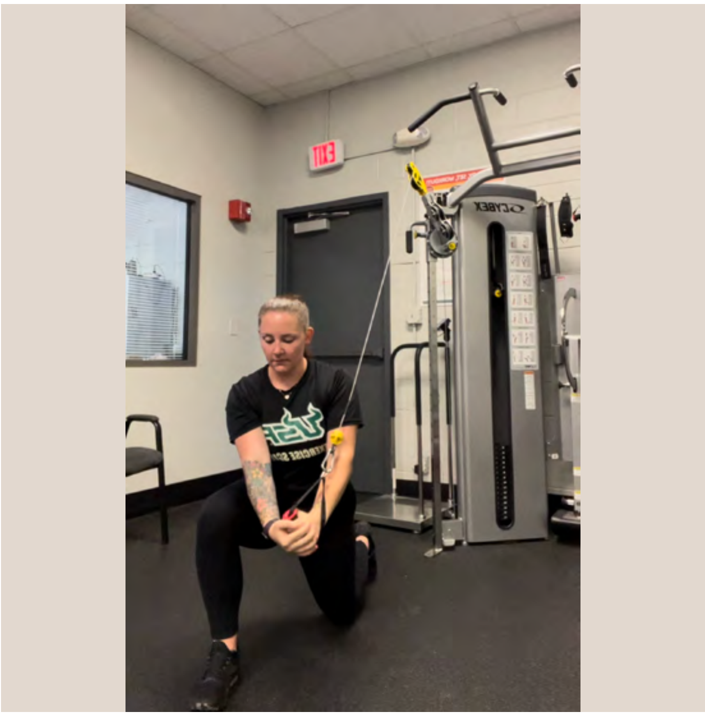

FIGURE 3B. SINGLE-LEG CHOP WITH LATERAL LUNGE

A cable machine will be utilized with the position at a diagonal from the individual. They will be standing on the leg closest to the cable machine with the opposite leg at a 90°/90° hip and knee flexion. Holding tight to the cable, they will proceed to chop in a diagonal pattern while pivoting the foot laterally to land in a lunge. This movement should be done smoothly with power and speed.

FIGURE 4A. SINGLE-ARM SPLIT STANCE LANDMINE PRESS

FIGURE 4B SINGLE-ARM SPLIT STANCE LANDMINE PRESS

This movement will require a post landmine or a stable barbell. The individual will be standing in a split stance with the landmine actively held near the shoulder. With a full grip, they will proceed to press upwards into an overhead position and back down to their shoulder.

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PERFORMANCE UNDER STRESS—IMPLICATIONS FOR TACTICAL PERSONNEL

INTRODUCTION

Among the most stressful occupations in the world are those that require working under extreme pressure and at high risk, placing tactical professionals (police, military, and fire and rescue) near the top of that list (32,36). Those in tactical professions often work in environments that are fast-paced and, at times, chaotic and unpredictable (21). Tactical professionals must have the ability to apply technical and tactical skills to emerging tasks while making critical decisions and judgement calls in real time. However, those decisions and subsequent actions can have long-lasting social, political, and moral consequences (19,43,46). For these reasons, one of the most desired qualities that organizations look for in tactical occupations is the individual's ability to perform tasks in extreme environments and under pressure, where factors can elicit high stress (46,54). In this article, performance under stress will be discussed as will factors influencing this performance.

EMERGENCY RESPONDERS

Domestic emergency responders (e.g., police, fire and rescue) have dedicated efforts to provide safety in the community they serve (6,20,32,36). For those in public safety, these responsibilities expose them to the acute and chronic stressors associated with the threat of physical harm, social unrest, shift work, and lack of organizational resources (3,6). Policing duties such as effecting arrests, crowd control, and responding to domestic disturbances, only compound stressors already experienced by routine patrol (20). Firefighters must also perform routine duties exposing them to a variety of stressors such as fire suppression, handling hazardous substances, performing tasks in hot and hostile environments, and conducting search and rescues in chaotic and unpredictable environments (26,36,60). Often, these duties are performed for an undetermined amount of time, with little or no rest. The physical demands of performing active work while donning personal protective equipment (PPE) are compounded by the psychological stress of participating in life-threatening events and pressure from organizational lack of support (26,61). Specialized emergency units (e.g., Special Weapons and Tactics [SWAT], Hazardous Materials [HAZMAT], Fugitive Task Force, Gang Task Force, Narcotics) are further exposed to high-risk encounters, often involving officer and firefighter survivability as well as imminent life-or-death decisions (23). The constant state of vigilance emergency responders must maintain due to the ever-present threat of violence, dangers, and the overwhelming exposure to critical incidents regularly places them under extreme stress (3,61).

MILITARY

Like emergency responders, tactical professionals in the military (special operations and general-purpose forces) are often exposed to tasks and situations that involve a high level of uncertainty, requiring immediate action when responding to an acute crisis (12,44). Military personnel are often exposed to stressors from varying deployments, direct action engagements, situations requiring (or leading to) hypervigilance, and extreme physical and environmental demands (43,44). The increase in psychophysiological demands (e.g., cognitive load, physical exertion, etc.) impact decision-making and target accuracy, resulting in increases in errors and a decrease in overall tactical performance (43,48). Professionals in the tactical community are often required to work alongside other tactical professions in many situations, performing multiple tasks simultaneously (creating extraneous cognitive load) while coordinating efforts (14). The impact that acute stress has on tactical professionals is critical to the safety of the citizens as well as the safety of tactical personnel (43,44).

THE PSYCHOPHYSIOLOGICAL RESPONSE TO STRESS

The body's stress response, being a complexity of interactive mechanisms, alters behavior in both allostasis and homeostasis, influencing psychological and physiological status (8,15,40). In tactical professions, when personnel encounter an immediate threat or a crisis, they will experience acute stress resulting in a psychophysiological response (6,20,48,55). This will require the tactical operator to self-regulate these responses to respond to the situation more appropriately within the standard operating procedures of their department (19,29,46,54,55). When a threat is perceived, the brain and periphery initiate a myriad of adaptive neurophysiological responses through the autonomic nervous system (ANS) and hypothalamus-pituitary-adrenal (HPA) axis (1,11,56). The stress response is comprised of two main components: the sympathetic-adrenal-medullary (SAM) axis, whose primary involvement is in acute stress, and the HPA axis, which is responsible for long-term defense (28,56). The initial shock response is activated via the SAM system, which triggers the sympathetic branch of the ANS, resulting in the "fight, flight, or freeze" response (56). The shock response then sends a signal to the HPA axis, triggering the release of hormones, specifically corticotrophin-releasing factor (CRF), adrenocorticotropic hormone (ATCH), and cortisol (2,28). Shock can be triggered in a variety of ways (e.g., extreme cold, stress, trauma, etc.), including the perception of threat (often experienced by law enforcement), which all initiate the HPA axis (2). When threat is perceived, the hypothalamus releases CRF, stimulating the pituitary to release ATCH, thereby signaling the adrenal glands to release cortisol into the blood stream (2,28). The release of these hormones are necessary to prepare the body for physical work (e.g., run, fight, defend) as well as to restore baseline values when there is no longer a threat (17,57). Short-term exposures are not harmful to overall health, however long-term exposure can have a negative impact on health (59).

The body's ability to perform work is primarily initiated from the central nervous system (CNS) arousal, not only other well-known physiological factors (e.g., cardiovascular function), making work a psychophysiological process (55). Extreme conditions and pressure negatively affect both cognitive performance and motor performance (fine and gross) leading to potential increases in error rates in decision-making and accuracy, increase in risk taking, poorer situational judgement, and also may increase stereotyping and bias (5,27,38,58). In addition, cognitive overload, as well as fatigue, can have a detrimental effect on the tactical performance of an operator, especially when the situation involves time sensitivity and information overload, affecting decision-making (7,20,38). In police officers, for example, the stressors imparted by time and information overload can have a critical effect on situations when an officer must make an immediate decision to shoot or not to shoot (16).

Tactical professionals require a high level of motor skills to enact required tasks, such as high-speed driving, physical restraint, and weapons and tool manipulation (43). Performing these skills and tasks under extreme situations allows them to be more susceptible to inhibition and errors that can result in physical and mental injuries (2). Tactical personnel are routinely faced with daily problem solving, reasoning, and planning, which can be negatively affected by acute stress (28). The acute response of an officer or soldier in a use of deadly force situation is heavily influenced by psychological and physical stress, impacting decision-making and shooting performance (e.g., accuracy, false positives, reaction-time), that have long-lasting consequences for the officer or soldier, suspect or combatant, and families (2,19,20,54). In addition, stress also accentuates avoidance behaviors, such as increases in eye blinks and initially turning away from the threat, making it more difficult to engage the threat appropriately and accurately, jeopardizing the survivability of tactical personnel (20,39).

EFFECT OF STRESS ON PHYSIOLOGICAL MEASURES (HORMONES AND CATECHOLAMINES)

The decrements observed in cognitive and physical performance are a result of what is happening inside the body when stress is applied. Although there is a wide variety of stressors tactical personnel experience, the physiological response to stress is much the same, involving a cascade of hormonal responses and activation of the adrenal system (described above). Acutely, this stress response is adaptive in nature as it prepares the individual to cope with threats and uncertainties. In such circumstances, the physiological responses such as increased brain blood-flow and arousal, peripheral vasoconstriction, vasodilation of the muscles, and increased heart rate, serve adaptive functions (22,45). Unfortunately, tactical personnel often find themselves in high stress scenarios and environments where the demands exceed this acute response. As the body remains stressed for longer periods of time, performance in physical and cognitive tasks begin to decrease (49,51).

Negative changes to endocrine markers have been observed in environments such as military survival and field training, special operations selection courses, simulated firefighting scenarios, and during shift work (8,22,37,45). These changes include increases in cortisol, blood lactate, alpha amylase, creatine kinase, sex-hormone binding globulin, dehydroepiandrosterone (DHEA), and catecholamines (epinephrine, norepinephrine, and dopamine) as well as decreases in testosterone, IGF-1, and neuropeptide-Y. Each of these are a result of changes to the sympathetic nervous system and HPA-axis, and the body's attempt to protect against itself. Energy restriction, minimal sleep, intense physical demands, and psychological stressors are just a few of the factors that play a role in the negative changes observed in the endocrine markers mentioned above. Prior exposure to high stress tasks and environments and experience of endocrine changes may increase an individual's resilience to the stressors imposed (9). Multiple factors play a role in the negative changes observed, to include energy restriction, minimal sleep, intense physical demands, and psychological stressors.

IMPACT OF STRESS ON COGNITION

Activation of the sympathetic nervous system can be associated with a range of performance deficits, including decrements in higher-level cognitive processes, such as decision-making, information processing, perception, memory, and attention (18,53). The unpredictable nature of the role of tactical personnel makes these high-level cognitive processes key aspects of job performance, as they are expected to execute their training and missions under duress. Under extreme stress, ratings of perceived exertion often go up, or are unclear, which can be a sign of decreasing cognitive performance (10,24). The inability to perceive exertion suggests that individuals may not be conscious of their responses in hostile or threatening environments. Other aspects of cognition that have been seen to be negatively impacted under stress include psychomotor performance, short-term and working memory, and spatial and abstract reasoning. Additionally, state- and trait-anxiety and mood states, to include depression, vigor, anger, fatigue, and confusion, are all impacted with activation of the sympathetic nervous system (22,40,52).

Experience can help reduce the negative effects of stress. According to Hans Selye's general adaptation syndrome (GAS), when an individual is exposed to a stressor, an adaptation process occurs whereby the individual adapts to the stressor, both physically and psychologically (42). When individuals are repeatedly exposed to extreme environments and stressful scenarios, it is possible they develop a decreased stress response, ultimately leading to better cognitive and operative performance as time goes on (13). In addition to experience, mental skills training can help mitigate the effects of stressful environments. For example, training psychological skills such as arousal control, performance-enhancing imagery, breath control, and attentional focus have been shown to moderate heart rate, with a significantly lower increase in heart rate observed following a psychological skills training intervention (p=0.00). Furthermore, a 30% increase in memory recall and improved performance in high stress training scenarios have been observed following mental skills training (4,35).

IMPACT OF STRESS ON PHYSICAL PERFORMANCE – GENERAL IMPLICATIONS

Tactical personnel perform jobs that require high levels of physical performance. Sustained levels of stress can lead to decrements in the ability to perform the physical tasks these individuals must carry out as part of their occupational duties. In addition to potentially negative changes in body mass and fat-free mass, maximal lifting strength, vertical jump performance, lower and upper body ballistic power, and muscle soreness have all been seen to be negatively affected in high-stress environments and during sustained task operations (25,30,31). While these performance parameters have been used as assessments of physicality, skill-based tasks have also been examined. Pressure brought on by urgency or fear of outcome can negatively affect skill-based tasks, resulting in undesired outcomes and a degradation in performance (33,34,41). Grenade throwing ability, marksmanship accuracy, obstacle course times, and time to complete relevant tasks such as placing a tourniquet on another person, recharging handgun loader, dragging a victim, and suppressing a two-room fire in a training scenario were all tasks found to be negatively affected by stress (15,31). While the tasks and environments tactical personnel are exposed to can have a negative impact on physical performance parameters, some of these decrements can be mitigated by having higher levels of physical fitness prior to involvement. Specifically, higher levels of aerobic fitness have been seen to be inversely related to trait anxiety leading to better performance on job tasks (47,50).

SUMMARY

The ability of tactical personnel to perform optimally under extreme pressure is critical to the mission outcome, with these outcomes having social, political, and moral implications. Understanding the effects that acute stress and pressure can have on performance, as well as the underlying mechanisms, is essential to developing mitigation strategies and training curriculums. When responding to critical incidents, the perception of tactical personnel to the situation influences the emotional and physiological response and is only manageable if these personnel possess the resources to modulate stress through down regulation or upregulation of their response. Performing under pressure can be managed through resources that aid in the modulation of psychophysiology in real-time that will mitigate the detrimental effects of acute stress. Unmanaged, acute stress can result in unwanted effects on task performance and execution. Tactical personnel who lack the resources or are unable to use effective coping skills while executing skills and tasks under extreme pressure are less likely to be able to modulate their own psychophysiology and risk underperforming. Although exposure to stress during training can mitigate these effects, both psychological resources and fitness have shown to be highly effective in mitigating the effects of acute stress that often impede performance. Coping skills, such as breath work, specifically prolonged exhalation, cannot only mitigate the negative effects, but may also enhance skills while performing under pressure.

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