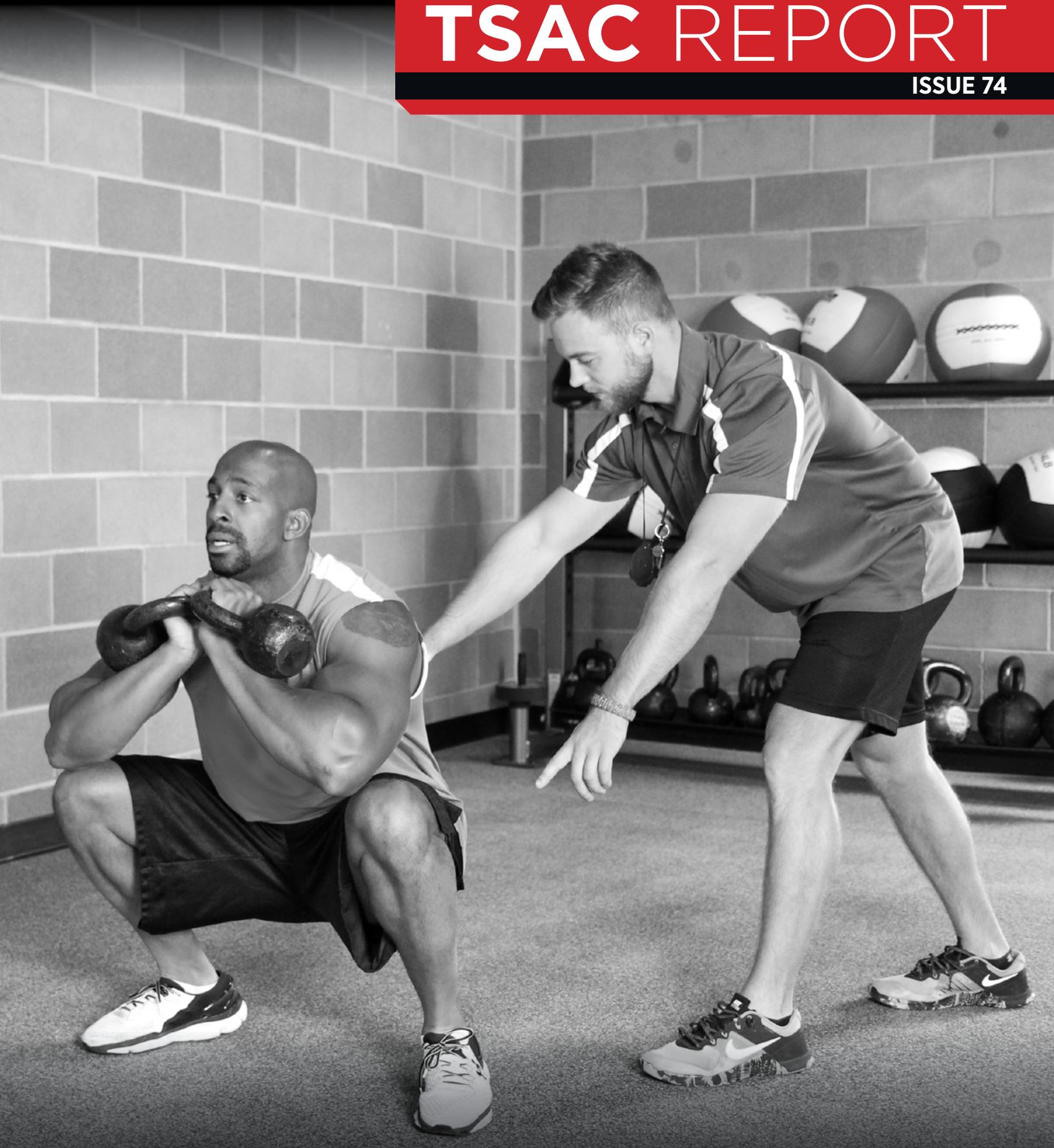
TSAC REPORT

ISSUE 74



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ISSN: 2378-7392



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BRANDON HOLDER, CSCS, AND MERRICK LINCOLN, PT, DPT, CSCS

ON-DUTY STRENGTH AND CONDITIONING PROGRAMMING CONSIDERATIONS FOR POLICE OFFICERS

INTRODUCTION

The purpose of this article is to review the physiological determinants of police work, provide the strength and conditioning professional with an overview of common constraints associated with training police officers, discuss the role of autoregulated training, and provide programming recommendations for training police officers around their patrol shifts. Police officers are expected to maintain physical abilities to withstand the chaotic demands and scenarios they may face on duty. While sedentary tasks such as deskwork and sitting in a patrol vehicle may comprise the majority of a police shift, police officers must be physically prepared for sporadic high-intensity tasks inherent to the occupation. These tasks may include, but are not limited to: sprinting, climbing, carrying external loads (e.g., weaponry, specialist equipment, or body armor), grappling with a perpetrator, or any combination of these tasks (9,10,19).

Police cadets complete fitness training and assessment for the physical demands of policing while in academies (7). Compared to cadets, incumbent police officers (i.e., police officers with multiple years on the job) tend to possess lower aerobic and anaerobic fitness, reduced muscular endurance, and increased body fat percentage (16). As these variances are not fully explained by age, one may conclude incumbent police officers lose fitness with time on the job (16). Longitudinal studies reporting changes in fitness of the same recruits at 12-year and 15-year follow-ups support this conclusion (4,22). A recent longitudinal study following a cohort of incumbent police officers for five years and reported small or trivial losses in fitness (8). These data suggest greater fitness losses are experienced by recruits as they transition to early career police officers, and fitness tends to be lost—not gained—throughout the career of police work (8). To counteract loss of fitness and improve occupational performance within their ranks, police agencies may seek the services of qualified strength and conditioning professionals.

CHALLENGES OF POLICE OFFICER FITNESS

In addition to facilitating improved job performance, physical fitness may support a police officer's physical and mental health as well as their ability to mitigate stress—all key potential facilitators of a healthy and long career in law enforcement. These features express the importance of physical fitness training throughout the established police officer's career. However, several potential challenges may interfere with efforts to improve physical fitness in incumbent police officers.

At the organizational and individual levels, multiple factors may interfere with a police officer's ability to maintain physical fitness. Many police agencies are suffering from greater personnel shortages than ever, which may result in shifting of personnel and limited time resources (1,2). Presumably, strength and conditioning professionals, facilities, and equipment may also be in short supply. Moreover, a challenge common across police work is planning physical fitness training around the patrol shift schedule. While there may be variability between police departments on how patrols are scheduled, here is a typical layout:

- Patrol scheduling is divided into 2 – 3 time slots over a 24-hr period—days, midnights, and, occasionally, evenings.
- Time slots are further divided into two distinct days: A Days and B Days. An individual police officer is assigned to a time slot on an A Day or B Day for a 10 – 12+ hr shift.
- The police officer works a consistent schedule of multiple days on, followed by multiple days off (e.g., two days on, two days off, three days on, two days off, then repeat).

If police officers have the opportunity to perform physical fitness while on duty, training will typically take place at their assigned station and be performed immediately prior to or following their scheduled patrol shift. When performing on duty fitness training, regardless of modality (e.g., strength training, cardio, yoga, etc.), it is imperative to consider training factors that could affect the police officer's job performance and recovery. Workouts cannot interfere with a police officer's job duties and should not appear as an extra hassle in their already busy lives; instead, fitness training should rejuvenate and energize the police officer.

If training pre-shift, exercise must be carefully programmed to ensure physical abilities are not masked by fatigue. If training post-shift, a police officer's vigor or desire to perform strenuous training may be diminished. The strength and conditioning professional should be prepared to make adjustments to training variables, such as rest periods, intensity, volume, and total duration to preserve readiness for patrol or account for varying levels after patrol. A brief subjective readiness assessment or objective test, such as a handgrip dynamometer squeeze or vertical jump, may help inform training modifications.

FITNESS PROGRAM PLANNING AND AUTOREGULATED TRAINING

Police officers benefit from fitness programming constructed around evidence-based training principles. However, the influence of occupational conditions may warrant considerations, such

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as exposure to high-stress situations, experiencing potentially dangerous work operations, lack of sleep due to long patrol shifts, and poor nutrition due to lack of access to nutritious foods while on patrol. For example, a single work call may lead to lasting residual stress—physical and emotional—that could affect readiness throughout the remainder of the patrol and beyond. Police officers may also contend with additional stressors related to health, families, finances, relationships, and other factors outside of work. A police officer's readiness and availability varies day-to-day; therefore, offering fitness training flexible enough to meet the needs of police officers helps to ensure training adherence and progress.

Volatility in the professional and personal lives of police officers makes planning the "perfect" training program unlikely, if not impossible. Rigid programming may be unsustainable. Long-term adherence to unsustainable programming may lead police officers to feel they have failed or believe that their lifestyles are not conducive to fitness training. Instead, educating and encouraging police officers to regulate aspects of their own training may be a more viable strategy for long-term success.

Autoregulation of exercise intensity, volume, and exercise selection can be accomplished through programming methods. For example, the strength and conditioning professional may provide Rating of Perceived Exertion (RPE) targets to encourage autoregulated selection of exercise load (24). The strength and conditioning professional may choose to include acceptable repetition ranges alongside RPE targets rather than fixed repetition targets to facilitate autoregulation of exercise volume. Another strategy would be to offer a menu of alternative exercise selections with varying neuromuscular demands rather than a single option. Anecdotally, providing police officers with a degree of autonomy in their training can lead to greater workout adherence and overall buy-in, helping to solidify physical fitness training as a long-term element in their lifestyles.

PROGRAM DESIGN

Designing a physical fitness program for police officers begins with a needs analysis. Similar to a needs analysis for sport, a needs analysis for policing identifies occupation-related training needs and helps guide programming. The needs analysis includes the definition of the tasks or demands of the occupation, a description of the characteristics of the police officer, identification of goals and priorities, and analysis of the resources and limitations of the program (21). The latter three categories of the needs analysis are heavily dependent on factors unique to the police officer. Meanwhile, directives of the program, characteristics unique to the department (e.g., funding, time allocation, and equipment availability), and task analysis that considers physiological, biomechanical, injury-risk, environmental, and psychological features of law enforcement may be generalizable across the occupation. The task analysis for police officers provided in Figure 1 is based on synthesis of relevant literature and the authors' personal occupational experiences (5,9,14,15,17,18,23). While a task analysis provides general guidance for program design, the strength and conditioning professional must also consider the individual features of police officers, which requires assessing previous training background, injury history, training availability, and personal goals.

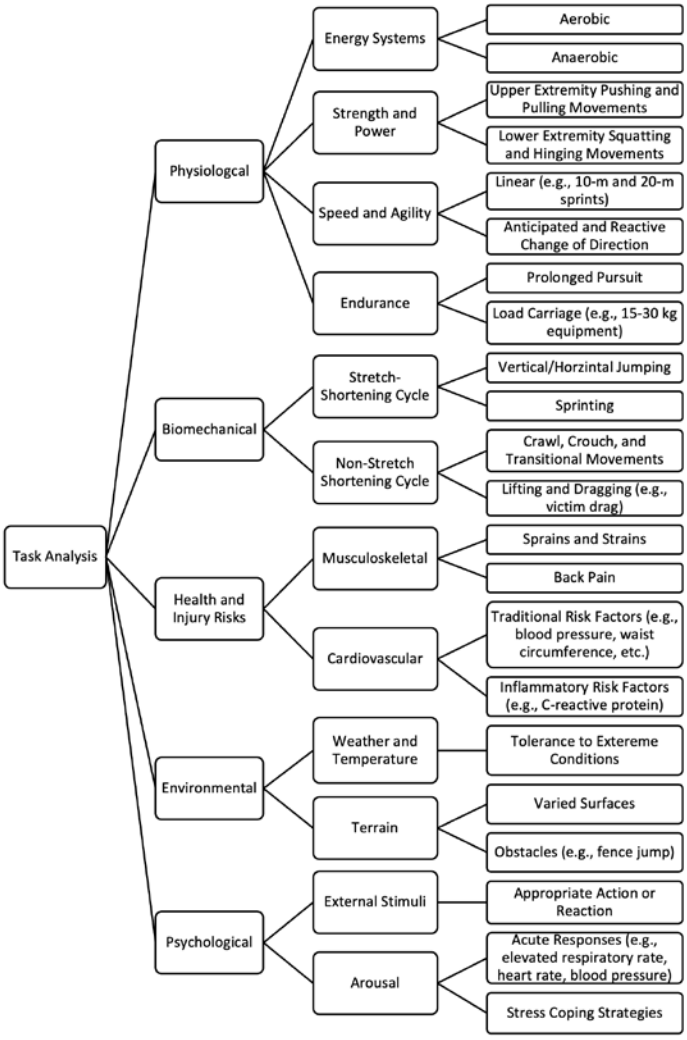


FIGURE 1. TASK ANALYSIS FOR LAW ENFORCEMENT PATROL OFFICERS

TRAINING SPLIT

Fitness training for police officers emphasizes training for full body strength, energy system efficiency, and functional ability. Single body part or isolation exercises may be appropriate to address deficiencies or mitigate injury risk. Body part splits are likely inefficient for this population. Police officers may not be consistently able to commit to a predetermined number of days per week to training. Moreover, they may not be able to allocate similar time or energy to each training session. Full body

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programs with concurrent emphases on strength, conditioning, and functional training in each workout helps to ensure equitable training across all body regions, energy systems, and abilities. With a full body and concurrent emphasis program, a police officer only available to complete one training session in a given week still experiences a comprehensive training stimulus. For police officers able to train more frequently (e.g., three or four sessions per week), full body, concurrent emphasis sessions allow the training volumes to spread out throughout the week, helping to mitigate muscular soreness and the potential negative effects of fatigue on patrol. Table 1 provides example workouts structured using "blocks" of occupationally relevant exercises performed as alternating sets. Each workout concludes with a conditioning "finisher."

TABLE 1. EXAMPLE 1-WEEK TRAINING PROGRAM FOR ON-SHIFT POLICE OFFICERS

DAY 1	EXERCISE	SETS X REPETITIONS	INTENSITY OR RATING OF PERCEIVED EXERTION (RPE)	REST	NOTES
BLOCK 1	Barbell front squat	4 x 8 – 10	7 – 8	1 min	Focus on technique as priority
	Farmer's carry	4 x 60 s	Total load of 50% of bodyweight	2 min	Can use dumbbells or kettlebells
BLOCK 2	Landmine press	3 x 6	8 – 9	30 – 45 s	Can use legs to assist in press
	Medicine ball scoop throw	3 x 3 each side	6 – 10 lb	1 min	Focus on power through hips
BLOCK 3	Kettlebell swing	3 x 6 – 8	7 – 8	1 min	Ballistic effort every repetition
	Inverted row	3 x 12 – 15	Bodyweight	1 min	Maintain body position as horizontal as possible
FINISHER	Assault bike intervals	10 x 15 s / 45 s	10 / 5	No rest throughout the series	Perform sprint effort for 15 s, followed by casual effort for 45 s

DAY 2	EXERCISE	SETS X REPETITIONS	INTENSITY OR RATING OF PERCEIVED EXERTION (RPE)	REST	NOTES
BLOCK 1	Dumbbell bench press	2 x 15, 2 x 12	7 – 8	1 – 2 min	Perform with a neutral grip position
	Chin-ups	3 x 5, 1 x AMRAP	Bodyweight	Full recovery	As many rounds as possible (AMRAP)
BLOCK 2	Dumbbell Romanian deadlift (RDL)	3 x 8 – 10	7 – 8	30 – 60 s	Achieve stretch in bottom position
	Front rack carry	3 x 40 m	10	Full recovery	Maintain an upright trunk
BLOCK 3	Dumbbell split squat	2 x 10 – 12 each side	6 – 7	1 min	Hold 2 dumbbells by side
	Landmine rotation	2 x 8 – 10 each side	6 – 7	1 – 2 min	Perform repetitions with slow tempo
FINISHER	AMRAP circuit	10 min	7 – 8	No rest while performing circuit	AMRAP

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TABLE 1. EXAMPLE 1-WEEK TRAINING PROGRAM FOR ON-SHIFT POLICE OFFICERS (CONTINUED)

DAY 3	EXERCISE	SETS X REPETITIONS	INTENSITY OR RATING OF PERCEIVED EXERTION (RPE)	REST	NOTES
BLOCK 1	Trap bar deadlift	5 x 5	8 – 9	1 min	Focus on technique as a priority
	Band standing rotation	3 x 10 each side	n/a	Full recovery	Rapid concentric rotation and slowly return to start
BLOCK 2	Goblet squat	3 x 8 – 10	7 – 8	30 – 60 s	Maintain a dumbbell or kettlebell slightly off the chest
	Dumbbell chest-supported row	3 x 8 – 10	8 – 9	1 – 2 min	Hold each repetition for 2 s at the top
BLOCK 3	Single-arm dumbbell overhead press	2 x 10 each side	7 – 8	30 – 60 s	Can be performed standing, seated, or kneeling
	Suitcase carry	2 x 20 m each side	Heavy enough to make it difficult when carrying	1 – 2 min	Maintain as upright of a position as possible
FINISHER	Steady state cardio	30 – 60 min (note: this can be performed as a separate session, if needed)	6 – 7	No rest while performing the series	Cardio exercise of choice (e.g., row, ski, bike, stair climber, etc.)

TABLE 2. SUGGESTED MOVEMENT PATTERN-BASED EXERCISE SELECTIONS

Squat Exercise Variations	Barbell front squat, dumbbell goblet squat, belt squat, dumbbell split squat, Zercher squat, safety squat bar squat
Hinge Exercise Variations	Kettlebell deadlift, trap bar deadlift, dumbbell single-leg Romanian deadlift (RDL), kettlebell swing, landmine RDL
Press Exercise Variations	Dumbbell bench press, landmine standing press, single-arm kettlebell overhead press, barbell incline press
Pull Exercise Variations	Chin-ups, inverted rows, single-arm dumbbell rows, chest-supported row
Carry Exercise Variations	Dumbbell farmer's carry, kettlebell front rack carry, dumbbell suitcase carry, plate overhead carry
Rotation Exercise Variations	Landmine standing rotations, medicine ball scoop throw, standing band rotations

EXERCISE SELECTION

Exercise selection for police officers includes foundational multi-joint movement patterns of squatting, pressing, pulling, hinging, rotating, and carrying in various positions. Police officers familiar with basic exercise technique may benefit from inclusion of various unilateral- and unilateral-biased variations of foundational exercises (e.g., dumbbell split squats, single-arm overhead kettlebell presses, and single-arm dumbbell rows). Having a bank of exercises for each movement pattern may assist in efficient selection and progression of appropriate exercises. Suggested exercises for each movement pattern are provided in Table 2.

While the fitness program should be built around exercises with occupationally-relevant movement patterns, the exercise selected for each pattern should be individualized for individual police officers based on the presence or history of injury, exercise experience, and technical abilities. For example, a police officer with shoulder or wrist restrictions may perform the Zercher squat

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or safety squat bar squat rather than the barbell front squat. Alternatively, if the police officer is unaccustomed to loaded squatting, the dumbbell goblet squat may be a superior initial exercise selection, as it has been proposed as part of a progression toward squatting with a barbell (3). Police officers' preferences should also be considered when selecting exercises. Ultimately, police officers should not be "forced" to perform any specific training exercise, as there is no single exercise required for police officer fitness improvement.

DURATION, VOLUME, INTENSITY, AND REST INTERVALS

Training session duration is a major variable when performing fitness on a police shift. Implementing a fitness program requires careful evaluation of a police officer's available time and schedule. It should be noted that a training session does not always have to fit into the traditional 60-min block that the field is so accustomed to. For example, Orr et al. reported that 45-minute training sessions with exercise intensities tailored to the ability levels of participants are as effective as 60-min sessions performed with standardized intensities (17). Training sessions ranging from 30 – 60 min in duration have been shown to improve physical fitness in police officers and cadets (6,17,20). Moreover, findings in non-police populations suggest the efficacy of short high-intensity functional training (HIFT) interventions (11). These workouts incorporate multiple types of exercises and require 15 min or fewer to complete (11). Although growing literature tends to support the efficacy of extremely short duration, high-intensity training sessions for reducing risk of cardiometabolic illness and premature death, their effectiveness for improving police task abilities has not yet been demonstrated (13). Due to the myriad of fitness-related qualities desirable for police work, the authors encourage police officers to commit a minimum of 15 min per session, with 30 – 60 min per session preferred. Ultimately, training session duration, exercise order, volume, intensity, and rest intervals may require modification based on the police officers' time constraints. Figure 2 proposes general structures of training sessions with various durations.

CONCLUSION

Program design for police officers is based on the same premises as program design for sport athletes; however, the constraints, needs, and individual features of these populations tend to differ. Training police officers may present a variety of challenges, including those imposed by scheduling around the patrol shift. Programming should be needs-based, individualized, flexible, and balanced. It should facilitate concurrent improvements in strength, conditioning, and functional abilities, while minimizing risks of injury and undue fatigue. Although training sessions should be directly supervised for best results, strength and conditioning professionals responsible for large geographic areas or large populations of police officers might need to use a remote training program delivery method (e.g., mobile applications) (12,20). Care should be taken to provide regular in-person or video check-ins with police officers to ensure exercises are performed with appropriate technique. Despite intrinsic challenges, a well-designed and properly implemented fitness training program is likely to result in enhanced job task abilities, improved health, and career longevity for the police officers who partake.

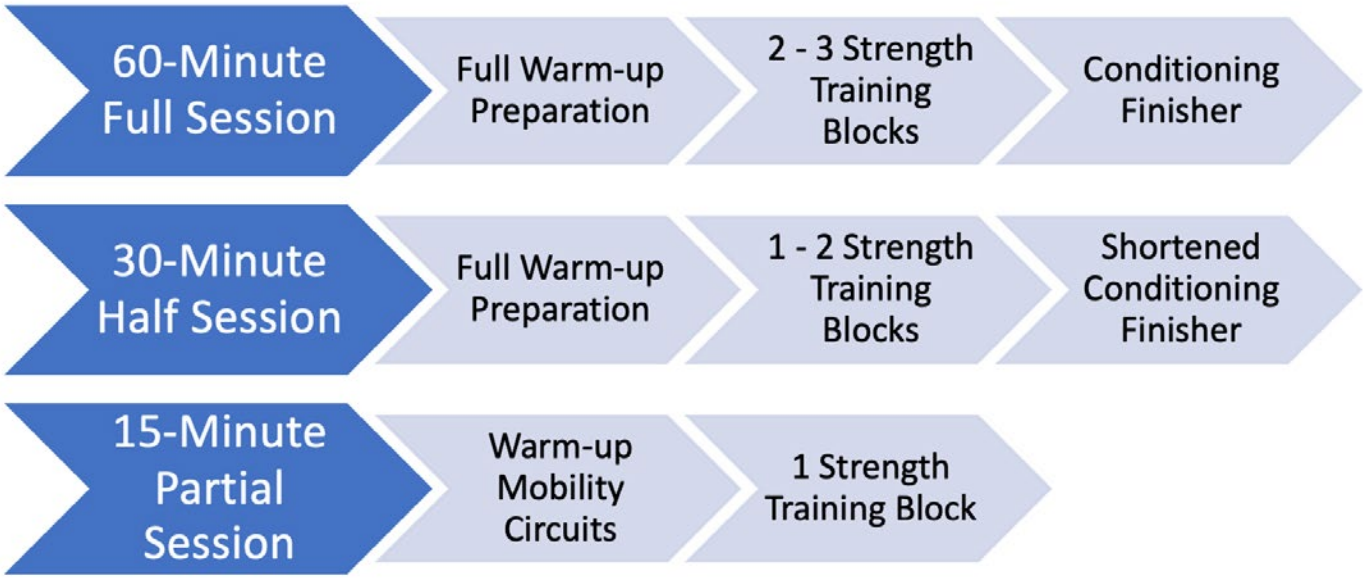


FIGURE 2. SAMPLE TRAINING SESSION DESIGNED BASED ON TIME CONSTRAINTS

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FIRST RESPONDER RESEARCH COLUMN—TSAC 74—THE IMPACT OF EXERCISE AND FITNESS ON FIRST RESPONDERS' MENTAL AND PHYSICAL HEALTH

First responders have been shown to be at a greater risk of mental and physical health morbidities than the general population (11,16,18,19). First responders require resilience to endure and recover from physically and psychologically demanding occupational tasks (7,19). Resilience describes the ability to endure isolated incidents of hardship in a healthy manner (5). Exposure to traumatic events can result in reduced quality of life, substance abuse, and mental or physical morbidities (7,12). Fortunately, adequate physical activity (PA) has been shown to reduce the risk of developing anxiety, depression, and metabolic syndrome, as well as reduce symptom severity for individuals diagnosed with depression or metabolic syndrome (4,9,12,15). This column will explore specific investigations that evaluate the impact of PA and fitness on mental and physical health outcomes among firefighters and law enforcement officers.

PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR, AND MENTAL HEALTH OUTCOMES IN FIREFIGHTERS: A CROSS-SECTIONAL STUDY. *JOURNAL OF WORKPLACE BEHAVIORAL HEALTH* 39(1): 88-105, 2023.

VANCAMPFORT, D, DE SOIR, E, VAN WINKEL, R, LOUW, QA, MCKEON, G, ROSENBAUM, S, ET AL.

Bottom Line Up Front (BLUF): Greater exercise time is associated with lesser symptoms and severity of post-traumatic stress disorder (PTSD) and greater overall well-being among volunteer and career firefighters.

The cumulative stress and traumatic events experienced from firefighting result in a higher prevalence of PTSD in firefighters (14%) than in the general population (4%) (11,20). Even though firefighters often perform strenuous PA when responding to emergencies, they spend the majority of their remaining time being sedentary (5). The primary aim of this study was to explore associations between PA and sedentary time with mental health outcomes in firefighters. The secondary aim of this study was to determine whether mental health outcomes differed among individuals who met the PA recommendation of 150 min of moderate-to-vigorous activity per week versus those who did not (2).

Eighty-seven Belgian firefighters (78 males, 9 females; age: 43.1 ± 10.3 yr; 51.7% volunteer) responded to questionnaires that assessed mental and physical well-being parameters. The Simple Physical Activity Questionnaire (SIMPAQ) was used to assess time spent in various PA intensity domains during the previous week. The Physical Activity Vitals Sign (PAVS) assessment was used to determine if firefighters met World Health Organization (WHO) PA guidelines for health benefits. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) PTSD Checklist (PCL-5) was used to determine PTSD symptom severity, with higher scores reflecting greater severity and a score of 41 out of 80 indicating a provisional diagnosis of PTSD in first responders (13). The Kessler-6 (K-6) was used to assess psychological distress, with a score of 13 suggesting severe distress (10). The WHO-5 Well-Being-Index was utilized as a measure of well-being over the previous two weeks by a summed scale of 0 – 100, with higher scores reflecting greater well-being and scores less than 50 often indicating reduced well-being (17).

Regarding psychological outcomes, 6.9% of firefighters indicated possible PTSD, 5.7% of firefighters reported high levels of psychological distress, and a mean WHO-5 score of 63.9 ± 18.9 out of 100 indicating that the typical firefighter response did not exhibit reduced well-being. However, 15.8% reported well-being scores of 45 or less, which may be of concern (17). Regarding PA, 31% of firefighters were not meeting guidelines; specifically, firefighters spent 55.2 ± 65.9 min walking, 33.6 ± 31.5 min exercising, and 168.1 ± 175.8 min of incidental PA per day.

Firefighters' gender and age were not associated with PA and psychological outcomes. Greater exercise time was correlated with lower PTSD severity scores ($\rho = -0.220$, $p = 0.041$) and better well-being scores ($\rho = 0.245$, $p = 0.022$). Greater incidental PA time was related to lower psychological distress scores ($\rho = -0.227$, $p = 0.035$). Greater sedentary time was trending with poorer well-being scores ($\rho = -0.203$, $p = 0.059$). The 6.9% of firefighters with PTSD accumulated more sedentary time and spent less time exercising than firefighters without PTSD ($p \leq 0.027$). Achievement of PA guidelines was not associated with poorer overall wellness, PTSD symptom severity, or psychological distress.

RELEVANCE FOR THE TACTICAL FACILITATOR

Greater exercise time was associated with reduced symptom severity of PTSD and increased overall well-being among volunteer and career firefighters. Unfortunately, due to the cross-sectional design of this study, it is not possible to determine if firefighters' exercise behaviors had a direct effect on mental health status, or if mental health status had a direct impact on exercise behaviors. Future longitudinal research is needed to evaluate these dynamics in firefighters. Thus, departments are encouraged to utilize tactical faciliators to develop comprehensive wellness programs to incentivize lesser sedentary behavior while on- and off-duty.

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Some examples may include organizing step or PA participation challenges, encouraging movement breaks, and providing exercise time, space, and equipment. Tactical facilitators should consider monitoring sedentary behavior time and provide educational resources regarding the negative implications of sedentary behavior on mental well-being. Mental healthcare professionals are encouraged to assess PA and sedentary behavior levels when developing treatment programs for firefighters suffering from psychological distress. Finally, it is important to consider that first responders often work in high-stress environments with organizational and systemic challenges such as long shifts, inadequate resources, and exposure to traumatic events. Thus, in addition to physical activity interventions, broader organizational issues, such as workload management, fair compensation, adequate rest, and comprehensive mental health support are factors to consider for firefighters' mental and physical health.

ASSOCIATION BETWEEN HEALTH-RELATED FITNESS, PERCEIVED STRESS, AND METABOLIC SYNDROME PREVALENCE IN A SAMPLE OF LAW ENFORCEMENT OFFICERS. *POLICING: AN INTERNATIONAL JOURNAL* 44(2): 261-274, 2020.

CHASE, B, BRUSSEAU, T, BURNS, R, HANNON, J, HENDERSON, H, AND KEHOE, B.

BLUF: 1.5-mile run completion time is associated with metabolic syndrome (MetS) risk factors and occupational stress among law enforcement officers.

Law enforcement officers (LEOs) often experience periods of physical and psychological stress during atypical working hours, which are otherwise predominantly sedentary (17,18). Chronic stress and insufficient PA are associated with an increased risk of developing MetS (16,17). The prevalence of MetS among LEOs is debated to be the same as or greater than of the general population (1,21). Thus, MetS presents an occupationally relevant health concern that needs to be addressed. MetS is characterized by positive status of at least three of the following five risk factors: obesity (waist circumference >102 cm for males, >88 cm for females), elevated blood pressure (systolic ≥130 mmHg or diastolic ≥85 mmHg), dyslipidemia (triglyceride levels ≥150 mg/dL), low serum high-density lipoprotein (<40 mg/dL for males, <50 mg/dL for females), and hyperglycemia (fasting plasma glucose ≥100 mg/dL) (6). Individuals with MetS are five times more likely to develop type 2 diabetes and twice as likely to have cardiovascular disease and premature cardiovascular mortality (14). Furthermore, LEOs are at the greatest risk of premature cardiovascular mortality during and shortly after altercations that require use of force (18). Therefore, the primary aim of this investigation was to examine the association between components of MetS with health-related fitness and perceived stress among LEOs.

Twenty-eight United States LEOs (26 males, 2 females; age: 39.6 ± 10.8 yr, height: 181.0 ± 8.0 cm, body mass: 94.1 ± 16.4 kg) completed health assessments (blood pressure, cardio-metabolic blood markers, circumference) and physical performance assessments (sit-ups, push-ups, and 1.5-mile run), two reputable stress surveys (Organizational Police Stress Questionnaire [PSQ-Org] and the Operational Police Stress Questionnaire [PSQ-Op]), and the Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH) to assess PA during the previous week. Multiple linear and bivariate regression analyses were used to examine relationships between physical fitness measures (1.5-mile run, sit-ups, and push-ups) versus MetS and stress outcomes.

Nearly 43% of the LEOs (12 out of 28) met MetS criteria. The 1.5-mile run time was related to MetS and stress outcomes. Specifically, for every one-minute increase in 1.5-mile run time, fasting blood glucose increased by 0.56 standard deviations (12.7 mg/dL, $R^2 = 0.24$, $p = 0.021$) and occupational stress scores worsened by 0.54 standard deviations ($R^2 = 0.25$, $p = 0.022$). Interestingly, sit-up and push-up outcomes were not associated with most MetS or occupational stress outcomes. However, the authors noted that LEOs may have terminated these assessments when they reached the minimum standard (i.e., 25 push-ups, 35 sit-ups), instead of volitional exhaustion. Thus, the submaximal effort and lack of variability in performance may have confounded these muscle endurance analyses. Despite several limitations, the findings support the consensus that greater cardiorespiratory fitness is associated with favorable physical and mental health outcomes.

RELEVANCE FOR THE TACTICAL FACILITATOR

Cardiorespiratory fitness is critical for LEO readiness, physical and mental health, and occupational stress. Departments are encouraged to assess multiple aspects of LEOs' physical fitness more than once per year, utilize LEO-specific mental health experts, and incorporate surveys to routinely monitor perceived occupational stress. Timely and open communication regarding concerns and stressors should be encouraged up, down, and across the chain of command. Training officers should educate incumbents and cadets regarding identification of occupational and personal stressors, effective stress management strategies, and use of relevant resources without fear of punitive action. Tactical facilitators are encouraged to develop programs to improve LEO cardiorespiratory endurance to reduce the risk of burnout and MetS (8). Tactical facilitators can stress the importance of cardiorespiratory endurance to LEOs in the context that improved physical health will translate to enhanced recovery and reduced risk of cardiovascular mortality following altercations that require the use of force (18).

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FIRST RESPONDER RESEARCH COLUMN—TSAC 74—THE IMPACT OF EXERCISE AND FITNESS ON FIRST RESPONDERS' MENTAL AND PHYSICAL HEALTH

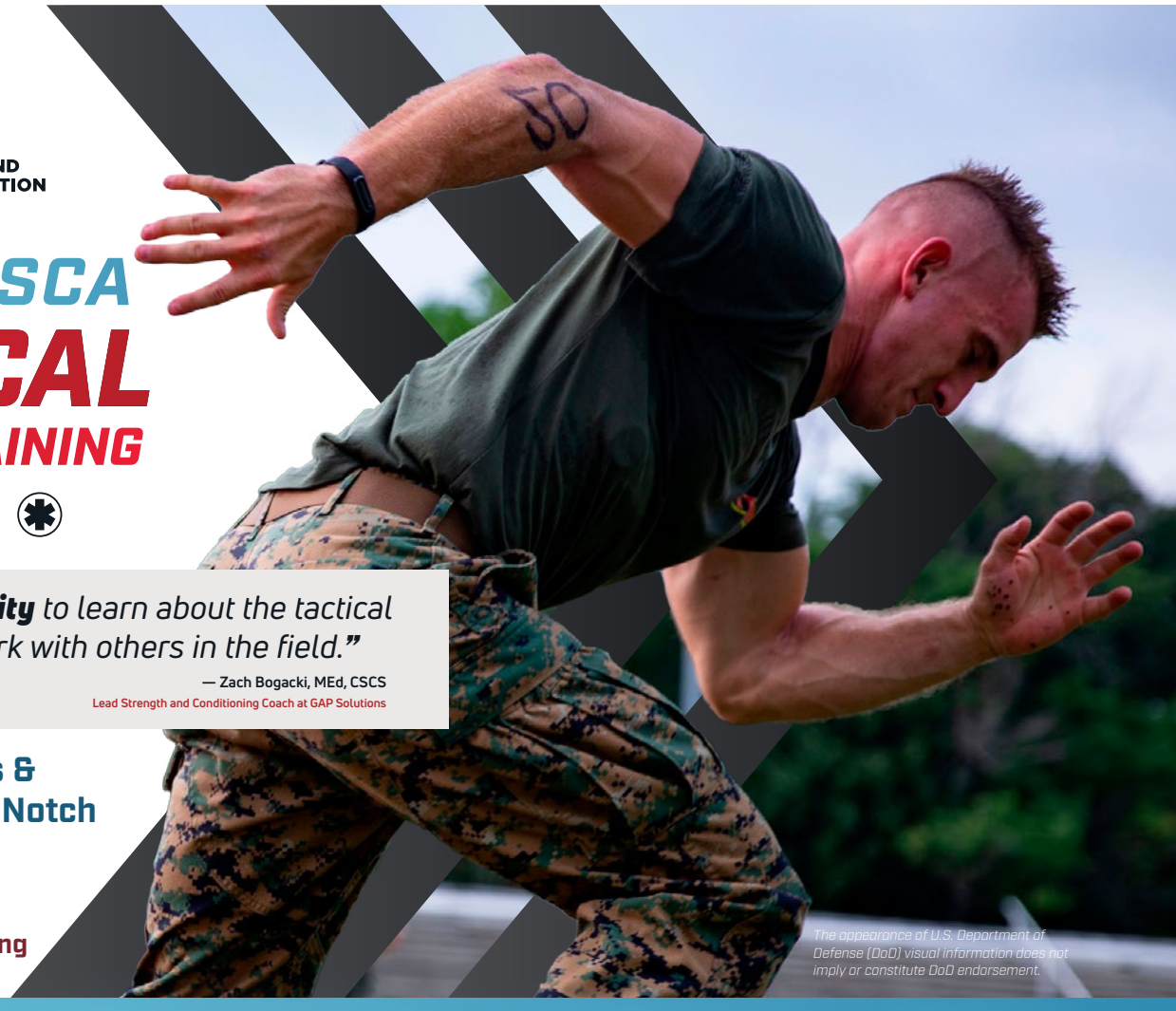
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POTENTIAL FOR USING THE REACTIVE STRENGTH INDEX (RSI) TO DECREASE INJURY RISK AND IMPROVE OPERATIONAL PERFORMANCE IN UK FIREFIGHTERS

INTRODUCTION

Much like police officers, paramedics, and military personnel, programming strength and conditioning training for fire service personnel requires physical and tactical training to enhance operational performance (6,7). Pre-operational work specific training in their rest times while at work awaiting emergency callouts prepares firefighters for the physical and psychological demands of their work. To be effective, fire service personnel must have muscular strength, power, and endurance to complete endurance work on operational duties and maneuver in close quarters while carrying external loads (3). Although tactical training programs aim for positive long-term adaptations, overtraining or chronic exhaustion can lead to decreased operational performance. Therefore, a measure of monitoring neuromuscular performance capabilities and central neuromuscular fatigue could provide deeper insights into the level of ability when carrying out actions such as stair ascending and descending while carrying heavy equipment under duress (5,7).

INJURY ACTIVITY IN THE FIRE SERVICE

Firefighters are trained for extremely hazardous work in harsh, chaotic, and unpredictable environments, with heated temperatures that cause deleterious effects on the firefigther (10). Firefighters face numerous hazards on the job, including toxic vapors, hazardous combustion products, high radiant heat loads, and a hectic work environment (9). In addition to the hazards experienced at the fire scene, firefighters execute rescues, extrication, and emergency medical system calls and respond to natural disasters and hazardous material spills. Descending stairs while fatigued, carrying heavy equipment, wearing personal protective equipment (PPE) under duress, and carrying victims can be the leading cause of lower limb injury (6). Additionally, firefighter may experience lower back pain when pivoting stairwells with ladders and victims (6).

CURRENT CHALLENGES IN THE FIRE SERVICE

The standard fitness test for the London Fire Brigade is split into six work-related tasks and must be passed with competence prior to qualifying as a firefighter. At present this is only required when leaving the academy and as of January 2024, the Chester treadmill test was introduced (4). Until recently, the fire service did not implement an annual fitness assessment for current personnel and fitness testing was not compulsory; however, now the Chester treadmill test must be completed to ensure cardiovascular standard ability for all current serving firefighters (10). The annual fitness assessment using the Chester treadmill test is in the pilot year (2024/2025). Strength and stamina assessments such as reactive strength index (RSI) testing will be brought into effect at some point following the outcome from the initial first year period.

- Aerobic Chester treadmill test: a progressive 12-min walk/run test, set at a speed of 6.2 km/hr on a treadmill, with a 3% gradient increase every two minutes beginning at 0%, wearing sports attire such as shorts and t-shirt (not wearing protective kit).
- Ladder climb: climb a 13.5-m (45-ft) ladder to a specific point, two thirds of the full working height, take a leg lock, remove the hands from the ladder, look down to the assessor below where they will be asked to identify a symbol.
- Ladder lift: raise the bar of a ladder lift simulator weighing 30 kg (4 stone) to a height of 190 cm (6 ft 3 in).
- Casualty drag: drag a 55-kg (8-stone) dummy backwards around a 30-m (100-ft) course around four cones within a set time.
- Enclosed space: wearing a breathing apparatus face mask, negotiate a crawl and walkway with clear vision. Halfway through the route, vision will be obscured, and the task is to retrace your steps to the start/finish point.
- Equipment assembly: assemble and then disassemble a portable pump while wearing fire gear.
- Equipment carry: carrying the equipment over a 25-m course around two cones within 5 min and 47 s. The equipment is made up of one 30-m (100-ft) hose reel tubing on a drum, three coiled 70 mm soft suction hoses, one 100 mm hard suction hose and suction strainer in a basket and one 33-kg (5-stone) barbell.

These tests are designed to identify the readiness of the recruits for entry into a working environment that may require them to perform all these tasks, with repeated bouts and continued exertion throughout an emergency situation that could last up to several hours. Firefighters routinely execute jobs in uncomfortable and injury-prone positions, increasing their risk of developing an occupational musculoskeletal injury. There is evidence that having appropriate core muscular strength can aid and assist in avoiding injury (3).

Despite the intense physical demands of firefighting, unknowingly, some firefighters may not maintain the necessary levels of conditioning for peak work performance. The United Kingdom fire

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service has recently identified minimal cardiorespiratory fitness standards (42.3 ml·kg^{-1}·min^{-1}) for firefighters using the Chester step test (10); with the six task-related assessments to pass academy are passed or failed on set timings and the ability to carry out the tasks with competence. However, there is still uncertainty about the necessary strength and muscular endurance for safe and effective firefighting operations (8). Firefighters have extensive periods of stress-free activities, but during an emergency there is an abrupt increase in energy demand. If they have proper physical fitness conditioning, their ability to conduct a rescue mission and increase recovery from firefighting in hazardous situations encountered such as climbing over debris and entering burning buildings, and reduced the risk of injury. If firefighters exhibit low physical conditioning, this could jeopardize safety when performing fire suppression responsibilities, which may occur with deconditioning due to the lack of continued testing that is seen at present, but due to change in June 2024.

Despite varying physical demands and vocational needs, monitoring muscular strength and power is essential for all tactical populations, specifically for firefighters that are often ascending and descending stairwells (London is becoming increasingly populated with high rise buildings), as well as carrying heavy equipment and/or victims (5,6,7,10). Human performance monitoring involves evaluating program efficiency and efficacy at the macro level, ensuring that training prescriptions and adaptations sought are met (7). A specific performance entity that can be measured that identifies the efficiency of the lower limbs within the kinetic chain while performing work is RSI. RSI measures the limb's ability to exert force from the eccentric to the concentric phases of muscle contraction, as explained extensively by Wilson and Flanagan (11).

A positive link is seen with higher RSI scores that attain superior endurance performance through a lower energy cost or a more significant overall distance traveled (7,11). Another critical performance factor for high scores of RSI is the increased ability to create safer change of direction (COD). High COD ability is essential when having to negotiate through buildings that may be littered with debris and uneven surfaces while filled with smoke and wearing heavy PPE. High RSI demonstrates the ability to facilitate energy preservation using elastic energy storage with the use of plyometrics (stretch-shortening cycle [SSC]). Without sacrificing strength gains, plyometric training is superior to resistance training in terms of enhancing power, jump, and stair climbing performance. While this type of training appears doable, it can carry a higher risk of injury that should be considered when creating programs for older and less experienced firefighters and physiological monitoring is required to ensure safe and effective application is ensured (12).

Merrigan et al. identified the effects of Newton's laws of motion on military personnel and their importance on performance and injury risk reduction (7). Such as improving leg strength and maintaining body mass, which can aid a person in accelerating and decelerating from ground reaction forces (GRFs). By observing Newton's Third Law of Motion, which asserts that "every action has a corresponding and opposing reaction," depicting the interaction between the body's muscle forces and opposing external forces (7). An example is during a drop jump protocol (Figure 1), a high-intensity plyometric exercise where the legs push back against the GRF when contact is made, propelling the body up.

RSI

All the performance factors affected by RSI scores can be attributed to the tasks involved in firefighter duties, from exiting the fire engine in an emergency (known as appliances or pumps in the UK) onto hard and uneven surfaces to rushing to secure equipment. High RSI thresholds would increase the physiological effectiveness of the firefighter when operating in highly hazardous environments, decreasing fatigue and injury risk. When ascending and descending stairwells while wearing heavy equipment, carrying hoses, lifting victims to safety, or breaking through obstacles, a high RSI threshold would potentially decrease muscular fatigue to counteract the eccentric forces met when stepping down (12).

In other athletic populations, female collegiate volleyball players who demonstrated lower RSI scores are linked to an increased likelihood of a non-contact lower limb injury; however, this outcome was not shared by the male volleyball players in the study by Brumitt et al (1). The outcome also suggested that further studies are necessary to confirm this preliminary result and assess RSI's suitability as a screening tool for sport and tactical populations.

TESTING RSI AND PROGRAMMING

GRFs can be measured using relatively inexpensive jump mats with the height (m) divided by contact time (s) from a drop jump of varying heights to land and rebound (Figure 1). Although force plates are the preferred choice for sports scientists and researchers, due to the complexity of software and data extrapolation and high prices, jump mats are ideal for tactical facilitators as they are inexpensive and easy to use. Testing at differing heights of the step-off should be 10, 20, and 30 cm to determine the thresholds of reactive strength training (2,11). Step heights of fire engines in the UK are 20 cm apart and 30 cm from the lower step to the floor, and the step height in private buildings are generally between 15 – 22 cm.

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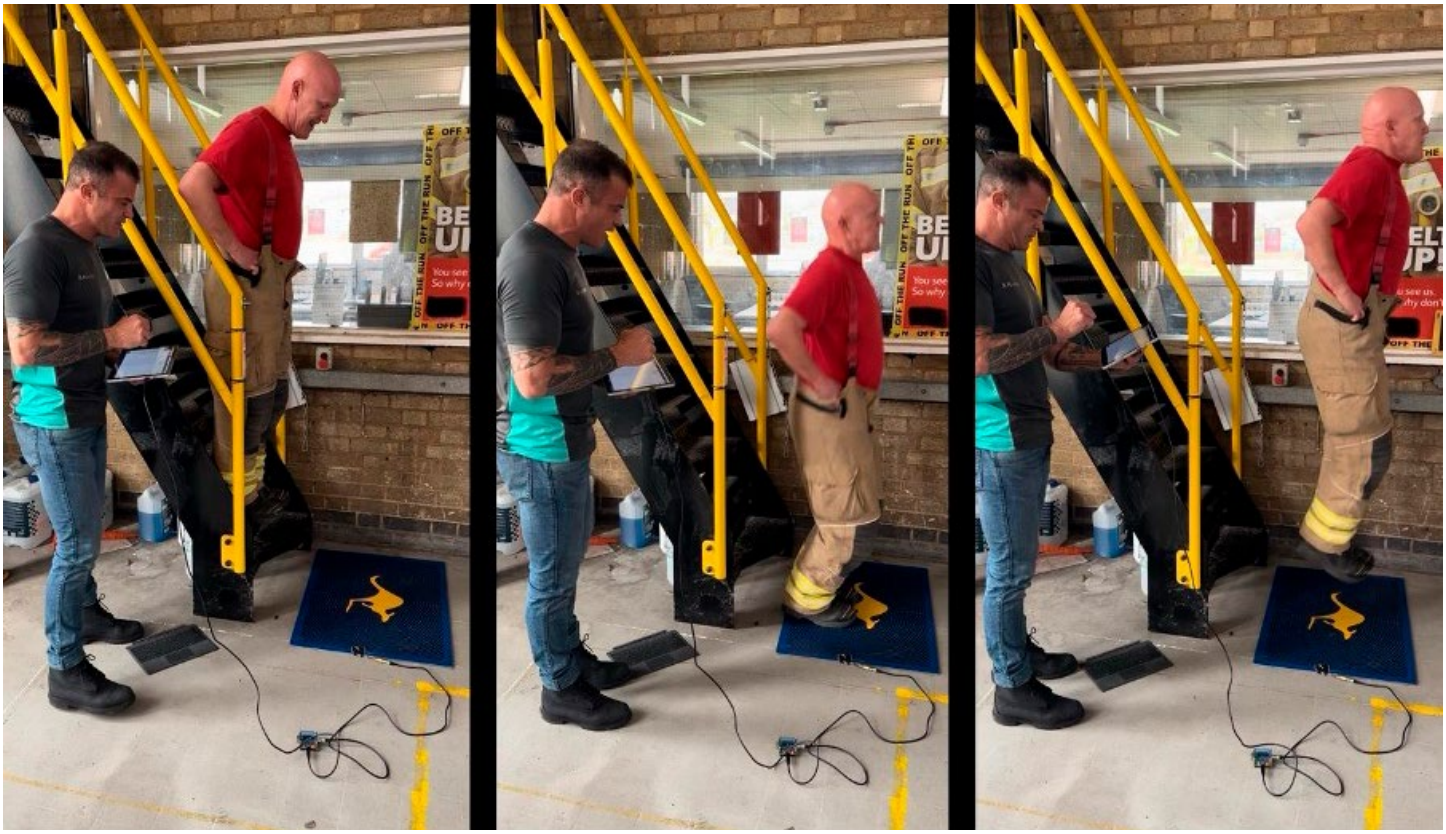


FIGURE 1. EXAMPLE OF DROP TEST PROTOCOL

The firefighter is performing the drop jump test protocol, stepping from 30 cm onto the jump mat (Chronojump, Spain), and rebounding on contact with hands placed on hips.

TABLE 1. SUGGESTED PROGRAMMING FOR PROGRESSION TO SAFELY INCREASE RSI CAPABILITY (2)

RSI SCORE	Plyometric Type	Strength Type	a) Frequency b) Intensity c) Volume
RSI <1.5	Light bounding Skipping rope Half squat jump (>0.25 s contact time on rebound)	Developmental base strength: squats, lunges, and calf raises	a) 2 per week b) Light c) Moderate
RSI 1.5 – 2.0	Lateral hops Pogo jumps	Increase in strength development	a) 2 – 3 per week b) Moderate c) Low to moderate
RSI 2.0 – 2.5	Depth/drop jumps Pogo jumps	Extensive strength training and ability to increase height on drop jumps	a) 2 – 3 per week b) Moderate to heavy c) Low to moderate
RSI 2.5 – 3.0	Multiple depth jumps to box jump combination. Hurdle jumps: determine height based on contact time. If the contact time is longer than 0.25 s for the rebound, decrease height. Weighted rebound jumps.	The maintenance level of reactive strength attained the possibility of diminishing returns if the intensity is increased	a) 2 per week b) Moderate to heavy c) Moderate
RSI >3.0	Altitude drops Weighted drops and rebounded jumps	Exceptional athletic capability with minimal potential for improvement	a) 2 per week b) Heavy c) Low

Use <0.25 s on contact time for high-intensity exercises but prolonged contact time for low RSI (<1.5)

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Thresholds identified to determine RSI ability found that those with scores <1.5 have low reactive strength ability and may be unprepared for high-intensity plyometrics while those with scores >3.0 are world-class athletes with slight potential for improvements in reactive strength training (2). The tactical facilitator should appropriately govern the intensity of the programming to the specificity of the needs and capability of the firefighter (Table 1). Low thresholds (<1.5) suggest the development of baseline strength is warranted. When the intensity of the jumps and explosive rebound activities are too high, with too little rest and too much volume, the outcome may cause musculoskeletal (MSK) injuries such as tendinopathies (2).

CONCLUSION

Although many other variables are attributed to a firefighter's physical readiness than RSI alone, such as core strength, endurance, and technical and tactical training, RSI can substantially determine readiness and injury risk reduction. RSI can be monitored by trained strength and conditioning coaches integrated into the fire service or consultants to design appropriate programs to aid and assist firefighting personnel readiness. The work of a firefighter is both arduous and hazardous. Firefighter safety is paramount to being an effective lifesaving service that works to save victims from danger. Operational duties can be lengthy, with exhaustion being the critical detriment to performance and precursor for increased injury risk. Therefore, strength should be placed in high importance when prescribing training programs. RSI levels should be observed and included in the needs analysis of program construction, where the musculotendinous units can be trained to save energy when performing tasks (1).

Like other tactical populations, firefighters often will not have the luxury of a warm-up prior to needing to move explosively. Still, high RSI capability may offset strains, sprains, and muscle tears, as well as increase firefighter readiness to deploy to more optimal operational standards. Increasing strength and power enhancement will decrease injury and improve performances, and more research is being published showing the positive effects of plyometrics to decrease falls and injury risk. However, as there is a dearth of research on RSI's ability to assess for injury prediction, researchers and practitioners should further develop a better understanding of how this tool could be used for such purposes to reduce injury risk.

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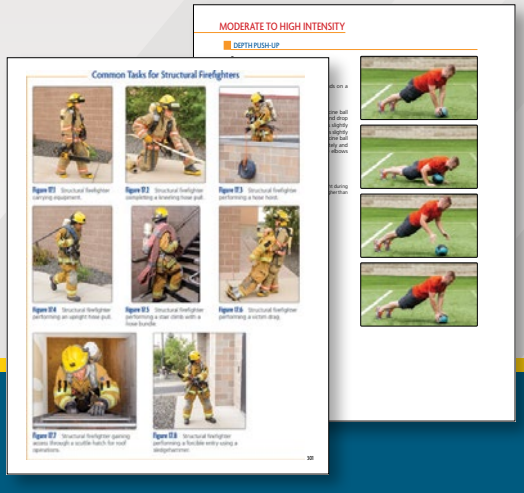
ABOUT THE AUTHORS

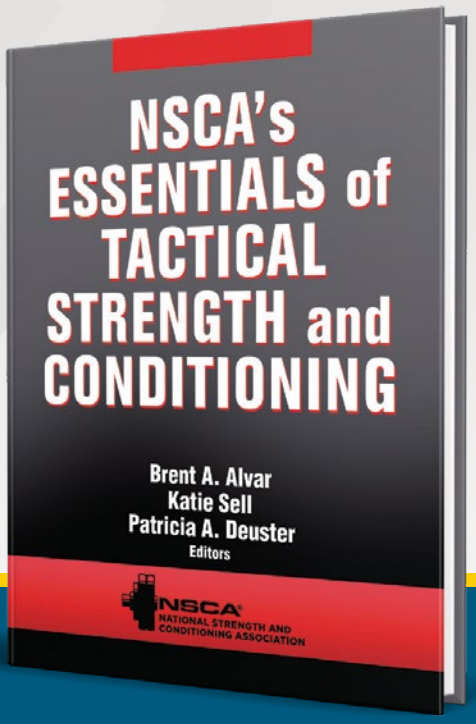
Lee Brown is currently working towards a PhD by publication of "Practical Application of Strength and Conditioning Preparation for Muay Thai Coaches and Athletes." He has experience with professional sports and tactical populations, such as the British Parachute Regiment and the London Fire Brigade. He holds the Certified Strength and Conditioning Specialist® (CSCS®) and Registered Strength and Conditioning Coach® (RSCC®) certifications through the National Strength and Conditioning Association (NSCA). Brown is also a Registered Clinical Physiologist (RCCP), Registered Clinical Exercise Physiologist and Chartered Scientist through the British Association of Sport and Exercise Sciences (BASES), and a senior lecturer at the University of East London in high performance sports. More recently, he has been working with Parkinson's United Kingdom on research that involves hypoxia and exercise. One of his roles is to oversee the working laboratory with clients and scholars at the human performance center. After recently opening a clinical physiology practice, Brown works mainly with neuro patients, as well as overseeing clients with cancer, metabolic, and cardiac conditions.

Scott Caufield oversees, develops, and manages strength and conditioning programs for 600+ student-athletes at Norwich University in 22 Division III varsity athletic programs. He guides Reserve Officers' training Corps (ROTC) leadership and cadets in best practices in strength and conditioning and manages the annual strength and conditioning plan for the Norwich Ranger Company. Caulfield is the National Strength and Conditioning Association Foundation (NSCAF) Vice President and the State Director for NSCA Vermont. He holds a Bachelor's degree in Physical Education from Castleton University and a Master of Arts degree in Sports Coaching from the University of Denver.



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KATHRYN BELL, MS, CSCS, AND BRIAN SCHILLING, PHD, CSCS

TSAC REPORT—MILITARY COLUMN—JULY 2024

Cost-effectiveness while maximizing performance and retention of personnel is a balancing act regularly practiced by the United States military. The focus of recent research has studied two different approaches to maximizing performance among United States Army and Air Force personnel. A long-standing approach to training large groups of soldiers has been through minimal-equipment training programs. This translated fairly well over the course of the previous Army Physical Fitness Test, considering this test was created to be taken anywhere, given its lack of required equipment. However, with the introduction of an equipment-heavy Army Combat Fitness Test, it is unclear whether the use of minimal-equipment training programs translates to improved ACFT scores. Additionally, retention of recruits during Air Force Basic Military Training relies on the mitigation of running-related musculoskeletal injuries; a problem that imparts nearly $22 million in annual military expenses. Therefore, it is important to quantify how training strategies may improve overall performance and retention across the branches and potentially improve cost-effectiveness.

EFFECTS OF MINIMAL-EQUIPMENT RESISTANCE TRAINING AND BLOOD FLOW RESTRICTION ON MILITARY-RELEVANT PERFORMANCE OUTCOMES. *JOURNAL OF STRENGTH AND CONDITIONING RESEARCH* 38(1): 55-65, 2024.

CINTINEO, HP, CHANDLER, AJ, MASTROFINI, GF, LINTS, BS, MCFADDEN, BA, AND ARENT, SM

It has been common practice among military personnel to adapt training programs that require minimal equipment, given the unpredictable nature of military operations. Furthermore, in order to train larger groups of people, minimal-equipment training programs are relied upon to improve time efficiency while attempting to maintain general fitness. However, prior field-training studies have suggested that minimal-equipment training programs do not result in the same strength and muscular power outcomes that resistance training (RT) confers, likely due to the inability to induce sufficient load or metabolic stress. This became a driving factor for implementation of an equipment-heavy Army Combat Fitness Test, a newly adapted fitness test by the US Army that comprehensively assesses a soldier's maximal strength, muscular power, endurance, anaerobic capacity, and aerobic capacity. Additionally, blood flow restriction (BFR) has grown in popularity for its ability to noninvasively and effectively bolster RT adaptations through production of ischemia, facilitating increases in metabolic stress. The purpose of this study was to determine the efficacy of a minimal-equipment RT program with and without BFR on the events of the ACFT relative to traditional-equipment RT in male and female Reserve Officers' Training Corps (ROTC) cadets and midshipmen.

Fifty-four US ROTC cadets and midshipmen (40% women) representing the Air Force (52%), Army (26%), and Navy (22%) were included in this training intervention. The study was spread across three testing days, followed by a four-days a week six-week training intervention, and ending with post-testing. Participants underwent a blood draw on day one in which serum samples were collected for analysis of cortisol, growth hormone, IGF-1, interleukin (IL)-10, IL-1β, and IL-6. Following the blood draw, height, weight, and body composition were measured, with body composition being assessed using air displacement plethysmography (BOD POD®). Muscle and tendon thicknesses of the biceps brachii and quadriceps were measured using a B-mode ultrasound transducer to assess changes in localized hypertrophy following each intervention. Day two of testing required the participants to perform an ACFT. Following a standardized 10-min dynamic warm-up, the participants performed the six-event ACFT, consisting of the following tests: three-repetition maximum (3RM) deadlift, standing power throw, hand release push-ups, sprint-drag-carry, leg tuck, and two-mile run. It should be noted that equipment used during the ACFT includes a hex-bar deadlift (3RM), a 4.5-kg (10-lb) medicine ball (standing power throw), a 40.8-kg (90-lb) sled, and two 18.15-kg (40-lb) kettlebells (sprint-drag-carry). Each event was scored out of 100 points for a maximum score of 600 points. Before the training intervention began, day three consisted of laboratory performance testing, in which participants were tested on their anaerobic peak power, upper body strength, and maximal aerobic capacity via performance of a countermovement vertical jump, 3RM bench press, and maximal aerobic capacity, respectively.

Participants were stratified by sex and randomly assigned into one of three groups: traditional-equipment RT (TRAD), minimal equipment RT (MIN), and minimal-equipment RT with BFR (MIN + BFR). Heart rate (HR) and blood lactate were continuously monitored throughout each of the training sessions during the six-week intervention. Within the MIN + BFR group, the BFR cuff remained inflated during the mid-exercise and post-exercise measurements. Recovery status and subjective measures of training distress were assessed at the beginning of each training session as a means of quantifying recovery status. A rating of perceived exertion (RPE) was also given by each participant following each exercise set and, in the MIN + BFR group, participants provided an RPE for pain or discomfort during administration of the BFR cuff. The BFR cuffs were placed proximally at the participant's arms and legs and were increased or decreased incrementally based on RPE throughout the intervention.

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The training intervention consisted of a full-body exercise routine that alternated between two different workouts throughout the six-week program. The TRAD group included large compound movements such as the power clean, trap bar deadlift, and bench press and utilized equipment such as barbells, kettlebells, dumbbells, and a trap bar. The MIN and MIN + BFR performed exercises and movement patterns that matched the TRAD protocol and used equipment such as sandbags, resistance bands, and a weighted vest. Repetition ranges for the TRAD group ranged from 3 – 10, with rest intervals between 2 – 3 min. Repetition ranges for the MIN and MIN + BFR groups ranged between 15 – 30, with rest intervals between 1 – 3 min.

Post-hoc tests showed a small to moderate improvement in ACFT scores in the TRAD (d=0.43), MIN (d=0.34), and MIN + BFR (d=0.31) groups, with the largest pre-training to post-training improvements in the TRAD group. All three groups improved across each event. All three groups increased body mass and fat-free mass while decreasing body fat percentage, with the TRAD group having the largest decrease in body fat percentage with a small to moderate effect (d=-0.28). Differences in body composition were not different between MIN and MIN + BFR groups. All groups improved in countermovement jump (CMJ) height, 3RM bench press, and VO_2max; however, CMJ height and 3RM bench press showed the largest overall improvement in the TRAD group with small to moderate effects (d=0.38; d=0.24). Participants in the MIN and MIN + BFR groups improved the greatest in VO_2max performance and showed small to moderate effects compared to the TRAD group (d=0.31 and 0.21 verses d=0.05). Results for biomarker detection revealed no group-by-time differences in basal cortisol, growth hormone, IGF-1, IL-10, IL-1β, or IL-6. Both males and females adapted similarly to RT with and without BFR following the six-week training intervention.

RELEVANCE FOR THE TACTICAL FACILITATOR

The results of this study support the utilization of field-expedient minimal equipment RT, although the effect of minimal-equipment RT is less than when performing traditional RT. The current data suggests that when using a minimal-equipment RT program, it is possible to improve ACFT scores by up to 8 – 12% after a six-week training intervention.

RUNNING GAIT TRAINING IMPROVES OUTCOMES AT UNITED STATES AIR FORCE BASIC MILITARY TRAINING. *MILITARY MEDICINE* 189: 692-697, 2024.

FISHER, R, KASPER, K, AND TRIGG, S

Running is an integral part of training throughout the 7.5-week long Basic Military Training (BMT) for US Air Force recruits. However, running is one of the primary causes of musculoskeletal injury among recruits, with bone stress injuries representing approximately 40% of diagnosed injuries at BMT. During BMT, injury occurrence may threaten retention of recruits, especially if the underlying cause is not resolved. It is suggested that sports medicine integration through the Versatile Injury Prevention and Embedded Reconditioning program (VIPER) in BMT may help in reducing running-related musculoskeletal injuries through education of proper running gait mechanics. This program includes minimizing ground reaction forces, increasing cadence, increasing angle of inclination of the tibia at initial contact, and proper activation and strengthening of the hip. However, it is unknown whether the characteristics attributed to reduced running-related injury risk could serve as a preventive measure for a large group of asymptomatic BMT recruits. Therefore, the aim of this study was to determine the effectiveness of large-scale running gait training to prevent running-related injury risk and to improve the rate of successful training outcomes in US Air Force BMT recruits.

A total of 19 training squadrons were monitored throughout each 7.5-week BMT. The study employed two control groups and two intervention groups, with the first intervention group (2,205 recruits) consisting of three sequential squadrons that received gait-training within the first week of BMT (three flights of 50 recruits per session). The second intervention group (6,223 recruits) included one intake from each of eight squadrons, where all recruits received gait training. To account for any differences in squadrons, two control groups were included. Control group A (3,941 recruits) represented two squadrons that began BMT several weeks before the gait training group arrived and three squadrons that started BMT at the same time as the gait training group. Control group B (6,223 recruits) represented three squadrons who started their BMT iteration several weeks following the initial week of gait training in the gait training group. The VIPER sports medicine staff regularly tracked timing of injury presentation relative to BMT start date and pain onset, referral to medical hold, and early separation from service for more severe injuries that threatened service eligibility. Regardless of intervention status, recruits had regular access to the VIPER sports medicine staff and were able to request further gait retraining following any run performance concerns. Two certified strength and conditioning professionals and two athletic trainers provided the mass gait training during the first week of training, which consisted of one training session lasting 45 min.

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The gait-trained group showed a decrease in the number of days from the start of BMT to the reported onset of pain compared with the control group, although the time between pain onset and pain reporting was not different. The gait-trained group was 21% less likely to have recruits who were medical holdover referrals (relative risk ratio = 0.79) and separations (relative risk ratio = 0.79), suggesting that prevention-based gait training interventions may reduce lost training time and improve retention of BMT recruits.

RELEVANCE FOR THE TACTICAL FACILITATOR

Gait training through the combined efforts of motor learning theory integration, minimizing ground reaction forces, increased hip extension, and elevated cadence improved mitigation of running injury incidence among US Air Force BMT recruits. From this study, it can be estimated that reducing running-related musculoskeletal injury would result in an annual cost avoidance of $5.2 million at BMT and the successful graduation of an additional 96 Air Force personnel per year.

ABOUT THE AUTHORS

Kathryn Bell is a third-year PhD student at the University of Nevada, Las Vegas. Her research interests involve the cardiorespiratory effects of load carriage on military and first responder performance, and she teaches the undergraduate course First Responder and Military Physical Performance. She currently serves as a sergeant in the Colorado Army National Guard and instructs company-wide physical fitness courses to improve unit readiness. She is currently certified through the National Strength and Conditioning Association (NSCA) as a Certified Strength and Conditioning Specialist® (CSCS®).

Brian Schilling is a Professor at the University of Nevada, Las Vegas. His research interest is tactical strength and conditioning, and he teaches both research methods and scientific communication courses. He has a background as an American football and weightlifting athlete, and worked as a strength and conditioning coach before pursuing his PhD. In addition, Schilling has published extensively in the field of strength and conditioning.

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