TSAC REPORT

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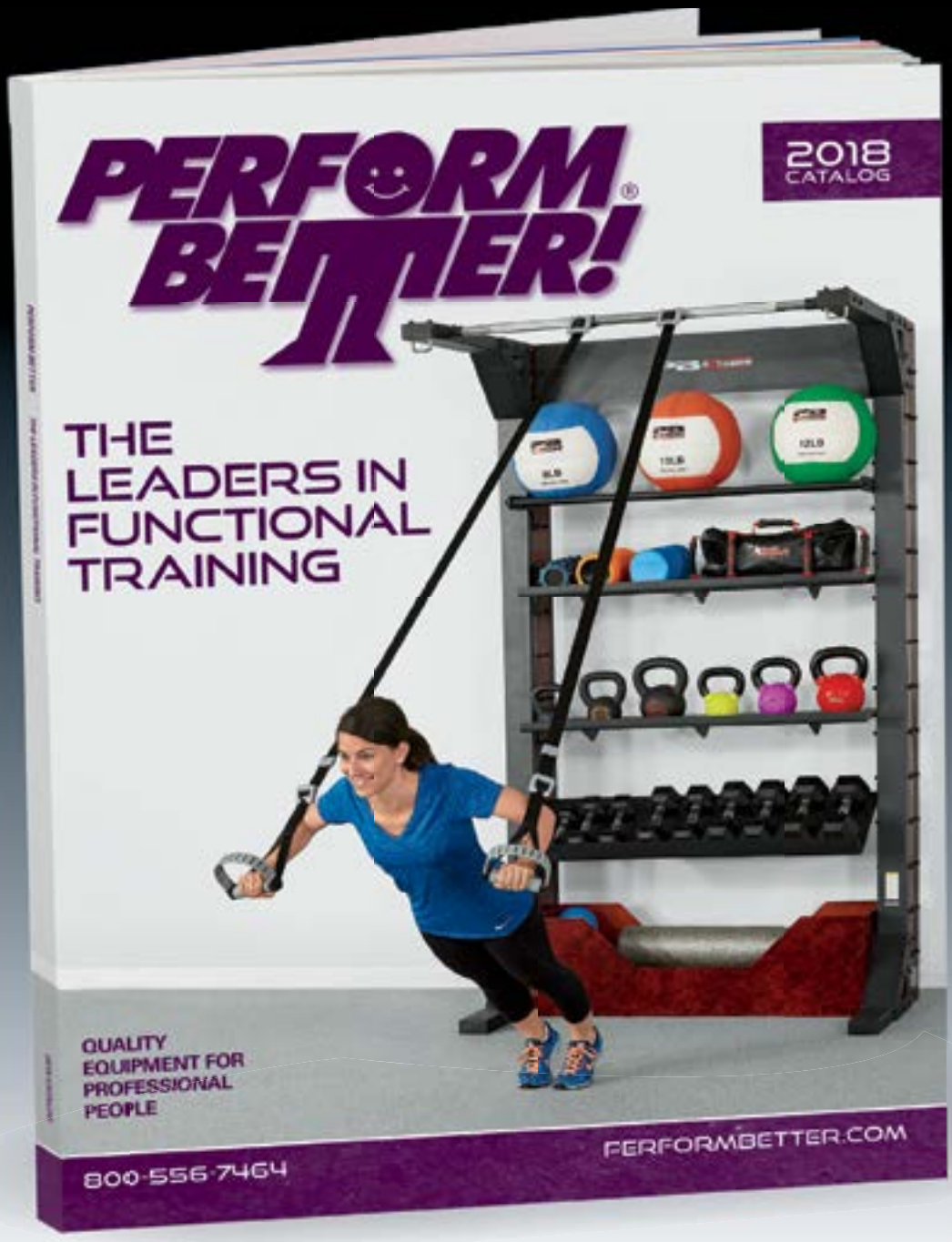

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ROBERT LOCKIE, PHD, KARLY CESARIO, ASHLEY BLOODGOOD, AND MATTHEW MORENO

HEART RATE RESPONSE TO PSYCHOLOGICAL STRESS—IMPORTANCE OF STRESS EDUCATION FOR LAW ENFORCEMENT RECRUITS

The data presented in this article was released with consent from the law enforcement organization in question for the purpose of conducting this retrospective analysis.

INTRODUCTION

Many law enforcement agencies (LEAs) operate their training academy by using a paramilitary model, which is reflected in how the staff approach the orientation and training of incoming recruits (9,14). The initial period of academy often appears similar to a military-style boot camp, where training staff impart great psychological stress on the recruits. As detailed by Berg, this approach is taken to socialize law enforcement or correctional recruits into the profession by establishing expected patterns of behavior, values, and attitudes (2). Stress has been defined as a disruption in an individual's psychobiological balance within one's self, or with the social and physical environment (4). During academy, the imposed stress provided by the verbal commands of training staff is generally designed to test the mental toughness and resilience of recruits, and find any character flaws that may impede being an effective law enforcement or correctional officer (e.g., displaying poor emotional stability in the face of adversity) (2).

Nonetheless, what has not been documented is the actual physiological stress experienced by law enforcement recruits when the psychological stress is being imposed. While physical training has been strongly recommended in the literature to prepare recruits for academy training, there has been little analysis of any potential psychological or mental preparation that could be completed (15,16,19). Psychological screening is used as part of the hiring process for most agencies to select the most appropriate candidates (3); however, these evaluations are not preparatory tools. There is generally no follow-up coaching with regards to stress management, which is an essential skill for law enforcement or correctional officers (1,5,9). If an individual is physically fit but does not have appropriate stress coping mechanisms, they may not respond well to any imposed psychological pressure. Indeed, anecdotal information from one agency has noted that within the initial two weeks of academy, there are always recruits who resign for "personal reasons," which could relate to how they handled (or did not handle) the stress imposed during the first few days. This could lead to the loss of potential recruits who could be good officers if they had some exposure to stress management training beforehand.

This article will discuss heart rate response of custody assistants (CAs) from one LEA during the first day of training academy. CAs or correctional officers are responsible for maintaining order and security in detention facilities (10,11,16). CA recruits benefit greatly from academy training, which is used to physically and mentally prepare them for the rigors of the job. This descriptive analysis will highlight the actual stress experienced by the CA recruits during the first day of training academy, which can be equivalent to strenuous exercise. This will help illustrate why it is important for the LEA training staff to consider incorporating some form of stress management training prior to or in the initial stages of training academy, as this could mitigate some of the potential negative stress responses of recruits.

THE FIRST DAY OF ACADEMY TRAINING

Within the agency in which this article is based, the first day of training academy is designed to elicit stress responses comparable to that experienced in their daily job tasks, and to assess each recruits tolerance and demeanor under these stressors. Furthermore, the recruit's decision-making under stress is also assessed (i.e., recruits are required to remember certain agency-specific procedures while experiencing verbal admonishment). The first day starts in the classroom, where recruits view an educational video, are given agency-specific information, and then split into their platoons. From here, the recruits are to assemble in a formation in a large open concrete space. Over an approximate two-hour period, recruits will need to follow the commands of the training staff, complete certain tasks and exercises (e.g., holding push-up or squat positions when they make mistakes), and change in and out of different uniforms to repeat these tasks. Although the physical activity is relatively minimal compared to an actual physical training session, the verbal instructions and commands are continuous, very stern, and sometimes contradictory. This is important to note, as even without physical activity, stress will initiate the "fight or flight" sympathetic nervous system response in an individual. This results in the secretion of the epinephrine and norepinephrine from the adrenal medulla, which causes an increase in heart rate (4,17). As such, heart rate can provide a measure of the stress being experienced by the recruit.

HEART RATE RESPONSE DURING THE FIRST DAY OF ACADEMY TRAINING

The heart rate responses experienced by the CA recruits discussed in this article were monitored via a heart rate device (Zephyr Performance Systems, Annapolis, MD) worn underneath their uniform. This system has been shown to be reliable and valid for measuring heart rate (12,13). Two classes were assessed, which encompassed 52 recruits (27 males, 25 females). The time for the data collection session was approximately two hours for each

class, from when the day started in the classroom until the recruits began a physical training session.

During the psychological stress session, the recruits attained, on average, a maximum heart rate of 194 ± 19 beats per minute, which was equivalent to 100.71 ± 9.63% of age-predicted maximum heart rate (APMHR). The mean heart rate for the recruits within this session was 157 ± 13 beats per minute, which was equivalent to 80.92 ± 5.64% of APMHR. Figure 1 displays the mean percentage of time spent within the session in aerobic training zones defined by the American College of Sports Medicine (ACSM) (6). These are classified as: very light (<57% of APMHR), light (57 – 63% of APMHR), moderate (64 – 76% of APMHR), vigorous (77 – 95% of APMHR) and very vigorous (>95% of APMHR). As can be seen in Figure 1, the recruits spent more than half the session in the vigorous heart rate zones, and approximately 17% of the time was spent in the very vigorous zone. When considering the total time of the session for each class was approximately two hours, this means that recruits spent more than an hour in a vigorous-to-very vigorous heart rate zone.

POTENTIAL APPROACHES FOR STRESS MANAGEMENT IN RECRUITS

The data shown in this article demonstrates that recruits are experiencing the equivalent to a vigorous-to-very vigorous aerobic exercise session while completing relatively minor physical activity over an extended period of time. This is important to note, because general exercise recommendations from numerous organizations ward against increasing exercise intensity too greatly for relatively untrained individuals (6,18). The first day of training academy essentially imposes psychological stress that could be beyond the capacities of certain recruits. If the LEA training staff provided some form of stress management training prior to the start of academy, this could limit the physiological strain imposed on recruits as they may better manage the imposed stress (7,20). By extension, this could also limit the loss of recruits who may get overwhelmed and resign, which reduces the potential number of graduates for a LEA.

Holmes and Kornhauser have detailed methods with which the Colorado State Patrol have introduced stress management and inoculation strategies in their training academy (9). This involved introducing a low-intensity "zero week" where, in addition to movement pattern clinics and education on fitness and nutrition, recruits complete a class on stress trauma. Holmes and Kornhauser noted that this has led to a reduction in the loss of recruits during the early training academy period (9). Some of the information and strategies that could be included in classes such as these that could fit into academy training across most LEAs include:

- Defining what stress is and what can cause stress, so it is clear to the recruits that there are environmental (e.g., job demands), mental (e.g., threats to personal well-being), emotional (e.g., anxiety), and physiological (e.g., physical exertion) stressors (4,8).
- Providing strategies that could be used to manage stress. As detailed by Edlin and Golanty, some examples of management strategies that could be communicated to recruits that have application during the training academy period include (4):
  - Altering perception of the stressor (e.g., the LEA training staff are there to help you become a better officer)
  - Setting attainable goals (e.g., focus on the completion of one task communicated by the training staff prior to moving onto the next task)

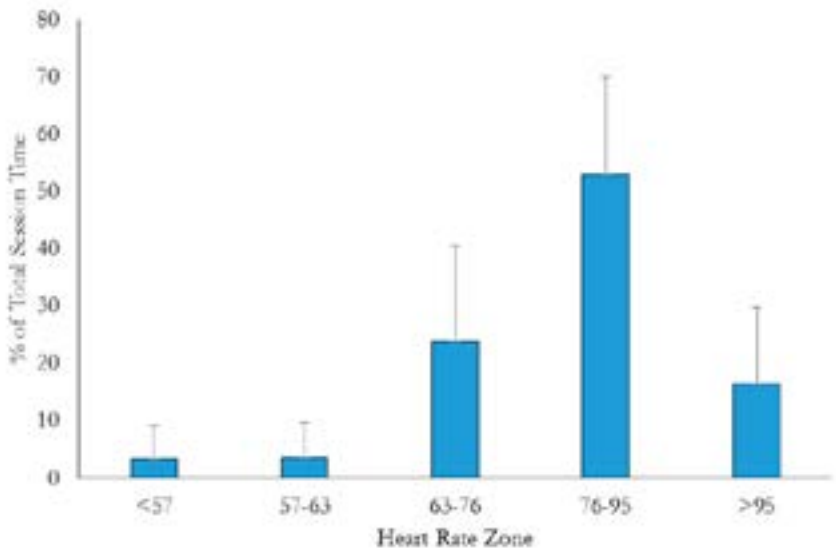

FIGURE 1. PERCENTAGE OF TOTAL SESSION TIME SPENT IN DIFFERENT HEART RATE ZONES BY CUSTODY ASSISTANT RECRUITS DURING A PSYCHOLOGICAL STRESS SESSION DURING THE FIRST DAY OF ACADEMY TRAINING

- Focusing on the individual's personal strengths, values, and personal qualities (e.g., trust in knowing that you have studied the procedures required for the LEA)
- Recognizing your social support (e.g., the other members of your academy class are there with you and will support you)
- Ensuring an acceptable level of physical fitness to allow for faster recovery from stressful situations (e.g., quicker reduction of an elevated heart rate that resulted from an imposed stress)
- Employment of methods to reduce the physiological stress response (e.g., breathing deeply to promote relaxation)

While this is not an all-encompassing list, this at least provides some information that stress should ideally be addressed prior to training academy, due to the potential physical toll that can be experienced by recruits. Although a "zero week" may not be possible for all law enforcement training academies, the strategies adopted by Holmes and Kornhauser could still be adopted in some form by the training staff (9). Furthermore, even if the training staff increases the intensity of the psychological strain imposed on the recruits because they have undergone some form of stress management training, recruits should be better prepared to tolerate this strain. In addition to this, even if the imposed stressors cause reactions in the recruits typical of what may be expected (e.g., incorrect decision-making), recruits should be better prepared to recover from these mistakes (4,9). Given the potentially high physiological strain experienced by recruits due to psychological stress, staff for LEAs should consider incorporating stress management training during the initial stages of academy.

REFERENCES

1. Anshel, MH. A conceptual model and implications for coping with stressful events in police work. *Criminal Justice and Behavior* 27(3): 375-400, 2000.

2. Berg, BL. First day at the police academy: Stress-Reaction-Training as a screening-out technique. *Journal of Contemporary Criminal Justice* 6(2): 89-105, 1990.

3. Cochrane, RE, Tett, RP, and Vandecreek, L. Psychological testing and the selection of police officers: A national survey. *Criminal Justice and Behavior* 30(5): 511-537, 2003.

4. Edlin, G, and Golanty, E. *Health & Wellness*. (11th ed.) Burlington, MA: Jones & Bartlett Learning; 2014.

5. Garbarino, S, Cuomo, G, Chiorri, C, and Magnavita, N. Association of work-related stress with mental health problems in a special police force unit. *BMJ Open* 3(7): 2013.

6. Garber, CE, Blissmer, B, Deschenes, MR, Franklin, BA,Lamonte, MJ, Lee, IM, Nieman, DC and Swain, DP. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Medicine and Science in Sports and Exercise* 43(7): 1334-1359, 2011.

7. Goodie, JL, and Larkin, KT. Changes in hemodynamic response to mental stress with heart rate feedback training. *Applied Psychophysiology and Biofeedback* 26(4): 293-309, 2001.

8. Hobfoll, SE. Conservation of resources. A new attempt at conceptualizing stress. *American Psychologist* 44(3): 513-524, 1989.

9. Holmes, RJ, and Kornhauser, CL. *Building injury free tactical athletes: A repeatable model for police academy recruit training*. Presented at TSAC Annual Training; Norfolk, VA, 2018.

10. Jamnik, VK, Thomas, SG, Burr, JF, and Gledhill, N. Construction, validation, and derivation of performance standards for a fitness test for correctional officer applicants. *Applied Physiology, Nutrition, and Metabolism* 35(1): 59-70, 2010.

11. Jamnik, VK, Thomas, SG, Shaw, JA, and Gledhill, N. Identification and characterization of the critical physically demanding tasks encountered by correctional officers. *Applied Physiology, Nutrition, and Metabolism* 35(1):45-58, 2010.

12. Johnstone, JA, Ford, PA, Hughes, G, Watson, T, Mitchell, AC, and Garrett, AT. Field based reliability and validity of the bioharness™ multivariable monitoring device. *Journal of Sports Science and Medicine* 11(4): 643-652, 2012.

13. Kim, JH, Roberge, R, Powell, JB, Shafer, AB, and Williams, JW. Measurement accuracy of heart rate and respiratory rate during graded exercise and sustained exercise in the heat using the Zephyr BioHarness™. *International Journal of Sports Medicine* 34(6): 497-501, 2013.

14. Kraska, PB. Militarization and policing—Its relevance to 21st century police. *Policing: A Journal of Policy and Practice* 1(4): 501-513, 2007.

15. Lockie, RG, Dawes, JJ, Orr, RM, Stierli, M, Dulla, JM, and Orjalo, AJ. An analysis of the effects of sex and age on upper- and lower-body power for law enforcement agency recruits prior to academy training. *Journal of Strength and Conditioning Research* 32(7): 1968-1974, 2018.

16. Lockie, RG, Orr, RM, Stierli, M, Cesario, KA, Moreno, MR, Bloodgood, AM, Dulla, JM, and Dawes, JJ. The physical characteristics by sex and age for custody assistants from a law enforcement agency. *Journal of Strength and Conditioning Research* Published ahead of print, 2018.

17. McKardle, WD, Katch, FI, and Katch, VL. *Exercise Physiology: Nutrition, Energy, and Human Performance*. (8th ed.). Baltimore, MD: Wolters Kluwer Health; 2015.

18. National Strength and Conditioning Association. NSCA strength and conditioning professional standards and guidelines. *Strength and Conditioning Journal* 39(6): 1-24, 2017.

19. Shusko, M, Benedetti, L, Korre, M, Eshleman, EJ, Farioli, A, Christophi, CA, and Kales, SN. Recruit fitness as a predictor of police academy graduation. *Occupational Medicine* 67(7): 555-561, 2017.

20. Wolever, RQ, Bobinet, KJ, McCabe, K, Mackenzie, ER, Fekete, E, Kusnick, CA, and Baime, M. Effective and viable mind-body stress reduction in the workplace: A randomized controlled trial. *Journal of Occupational Health Psychology* 17(2): 246-258, 2012.

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JOHN MATA, MS, CSCS,*D, TSAC-F

BOOTS ON THE GROUND

STRENGTH AND CONDITIONING IN THE UNITED STATES ARMY—LESSONS LEARNED FROM A YEAR COACHING INFANTRYMEN

One year ago, I was presented an opportunity to be part of a pilot program directed by United States (U.S.) Army Forces Command (FORSCOM). The program was directed toward providing strength and conditioning guidance to active duty units. The program's goals were multi-tiered, but my role would be to operate within two battalions and advise the direction of the physical training to the best of my ability. I accepted the position and reported to my assigned location of duty.

Initially, my personal intention was to come in and "fix" everything that was wrong with military physical training (PT). I had a good idea of the problems with PT and the misconceptions that lead to so many of the limitations we see across all branches. This was an error in judgement and execution on my behalf. The majority of the soldiers I was assigned to coach were, and still are, in need of foundational principles of movement and understanding of proper strength and conditioning practices. I focused a great deal on simplifying the PT plans to incorporate movement regressions intended on reducing the likelihood of injuries resulting from improper resistance training technique and selection with regard to skill-level and training age. I also sought to address a common source of overuse injuries by instilling more suitable forms of conditioning, namely reducing the weekly volume of long-slow distance (LSD) running.

THE GROUP TRAINING DILEMMA

Something interesting began to happen; the more time I invested in developing the common understanding of the program's foundation, the more the "high performers" in each platoon began to disregard what I was teaching. In my efforts to get everyone at the same starting place, I neglected to challenge the high performers, who are often the leaders in the formations, and this set back integration of the basic strength and conditioning principles, which I felt needed to be incorporated. After spinning my wheels for a couple weeks, I reached out to a few of the individuals the junior soldiers look to as the pace-setters, and I asked them what they struggled with or how they thought their own performance could be improved. Rather than speaking as the expert and telling them what I "knew" to be "wrong," I sought out to understand their needs and motivations.

Through these conversations, the most common theme of necessary improvement being voiced was simply to get the soldiers more physically capable. Which for many, first involved simply passing the Army Physical Fitness Test (APFT). Many soldiers are showing up to their units not being able to pass a PT test to active duty standards. Being "on the line" in an infantry unit carries a great deal of lateral accountability throughout each individual team, the platoon, company, and battalion. This was something I was aware of, but I did a poor job of relating to as far as my intentions with the changes being introduced were concerned. It was not a matter of poor attitudes as much as it was a failure on my behalf to provide what was desired, even if the soldiers did not know specifically what they wanted until I presented something they did not want. This is where I had to put my "expert" hat aside and become more intimately involved with operations and needs as a student in order to foster a better understanding between myself and the soldiers across the formations.

THE JOURNEY OF THE TACTICAL FACILITATOR

My intention shifted from a "ground-up" approach, or start-up mindset, to a view of optimization and improvement. I asked myself, "How can I effectively alter their routines while staying within the framework of what is normal?" Additionally, I continued to look for ways to interject into the soldier's concerns of transferability and specificity of training. There is a large movement within tactical fields where the professionals execute PT under the assumption the training must be completely specific to the tasks which occur "in the field." As most who have worked in other sports understand, absolute specificity is not effective and can lead to substandard training, misuse of time, and overuse injuries—all serious problems with U.S. Army PT programs. Educating the soldiers, often one by one, on the concept of general capacities (e.g., maximal strength, power, and anaerobic endurance) driving specific performances, such as breaking contact or rucking up and over uneven terrain, has produced a net-positive effect on reducing resistance to incorporating more general strength and conditioning elements into the physical training plans.

These seemingly small daily interactions with leaders and junior soldiers allowed me to greatly develop my understanding of what motivates them individually. It is often a critical mistake to impress one's own concerns or preferences onto others, rather than to seek to understand the other party, especially when you have very similar backgrounds and experiences.

ATHLETIC BACKGROUND AND PERSONAL DESIRES DRIVE TRAINING CONCERNS

Case in point: I have two lieutenants who oversaw PT, and most other operations, for their rear detachment companies while the main formation is deployed. One of which was, and still is, extremely motivated to overhaul the PT plans and become more compliant with the recommendations I was providing. This young man is a powerlifter in his spare time and has no issues with prescribed weight room work and reducing the running volume. The other, who has a generally less motivated group, was very reluctant to reduce LSD sessions. Fortunately, I sat down with the other lieutenant and simply asked about his athletic history and what his goals were in and out of the Army. After a few minutes of discussion, I found out he ran cross-country at a fairly high level and wanted to compete in a marathon in the next year. His understanding of performance up until this point had been shaped by being isolated in the world of running as sport and his sparse weight training was led by the same cross-country coach.

The problem was we simply resided in disconnected realms of understanding. After an hour of explaining my background and justification for the changes to the PT plan, an agreement of compromise was made, and the PT plan was shifted toward my prior recommendations. I also provided him a supplemental running plan to help with his individual goals that would allow for recovery and adaptation with the existing PT plan. Interestingly enough, I had to have a very similar conversation with the lieutenant who was focused on weight room work but did not see the value in low-level plyometric training and moderate to low-intensity running intervals.

CHANGING THE CULTURE

There are countless moving parts and individual interests in these communities, a strength and conditioning professional assigned to a large tactical organization must become a master of "Plan B" in practice and intent. It is not enough to simply know what best-practice is or more optimal, one must be equipped with the skills of listening, reasoning, and possibly most important, compromise. How may the organization best meet the goals and requirements, regardless of which party is right or wrong? Can the strength and conditioning professional connect with their tactical leaders and subordinates to provide service which feeds directly into a shared vision? Once we can all operate within a shared intellectual space, the better the coach and tactical leaders can effectively manage workload and time expectations.

There is often little to no separation between physical training, daily life, and field operations within a functional Army unit. This is especially prevalent in combat arms. For instance, the physical training and sleep this week will impact the field training exercise conducted over the subsequent two weeks, and so on. One of the greatest concerns within the formations I have encountered is "losing everything" after a field exercise. Anyone who has spent an extended amount of time in austere environments, with substandard sleeping conditions and time allotments, while also conducting arduous physical activity can attest to the fatigue and associated decline in physical capacity that comes along with such conditions. Mitigating these losses of physical qualities, from the strength and conditioning professional and tactical supervisory level, can be viewed as a three-pronged approach.

THE THREE-PRONGED APPROACH

First, effective pre-planning and reactive adjustment, or simple and understandable modifications to the training plan with regard to overall workloads and readiness, with guidance by the strength coach and team, platoon, and/or company leader to ensure operational levels are not needlessly diminished prior to engaging in field training is essential. This understanding will require careful coordination of the training schedule between each party and often an understanding that "less is more" when structuring PT for soldiers under high operational loads. This understanding extends itself well to a block periodized model (1). This is a model where the most important or lacking physical quality is stressed prior to major times of performance, while maintaining all other qualities with bare minimum workloads to mitigate fatigue. Each situation will dictate the best course of action and that should be the overarching goal of increasing performance and maintaining health.

Secondly, each soldier should be provided with the understanding of training residuals, or the time a physical quality will be present without more training, which can help guide what training, if any, needs to be conducted in the field (1). For example, if a field exercise is set to last five days, explaining the soldier's maximal strength, aerobic endurance, maximal speed, and anaerobic endurance capacities gained via participation in the training program will not diminish, outside of the effects of fatigue, can greatly enhance their understanding of their body's capabilities. Understanding which qualities have lesser training residuals will allow the individual to self-select the necessary training regimen, at the right dose, and within the proper time course. This information can become invaluable in reducing unnecessary fatigue associated with the fear of "losing gains," as the soldiers have stated numerous times during our educational sessions.

The final, and what I consider to be the most important consideration, is to provide each soldier a performance capability buffer to account for these times of compounded fatigue and increased workload. If the strength and conditioning professional can help the tactical leaders establish performance baselines well above what is normally required on a daily, operational-basis, each soldier can hopefully become more resistant to injury and reduced performance while under excessive fatigue. Utilizing organizational performance norms that are specific to the general capacities required by the unit and in great excess of the common standard as of now, the APFT, soldiers will have a greater physiological and psychological defense to any stress they may encounter in the battle space or training field.

THE HARD SELL

Convincing someone, especially an infantry soldier, to change their PT routine to one that may be more challenging or at least greatly foreign is not an easy task. This change does not occur only from the top down, from the bottom up, or laterally across the formation. Changing a culture of physical fitness in such a custom and habit driven environment, requires coordination and buy-in across all levels. If you neglect one segment of this hierarchy, it becomes a battle between someone being told what to do and a leader fighting for control of their domain of influence. The role of the strength and conditioning professional within this context, in my opinion, can be one of coordinator or director of performance and physical training.

Presenting a unified front through proper education and informational dissemination across all levels by empowering any embedded medical assets such as a physical therapist, registered dietitian, or occupational therapist, can allow each to utilize their specialized knowledge to further shape and influence the organizations goals. This practice worked very well during the middle stages of the FORSCOM pilot program, where a team of the aforementioned specialists worked in concert to provide what is commonly referred to as human performance optimization (HPO) service. Each specialist had their role, which they were ultimately enabled to execute to their best ability to provide their portion of the unified mission of increasing soldier readiness, deployment availability, and overall health.

PUTTING IT ALL TOGETHER

As the program continued forward, lateral referrals between the HPO team were not only common practice, but an expected standard. Providing an Army occupational therapist insight into the role of the kinetic chain in possible hand and wrist injuries, one of their specialties, led to better diagnoses and lateral referrals to the strength and conditioning coach and physical therapist for movement and workload analysis. The registered dietitian began to coordinate with the coach and company leadership to provide a multi-layered approach to body composition issues, which led to much greater awareness and adherence. The physical therapist and strength and conditioning coach, after identifying and formulating a joint treatment plan following a musculoskeletal injury, would sit down with that individual's first line supervisor to map out their recovery plan and reduce the time that soldier was unavailable due to a medical restriction. Having this cohesive, team-oriented approach to performance greatly aided in cultural buy-in and contiguity of the program across all companies within the battalion.

At the forefront of this push for greater coordination was the strength and conditioning coach having big-picture discussions with battalion leadership. Making these leaders aware of the HPO team's unified capabilities provided leaders more oversight and freedom to ensure unit readiness could be maximized. Each team will likely operate at different tempos, with differing capabilities, but having a generalist to manage the program without being grounded in one specialty provided the team greater power to treat soldiers with limited resources. Identifying soldiers with the interest and aptitude to lead physical training sessions, as an extension of the HPO team, is vital.

THE NEXT STEPS

When this program was developed, it was decided soldiers would attend a National Strength and Conditioning Association Tactical Strength and Conditioning (TSAC) Practitioner's Course as well as sit for a TSAC-F® certification test. The soldiers' APFT score was weighed into this selection process. There are two fundamental problems with this criterion. First, in no way does APFT score directly correlate with aptitude or understanding of strength and conditioning principles and second, those with higher scores are usually either commissioned officers, seasoned enlisted soldiers, or "high achievers." Each of these types of individuals routinely have several secondary and tertiary responsibilities within their organization and have little time to provide the requisite time to learn or coach during PT sessions or any other time during the day.

Moving forward, it has been recommended these individuals be identified by their leaders or the HPO team and a consensus decision be made among all parties for these individuals to be included into the coaching staff as an additional duty. This model would most likely best serve a young soldier with limited additional duties, but who requires preparation in the fields of scheduling, leading, and improvisation. Lastly, these soldiers need to be provided the freedom to deliver instruction to their peers during training sessions, as well as time to conduct PT on their own. Time and resources allocated into training these individuals is largely wasted without the ability to focus on the job of coaching and/or leading the sessions.

It is essential the strength and conditioning professional provides continuing education to these soldiers to provide the best programs possible. Simply attending a week-long course and returning soldiers to their units is wasteful at best and negligent at worst. Many of the soldiers I encountered who were filling the role of coach within their formations had very loose understanding of the tools at their disposal. This resulted in improper, and sometimes borderline dangerous, session-volume prescriptions and misuse of technically demanding exercises, which can lead to the very injuries we are trying to eliminate. The role of the strength and conditioning professional cannot only be one of "trainer," but of director, subject matter expert, and educator. The US. Military is a great and powerful entity but is one with much room for improvement of understanding and execution of physical training and human performance. With effective and coordinated effort, there is no reason the modest improvements garnered today will not lead to momentous positive change in the near future.

REFERENCES

1. Issurin, V. Block periodization versus traditional training theory: A review. *Journal of Sports Medicine and Physical Fitness* 48(1): 65-75, 2008.

ABOUT THE AUTHOR

John Mata is currently a contractor with REEF Systems Corp as a Strength and Conditioning Coach and Educator working for two United States Army line units as part of a pilot program directed by United States Army Forces Command (FORSCOM). Prior to accepting this position, Mata was a professional intern with the National Strength and Conditioning Association (NSCA) in Colorado Springs, CO. He completed his graduate studies at Texas Christian University, researching athlete health, human performance, and interning with the strength and conditioning program. Mata is a 10-year United States Air Force veteran with deployment experience in support of Operation Iraqi Freedom, Operation Enduring Freedom, as well as Combined Joint Task Force – Horn of Africa (CJTF-HOA), and completed his undergraduate studies while enlisted with the American Military University.

BRIAN SCHILLING, PHD, CSCS

TSAC REPORT JULY 2018 RESEARCH COLUMN

This article is part of a continuing series of tactical strength and conditioning (TSAC) research reviews. It is designed to bring awareness to new research findings of relevance to tactical strength and conditioning communities.

U.S. ARMY PHYSICAL FITNESS DEMANDS STUDY: DIFFERENCES IN PHYSICAL FITNESS AND OCCUPATIONAL TASK PERFORMANCE BETWEEN TRAINEES AND ACTIVE DUTY SOLDIERS. *JOURNAL OF STRENGTH AND CONDITIONING RESEARCH*, IN PRESS, 2018.

CANINO, MR, FOULIS, SA, ZAMBRASKI, EJ, COHEN, BS, REDMOND, JE, HAURET, KG, FRYKMAN, PN, AND SHARP, MA.

Researchers from the Military Performance Division, at the U.S. Army Research Institute of Environmental Medicine recently published a study comparing physical fitness and occupational task performance between trainees and active-duty soldiers. The purpose was to evaluate combat readiness in trainees, which is important due to the new physical employment standards that the Army instituted in 2017. The research team tested 179 U.S. Army male trainees at the end of their initial entry training (IET) along with 337 active-duty male soldiers. These volunteers were all infantrymen, infantrymen-indirect fire, fire support specialists, or cavalry scouts.

This large sample of U.S. Army personnel self-reported their Army Physical Fitness Test (APFT) results. The APFT consists of maximum sit-ups and push-ups, both in two minutes, along with a timed two-mile run. Both the trainee and active-duty groups were also tested on three specific tasks: sandbag carry, casualty drag, and move under direct fire. The groups were similar for most demographics, but the active-duty soldiers were significantly older. This result is interesting, since the difference was only two years, and the variability in the ages makes that difference only moderate. Since statistical significance is dependent on the sample size, looking at the actual magnitude of differences can help interpret the meaningfulness. Tactical strength and conditioning (TSAC) facilitators reading published science in order to be evidence-based in their practice should be aware that "statistically significant" results are not always large, as is the case here.

The active-duty soldiers' self-reported push-up (21% more) and sit-up (11% more) results were significantly better than the trainees' self-reported scores. The trainees, however, had significantly shorter self-reported 2-mile run times (7%). After statistically controlling for age, height, and body mass, there were moderate-to-large differences between the groups on sandbag carry time and casualty drag velocity. The active-duty soldiers performed about 17% and 43% better on the sandbag carry and casualty drag, respectively. There were no meaningful differences in the move under fire drill. More than 90% of the trainees were able to complete the tasks within the minimal acceptable performance standard, which is also an important finding.

This study demonstrated that recruits were sufficiently able to perform the tasks after IET, suggesting that they were either able upon being recruited, or that they responded well to IET. TSAC facilitators can play a large role in preparing those who plan to join the military by being familiar with the physical tasks that new recruits might encounter, and knowing how to best train new recruits for those tasks.

COMPARISON OF THE EFFECT OF TYPICAL FIREFIGHTING ACTIVITIES, LIVE FIRE DRILLS AND RESCUE OPERATIONS AT HEIGHT ON FIREFIGHTERS' PHYSIOLOGICAL RESPONSES AND COGNITIVE FUNCTION. *ERGONOMICS*, IN PRESS, 2018.

ZARE, S, HEMMATJO, R, ALLAHYARI, T, HAJAGHAZEDEH, M, HAJIVANDI, MA, AND KAZEMI, R.

In a recent publication in the journal *Ergonomics*, researchers reported the physiological responses and cognitive function of firefighters performing job-specific tasks, including a rescue at height. The authors noted that physiological responses have been studied before in this population, but that the effect of live-fire drills and working at height had not been thoroughly studied.

The researchers recruited 18 experienced, professional firefighters to participate in three types of activities: live-fire activities, typical firefighting tasks, and rescue at height. The live-fire and typical firefighting tasks were performed in personal protective equipment. Before and after each task, heart rate (HR), temporal temperature, and cognitive function (paced auditory serial addition test; PASAT) were recorded.

The simulations in this study were highly sophisticated. For the live-fire activities, participants passed through live fire, extinguished a fire using water, and put out a fire with a fire extinguisher. In the typical firefighting activities, the firefighters used a smoke-diving room and performed hose pulling, ladder handling and climbing, passed through narrow routes, and passed through an escape tunnel. For the rescue operations performed at height, firefighters had to move themselves up with special ropes and use a rescue belt to bring down a person suspended as a victim. The PASAT cognitive task took three minutes, with a maximum score of 60. This test assesses information processing and working memory, where the participants listen to a series of single-digit numbers that have a 3-s break between pairs. They are asked to give the sum of each pair before the next pair is presented.

All of the activities caused large, significant increases in HR (up to 227% of resting HR) and temperature (3%), with corresponding large, significant decreases in PASAT scores of about 7%. Rescue at height caused the largest changes in all measures, which is interesting since personal protective equipment was not used in this condition. TSAC facilitators should be informed on the physiological responses induced by job-related tasks. Properly designed and implemented training programs may help tactical operators better tolerate these work-related stresses. Adding some forms of cognitive challenge during physical training might help these populations with dual-tasking.

DOES BODY MASS INDEX INFLUENCE THE PHYSIOLOGICAL AND PERCEPTUAL DEMANDS ASSOCIATED WITH DEFENSIVE TACTICS TRAINING IN STATE PATROL OFFICERS? INTERNATIONAL JOURNAL OF EXERCISE SCIENCE, 11(6): 319-330, 2018.

DAWES, JJ, KORNHAUSER, CL, CRESPO, D, ELDER, CL, LINDSAY, KG, AND HOLMES, RJ.

Physiological stress in law enforcement has also been recently studied, specifically, the stress of Defensive Tactics and Arrest Control (DEFTAC). This type of training is common in law enforcement agencies. The authors were concerned about the effects of body mass index (BMI) in relation to DEFTAC. If higher BMI is associated with adiposity, it is conceivable that law enforcement officers who are obese may respond differently from DEFTAC training or when using these techniques in the field. Since some of the DEFTAC training may be similar to combative sports, the investigators looked at outcome measures used in judo, taekwondo, and wrestling.

In this study, 24 male highway patrol officers with a mean age of 36 were assessed for heart rate, rating of perceived exertion (RPE), and blood lactate during a scored DEFTAC "gauntlet." The officers performed the gauntlet in their personal protective equipment and uniform. There were seven stations set 49 ft apart in on a wooden gym floor. At the first station, the officers performed 50 straight punches into a punch shield. Then they ran to the next station and closed their eyes when instructed to "stop." They were given a verbal cue of "attack," upon which they opened their eyes and were confronted by an attacker wielding a knife overhead. After performing the proper defense to the attack, the officers ran to the next station (30 front kicks into a pad). After sprinting to the next station (a similar "stop" and "attack" cue), they were to perform holster-retention as the attacker attempted to take their holstered pistol. They then sprinted to the next station and performed 50 knee strikes against a pad held by a volunteer. The officers were confronted with another stop/attack station where they had to defend themselves against an overhead blunt object attack. After this task, the officers moved 15 ft to the next station and laid down supine with their arms and legs flat on the floor. After a command to "get up" the officers went another 15 ft to a final station, where they were again told to "stop." Upon the "attack" cue, they were to defend themselves against a direct handgun attack, disarm the attacker, order the attacker into a prone position, and handcuff them. The entire event was timed, and four subject matter experts evaluated each officer's ability to perform the technique, intensity/speed of their actions, physical ability to continue the gauntlet, and the overall success of the techniques. The officers were timed for completion of the gauntlet and given a pass/fail rating.

All officers reached heart rates in the range of 82 – 100% of their age-predicted maximum, so the DEFTAC drill was sufficiently taxing to the officers. When comparing the 12 "healthy" BMI to the 12 "overweight" BMI officers, there was a difference of about one standard deviation in DEFTAC score. The overweight group had a very large amount of variability in their scores, so this result is difficult to interpret. There was a moderate, 12% difference in RPE, with the healthy group having higher values. Similarly, the healthy group had higher post-DEFTAC lactate values (12%). The authors suggested that this could be due to the overweight group purposefully performing the drill with a lower intensity, but the self-reported RPE values are difficult to interpret in this case.

Within the overweight group, bodyweight and duty weight explained about 46% and 49%, respectively, of the variance in the time to complete the DEFTAC drill. Because performance seems to be associated with BMI, TSAC facilitators should assess anthropometric variables in the tactical operators they work with and be able to design and implement programs to maximize lean mass and strength so that job-related tasks can be performed safely and successfully.

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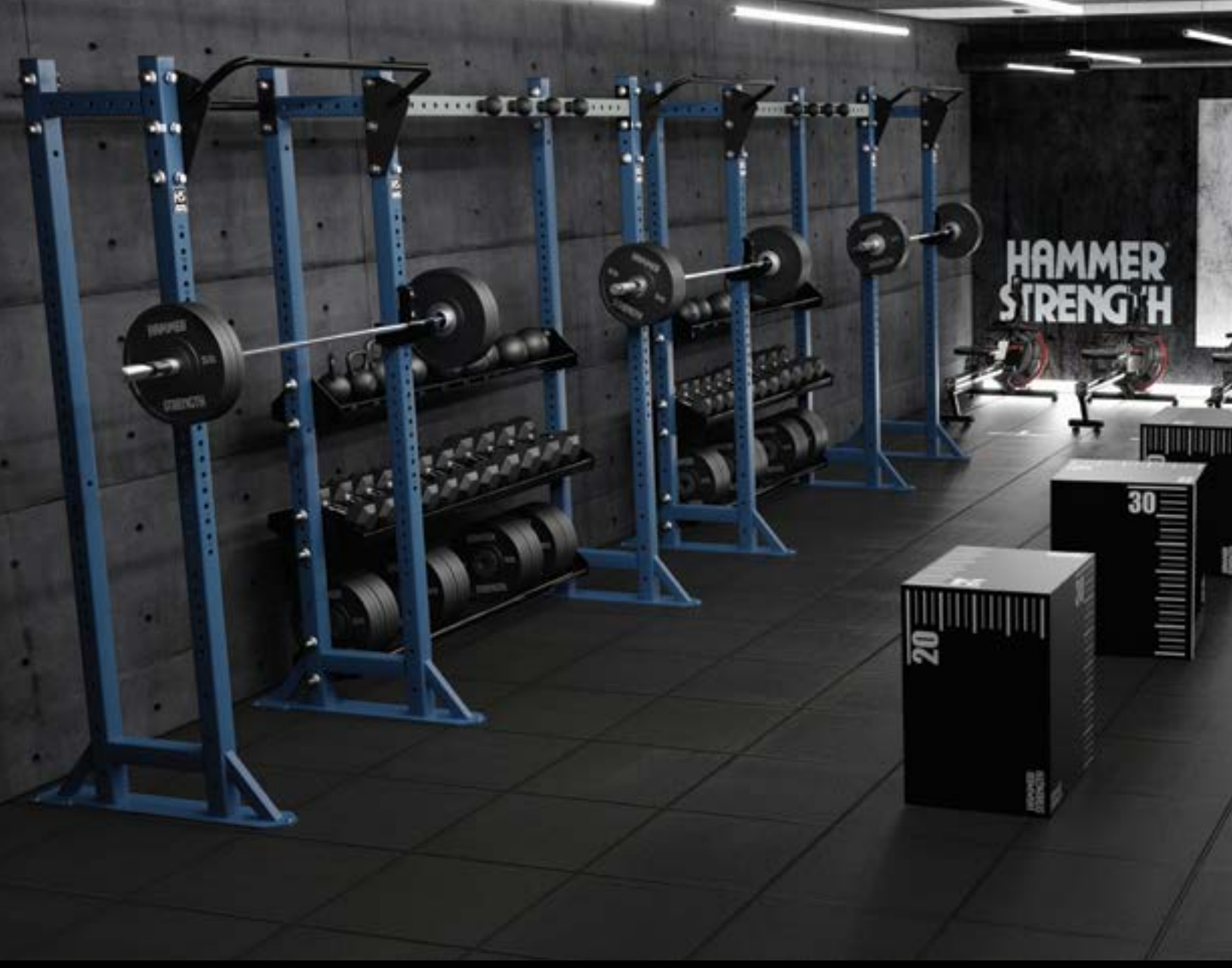

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MANDY NICE, NSCA-CPT, NPTI-MPT

LAW ENFORCEMENT TACTICAL STRENGTH AND CONDITIONING PROGRAMS—TRANSFORM "IMPOSSIBLE" OBSTACLES INTO IDEAL OPPORTUNITIES

Science-based tactical strength and conditioning programs have produced outstanding value to a multitude of law enforcement agencies, particularly when incorporated into a comprehensive wellness program. A recent example is the Ohio State Highway Patrol's (OSHP) Health and Physical Fitness Program (HPFP) program, which was developed to serve a large department of 1,600 officers. Featured in an article from The International Association of Chiefs of Police (IACP), *The Police Chief Magazine*, the program "improves dependability and attendance because officers use less sick leave. Keeping people at work and healthy also ensures that on-the-job injuries are not related to an unfit or unhealthy workforce," (2). In the article, OSHP directly credits the HPFP with helping the department successfully serve the community. OSHP highlights the strong workforce productivity that the department maintains with the HPFP in place. Specifically, the article states that, "HPFP works — OSHP has a healthy, happy, and productive workforce. Since 2011, the agency has achieved record levels of drug interdictions, criminal arrest activity, and the safest years ever on Ohio's roads in terms of traffic fatalities. On top of that, the Mobile Field Force has responded to numerous call-outs around the United States to support law enforcement operations," (2).

Although law enforcement health and fitness programs can produce a multitude of intrinsic and extrinsic benefits, including reduced departmental operating costs, sometimes seemingly impossible obstacles can prevent law enforcement agencies from implementing and expanding health and fitness programs. This article will address these "seemingly impossible" obstacles using strategies, which include: funding challenges, opposing perspectives on Physical Ability Testing (PAT), recruitment and retention challenges, understaffed shifts, and increasing needs of the public. Tactical strength and conditioning (TSAC) professionals can use these strategies to implement fitness programs that deliver significant value to employees, the agency, and the community as a whole.

STRATEGY 1: OVERCOME FUNDING CHALLENGES BY DELIVERING COST SAVINGS

OBSTACLE TRANSFORMED INTO OPPORTUNITY

When an agency is facing the obstacle of funding, TSAC professionals can transform the obstacle into a positive opportunity to help reduce healthcare costs. To do so, they can collect and analyze accurate data of healthcare cost drivers (such as employee injuries, extended return-to-work timeframes, absenteeism, preventable illnesses, etc.), then use the results to implement an associated data-driven, results-oriented strength and conditioning program that helps employees use exercise and healthy habits to reduce their risks and the agency's costs in those areas.

SPECIFIC STEPS TO LEVERAGE THE OPPORTUNITY

It is important to establish a baseline first by identifying the most significant controllable factors that have increased the agency's healthcare costs in recent years (such as high rates of orthopedic injuries, heart disease, diabetes, etc.). Next, TSAC professionals can plan a specific strength and conditioning program and/or wellness program that will measurably reduce costs in those areas.

For example, if healthcare costs are being driven largely by high rates of employee injuries, the strength and conditioning program could be designed to help mitigate injuries. The cost effectiveness could be measured by reductions in annual workers' compensation claims, reductions in the yearly volume of Notice of Injury forms filed by employees, and other related healthcare reports. Significant savings within a relatively short time period are possible. For instance, one law enforcement wellness program used tactical strength and conditioning as the foundation of their injury risk reduction strategy and reduced annual injury occurrences and associated costs by approximately $250,000 within two years of starting their program (10).

Another example is to implement a wellness program that includes tactical strength and conditioning to measurably reduce employee risks of costly chronic conditions like heart disease and diabetes, thereby reducing the agency's healthcare costs. "Operation Thrive" did just that and helped law enforcement employees shed well over 1,000 b while developing healthy lifestyles of exercise, sleep, and good nutrition to reduce the risks of heart disease and diabetes (9). The strength and conditioning component of that program was fundamental because it intrinsically motivated employees to practice exercises that directly correlated to their job tasks so that they could optimize their safety and performance while on duty.

While lack of funding may initially appear to be an obstacle to implementing a strength and conditioning program, these examples are proof that strength and conditioning professionals and health professionals can transform it into a valuable opportunity to help agencies neutralize their financial challenges.

SIGNIFICANT VALUE ADDED FOR THE AGENCY

Helping agencies overcome funding challenges, which could otherwise prevent the implementation of fitness and health programs, will help employees reduce their risk of illness and injuries. It will also help the agency achieve measurable reductions in associated healthcare costs. Results will be reflected in data (such as insurance claims associated with healthcare cost drivers, injury rate reports, number of sick days, fitness test results, etc.) collected before, during, and after program implementation.

SIGNIFICANT VALUE ADDED FOR THE EMPLOYEES

Providing employees with a tactical strength and conditioning program is highly beneficial given that when they are stronger and less prone to injury, they can better protect their own safety and the safety of everyone around them while on duty. Implementing a program is a proven way to help employees successfully practice the healthy habits of nutrition, sleep, stress management, and weight management that they need to sustain a healthy career and retirement (9,10).

STRATEGY 2: HELP OPTIMIZE OFFICER FITNESS, EVEN IF MEMBERS OF THE AGENCY HOLD DIFFERING VIEWS REGARDING PHYSICAL ABILITY TESTING

OBSTACLE TRANSFORMED INTO OPPORTUNITY

It is not uncommon for the most well-intentioned members of Command Staff and the most hardworking, noble officers to hold significantly different views regarding Physical Ability Testing (PAT). Some believe it should be a necessary requirement for employment and thus a cornerstone of the department's fitness program; however, others do not. Debates and costly court cases can center on the necessity, fairness, job-relevancy, and legal justification for PAT testing. This is important because those debates can sometimes stop agencies from developing fitness and/or health programs altogether. However, regardless of those types of debates, a common point of agreement in law enforcement, as stated by reputable organizations within the industry such as the IACP, is that whether or not an agency uses a PAT, it is very important for law enforcement officers to minimally maintain the physical fitness level necessary to do his/her job safely and to support their law enforcement partner when needed. Specifically, IACP's *Reducing Officer Injuries* states in the Executive Summary that, "Agencies should recognize the evidence of a strong connection between fitness and health and injury severity, and it is recommended that agencies implement mandatory fitness programs to curb injury and injury severity," (5).

Therefore, even if members of an agency hold differing views on the use of a PAT, it does not have to create a roadblock for implementing fitness programs that support officer health and fitness. Regardless of an individual's stance for or against the use of PATs, all agency members can unite when they shift the focus to the larger goal of taking action to support officer physical fitness and health. Once agency members are united on that goal, new approaches to achieve it can be considered.

SPECIFIC STEPS TO LEVERAGE THE OPPORTUNITY

Strength and conditioning professionals can structure programs to align with the IACP's recommendation of supporting officer physical fitness (5). For example, in addition to (or as a substitute for) a PAT, an agency could implement a multilayer tactical strength and conditioning program that would gradually and systematically help officers improve their fitness, reduce their risk of injury, improve their physical ability to perform job-related tasks, and improve their physical resilience. The program could gradually and systematically increase officers' fitness levels by using protocols listed in the National Strength and Conditioning Association's *Essentials of Tactical Strength and Conditioning* textbook, which covers the care and rehabilitation of injured tactical populations, resistance training exercise techniques, flexibility and mobility exercise techniques and programming, plyometric, speed and agility exercise techniques and programming, aerobic endurance exercise techniques and programming, and functional fitness for law enforcement personnel (1). When structuring this type of a tactical strength and conditioning program, it can be helpful to review the officers' job task analysis and start with the fundamentals, as recommended in the *TSAC Report* article "Programming Considerations for the Tactical Officer in Law Enforcement- Focusing on Fundamentals," (6). Also, taking measures such as having employees sign an agency-approved liability waiver before participating in activities can help address liability concerns prior to program implementation. Program outcomes, such as measurably improved fitness and physical ability to perform job-related tasks, can be measured using assessments that are most appropriate for each agency. This can include results from either PAT assessments or other relevant assessments such as those described in the *TSAC Report* article "Practical Assessments of Power for Law Enforcement Populations," (8).

SIGNIFICANT VALUE ADDED FOR THE AGENCY

The agency will benefit from the establishment of a science-based training system that helps officers optimize their fitness for job-related tasks so that they can do their job safely while simultaneously reducing their risk of costly job-related injuries (5,10).

SIGNIFICANT VALUE ADDED FOR THE EMPLOYEES

Tactical strength and conditioning training will help employees maintain the fitness levels they need to safely perform their jobs throughout the year (with or without a PAT).

STRATEGY 3: USE TACTICAL ATHLETIC TRAINING TO HELP THE AGENCY OVERCOME RECRUITMENT AND RETENTION CHALLENGES

OBSTACLE TRANSFORMED INTO OPPORTUNITY

Reports show that recruitment and retention has been a challenge in the past and remains a challenge today. Over a decade ago, the IACP published an article in *The Police Chief Magazine* that stated, "In fact, many law enforcement agencies around the United States are facing staffing shortages. In 2006, it was estimated that more than 80 percent of U.S. law enforcement agencies had sworn positions they were unable to fill. In 2007, vacancies were still high for many departments, with the average large department (at least 300 sworn officers) having 73 vacant openings. In order to continue fulfilling their mission, today's law enforcement administrators must find ways to actively attract quality candidates to fill their ranks," (7).

This challenge has continued through recent years. As one retired law enforcement officer and columnist stated in 2016, "Some agencies have to collect over 100 applications to get one viable hire. Some of those hires won't make it through the police academy. Some who do won't complete field training. About half of new hires leave law enforcement within five years. Mainly because of anti-police sentiment, it's more difficult to recruit new cops than ever before," (3). Furthermore, research has shown that less members of the incoming generation of recruits are physically fit enough to serve as officers. Specifically, "A lower birth rate, which equates to less of the prime recruiting demographic (18 – 30 year olds), lower rates of K – 12 general and aerobic fitness, less national physical fitness participation, less multi-sport K – 12 athletes, underfunded sport programs, incumbent injuries, rising obesity rates, and other factors combine into formidable challenges for tactical facilitators," (4).

While there are many factors involved in the challenge of officer recruitment and retention, lack of physical fitness is a factor that can be overcome when tactical strength and conditioning professionals help recruits and employees increase their fitness levels.

SPECIFIC STEPS TO LEVERAGE THE OPPORTUNITY

Some ways that strength and conditioning professionals can help law enforcement agencies with officer recruitment and retention include:

Recruitment

- **PAT Success Guidance:** Agencies can use short- or long-term contracts to hire tactical strength and conditioning professional(s) to produce a PAT Exercise Training Guide (or free online video) to distribute to recruits at job fairs and other recruiting events.
- **Community Events:** If an agency has not employed or is not in contract with strength and conditioning professional(s), they can explore partnering with local businesses and gyms in the community providing they have highly trained, experienced, certified professionals. Together, they can host community fitness activities and/or physical fitness challenges to raise funds for local charities. Benefits are three-fold: the community benefits from the promotion of health, fitness and positive police relations; the law enforcement agency benefits by building positive relationships with the community and having the opportunity to meet and recruit some of the most physically fit local civilians; and the charity benefits from raised funds and awareness. Local businesses often join with non-profit organizations, local city and county governments and occasionally an agency's health insurance provider to sponsor these endeavors.

Retention

- **Injury Risk Reduction:** Agencies can hire or contract strength and conditioning professionals to design and implement injury risk reduction exercise programs to reduce attrition and short-staffing that results from on-duty injuries. Specifically, a recent *TSAC Report* article states, "Tactical facilitators and other strength and conditioning professionals can assist in diagnosing poor movement patterns, adjusting programming accordingly, reducing factors that contribute to injury, saving money, and preserving the most precious asset—tactical personnel," (4).
- **Light Duty Assistance:** Agencies can hire or contract strength and conditioning professionals to provide exercise programs that bridge the gap that employees experience when they are injured and have completed physical therapy but are not yet as strong as they need to be to perform their job safely and efficiently.
- **Tactical Athleticism Optimization:** Agencies can hire or contract tactical strength and conditioning professionals to provide job-specific exercise training programs to help officers optimize their strength, speed, agility, flexibility and overall tactical athleticism. These types of training programs can be provided for individuals, small groups (such as those who do not pass the agency's PAT), or for the entire department as part of in-service training or as an off-duty benefit.

SIGNIFICANT VALUE ADDED FOR THE AGENCY

Physical fitness is a very important component in the multitude of criteria used to evaluate new recruits. This strategy will increase the percentage of physically fit recruits from which an agency can select to hire, thereby enhancing recruitment opportunities. Providing tactical athletic training for employees will also make retention easier because it will help incumbent officers lower their risk of injury and illness, optimize their tactical athleticism and thereby sustain longer, healthier career spans (5,10).

SIGNIFICANT VALUE ADDED FOR THE EMPLOYEES

Among the other benefits listed above, incumbent officers benefit from personally improved tactical strength as well as the increased safety of working with a physically stronger workforce.

In a day and age where understaffed shifts are common and each officer's service is more valuable than ever, it is very important for strength and conditioning professionals to use strategies such as those outlined above to help officers optimize their strength and wellness. They should work hand-in-hand with the agency's command staff and employees to accommodate their schedule and resources. When officers feel their best, they can do their best and maximize their energy to meet the ever-increasing needs of the public. TSAC professionals can provide immense value to agencies by helping them overcome the seemingly "impossible obstacles" outlined above. Because the National Strength and Conditioning Association's TSAC Program equips professionals with science-based solutions and support to help members of law enforcement increase their performance, readiness, and longevity while decreasing the risk of injuries, there are no obstacles that are impossible to overcome, only opportunities through which we can make an extraordinarily positive impact.

REFERENCES

1. Alvar, B, Sell, K, and Deuster, P. *NSCA's Essentials of Tactical Strength and Conditioning*. Champaign, IL: Human Kinetics; 2017.

2. Born, J, and Pride, P. Ohio's model of a comprehensive health and physical fitness program. *The Police Chief* 34: June, 2017. Accessed August 2018 from http://www.policechiefmagazine.org/ohios-model-of-a-comprehensive-health/?ref=138b9aec6248ec1fd967d7c844b66a75.

3. Dees, T. 15 things cops wish the public knew about policing. *PoliceOne.com*. 2016. Retrieved August 2018 from https://www.policeone.com/use-of-force/articles/182662006-15-things-cops-wish-the-public-knew-about-policing/.

4. Dulla, J. Factors impacting first responder and military recruits and how certified strength and conditioning professionals are needed now more than ever. *TSAC Report* 47: 32-38, 2017.

5. International Association of Chiefs of Police Center for Officer Safety and Wellness and Bureau of Justice Assistance. *Reducing Officer Injuries FINAL REPORT: Executive Summary*. Accessed August 2018 from http://www.theiacp.org/portals/0/pdfs/IACP_ROI_Final_Report.pdf.

6. Kornhauser, C. Programming considerations for the tactical officer in law enforcement - Focusing on fundamentals. *TSAC Report* 49: 14-16, 2018.

7. Langham, B. Millennials and improving recruitment in law enforcement. *PoliceChiefMagazine.org Officer Safety and Wellness.* 2017. Retrieved August 2018 from http://www.policechiefmagazine.org/millennials-and-improving-recruitment/?ref=abd97a6cfb5b07eb6334ac5164f933bc.

8. Lockie, R, Moreno, M, Bloodgood, A, and Cesario, K. Practical assessments of power for law enforcement populations. *TSAC Report* 49: 6-12, 2018.

9. Nice, M. Operation thrive: An action plan for strategic wellness success. *The Police Chief* 22–25: May, 2017.

10. O'Malley, EJ, and Nice, M. Winning wellness in law enforcement. *FBI National Academy Associate* 21-25: December, 2016.

ABOUT THE AUTHOR

Mandy Nice is serving her 11th year as the President and Founder of The Nice Life, LLC, an award-winning employee wellness firm that applies practical, affordable, science-based solutions to measurably improve the physical strength and resilience of tactical and civilian populations. Some of her best practices have been featured in the Police Chief Magazine of the International Association of Chiefs of Police (IACP) and the FBI National Academy Associate magazines. She specializes in providing positive, results-focused exercise and wellness programs that help employees reduce risk of injury and illness, optimize health, and reduce healthcare costs. She also currently serves as a member of the Editorial Review Panel for the TSAC Report and as a Subject Matter Expert for the National Strength and Conditioning Association (NSCA).

JOE SWINFEN, MS

GLUTEAL MUSCLE STRENGTH AND ACTIVATION, AND THE RELATION TO KNEE PAIN

Patellofemoral pain syndrome (PFPS) is a chronic condition described as generalized anterior knee pain that occurs during a multitude of activities, typically becoming worse with prolonged activity (14). Activities such as walking, jogging, squatting, lunging, kneeling, and walking up and down the stairs, along with many others can induce or exacerbate pain. A 2008 retrospective study found that due to PFPS, as many as 74% of adults cease their activity at some level or stop because of this pain (3). Musculoskeletal disorders can unfortunately be a major issue in the military setting. Military personnel encounter a myriad of activities (e.g., physical training, recreational sport and work) that may result in some form of musculoskeletal disorder.

Physical training (PT) is a large part of military training and readiness. Most individuals in the military are required to perform PT of some form on a nearly daily basis. In many instances, this comes in the form of running. A study by Hauret et al. in 2006 found that of the over 700,000 musculoskeletal-related injuries, the knee/lower leg made up 57% of all lower extremities and 22% of all injuries (8). Of these injuries, over 250,000 were related to overuse (inflammation and pain) (8).

Belmont et al. states that "noncombat musculoskeletal injuries are endemic within military deployed service members and occur at a greater than threefold rate compared to (combat) musculoskeletal injuries," (2). When Belmont and his colleagues looked at non-combat injures, they found a ratio of between 2.2:1 and 3:1, respectively, of disease and non-battle casualties to combat injuries throughout the Iraq and Afghanistan wars (2). Musculoskeletal disorders in military personnel can greatly affect their overall mission and readiness by creating substantial losses of time from work and training. Belmont et al. showed that of nearly 20% of all service members that were able to finish a combat deployment, 4% required an orthopedic procedure of which the shoulder and knee region made up 50% (2).

ANATOMY OF THE PATELLOFEMORAL REGION

PFPS is characterized by recurring pain and irritation in the front of the knee. The knee consists of two major joints, the patellofemoral joint and the tibiofemoral joint. The patella is the largest sesamoid (floating) bone in the human body. The main functions of the patella are to improve knee flexion efficiency and to protect the tibiofemoral joint. The combination of the quadriceps tendon, lateral retinaculum, medial retinaculum, and the patella tendon help stabilize the patella. If the patella is not completely aligned in the patellar groove during movement, the quadriceps tendon, lateral retinaculum, medial retinaculum, and patella are at an increased risk of injury with a potential cause of this malalignment being relative patellar stabilizer weakness, which in turn impacts alignment (14).

GLUTEUS MUSCLE OVERVIEW

The gluteals consists of three muscles, the gluteus medius, minimus, and maximus. For the purpose of this article the focus will be on the gluteus medius, which abducts and assist to internally rotate the thigh when the hip is extended, and externally rotates and extends the thigh when the hip is flexed. One common theory is that weakness in the gluteus medius when the hip is flexed can lead to an increase in hip adduction (the femur moving in towards the other leg due to relatively stronger adductors) and internal rotation. The increase in hip adduction and internal rotation is thought to impact on the tracking of the patella in the patellofemoral joint, which may potentially lead to PFPS. Ireland et al. found that females with patellofemoral pain showed 26% less hip abduction strength that those without pain (9). Additionally, a study by Tyler et al. showed that a six-week treatment program consisting of hip flexion, abduction, and adduction greatly decreased the overall symptoms of PFPS in the subjects (13).

From an article in 2013, Barton et al. found that there is moderate to strong evidence that gluteus medius muscle activity is delayed and occurs with shorter duration during stair ascent and descent in individuals with PFPS (1). There appears to be limited evidence that this also occurs during running. However, Barton et al. stated, "further research evaluating the value of gluteal muscle activity screening in identifying individuals most likely to develop PFPS, and the effectiveness of interventions targeting changes to gluteal muscle activation patterns is needed," (1).

These changes in the activation and strength of the gluteal muscles is thought to be important in PFPS. A systematic review of literature on hip muscle weakness in women with PFPS found strong evidence of a decrease in abduction, extension strength, and external rotation compared with healthy controls (11). Dierks et al. in both 2008 and a follow-up study in 2011 found a correlation between strength and hip adduction angle during running and found three distinct subgroups of running characteristics in subjects with PFPS (6,7). These subgroups included knee valgus, increased hip abduction, and increased hip and knee abduction.

EXERCISES TO ASSIST WITH GLUTEUS MEDIUS WEAKNESS

First and foremost, seeking a medical professional (e.g., medical doctor, physiotherapist, etc.) to determine if the gluteals are the factor leading to pain should be the first step. Having relative gluteal strength and function assessed during static and dynamic tasks will help determine if they have a role in the presenting symptoms. Some of these assessment tasks should include single-leg balance to assess control of hip and pelvic alignment. Also, Crossley et al. found the single-leg squat to be a reliable tool that can be used to identify people with hip muscle dysfunction (5).

If relative weakness in the gluteals is found there are multiple exercises that have been found to improve gluteal strength, reduce joint loading, and may decrease patellofemoral pain. A study by Boren et al. looked at a multitude of exercises involving the gluteus medius and found the following exercises to be most effective at targeting the gluteus medius while also targeting the gluteus maximus (4). Recommended exercises include a front plank with hip extension, a single-leg squat, and a side plank on either extremity with hip abduction.

FRONT PLANK WITH HIP EXTENSION

1. Start prone with elbows in plank with trunk, hips, and knees in neutral alignment.
2. Lift the right leg off the floor.
3. Flex the knee of the right leg and extend the hip past neutral hip alignment by bringing the heel toward the ceiling, pause for 1 s and return to parallel.
4. Repeat for 10 – 20 repetitions for 3 – 4 sets.
5. Repeat with the opposite leg.

SINGLE-LEG SQUAT

1. Stand on the dominant leg for the exercise.
2. Slowly lower the buttock towards a chair (as if sitting backwards) dropping as low as possible while maintaining good hip and knee alignment then hold for 2 s.
3. Extend back to standing for another 2-s hold.
4. Repeat for 10 repetitions for 3 – 4 sets.

FIGURE 1. FRONT PLANK WITH HIP EXTENSION—START

FIGURE 3. SINGLE-LEG SQUAT—START

FIGURE 2. FRONT PLANK WITH HIP EXTENSION—END

FIGURE 4. SINGLE-LEG SQUAT—DESCENT

SIDE PLANK WITH HIP ABDUCTION

1. Start in a side plank position with the dominant leg up. Keep the shoulders, hips, knees, and ankles in line.
2. While balancing on the elbows and feet, rise up into plank position with the hips off ground (make sure to maintain neutral alignment of the trunk, hips, and knees).
3. While in this position, abduct the top leg for 1 s, then return to the starting position.
4. Repeat for a pre-determined amount of repetitions and sets, depending on training experience.

FIGURE 5. SIDE PLANK WITH HIP ABDUCTION—START

FIGURE 6. SIDE PLANK WITH HIP ABDUCTION—ABDUCTION

REFERENCES

1. Barton, CJ, Lack, S, Malliaras, P, and Morrissey, D. Gluteal muscle activity and patellofemoral pain syndrome: A systematic review. *British Journal of Sports Medicine* 47(4): 207-214, 2013.

2. Belmont, PJ, Owens, BD, and Schoenfeld, AJ. Musculoskeletal injuries in Iraq and Afghanistan: Epidemiology and outcomes following a decade of war. *Journal of the American Academy of Orthopaedic Surgeons* 24(6): 341-348, 2016.

3. Blond, L, and Hansen, L. Patellofemoral pain syndrome in athletes: A 5.7 year retrospective follow-up study of 250 athletes. *Acta Ortho Belg* 64: 393-400, 1998.

4. Boren, K, Conrey, C, Le Coguic, J, et al. Electromyographic analysis of gluteus medius and gluteus maximus during rehabilitation exercises. *International Journal of Physical Therapy* 6(3): 206-223, 2011.

5. Crossley, K, Zhang, WJ, Schache, AG, Bryant, A, and Cowan, SM. Performance on the single-leg squat task indicates hip abductor muscle function. *The American Journal of Sports Medicine* 39(4): 866-873, 2011.

6. Dierks, TA, Manal, KT, Hamill, J, and Davis, I. Lower extremity kinematics in runners with PFP during a prolonged run. *Medicine and Science in Sports and Exercise* 43(4): 693-700, 2011.

7. Dierks, TA, Manal, KT, Hamill, J, and Davis, I. Proximal and distal influences on hip and knee kinematic in runners with patellofemoral pain during a run. *Journal of Orthopaedic Sports Physical Therapy* 38(8): 448-456, 2008.

8. Hauret, KG, Jones, BH, Bullock, SH, et al. Musculoskeletal injuries: Description of an under-recognized injury problem among military personnel. *American Journal of Preventive Medicine* 38(suppl 1): S61-70, 2010.

9. Ireland, ML, Wilson, JD, Ballantyne, BT, and Davis, IM. Hip strength in females with and without patellofemoral pain. *The Journal of Orthopaedic and Sports Physical Therapy* 33(11): 671-676, 2003.

10. McBeth, JM, Earl-Boehm, JE, Cobb, SC, and Huddleston, WE. Hip muscle activity during 3 side-lying hip-strengthening exercises in distance runners. *Journal of Athletic Training* 47(1): 15-23, 2012.

11. Prins, MS, and van der Wurff, P. Females with patellofemoral pain syndrome have weak hip muscles: A systematic review. *Australian Journal of Physiotherapy* 55(1): 9-15, 2009.

12. Pollock, ML, Gettman, LR, Milesis, CA, Bah, MD, Durstine, L, and Johnson, RB. Effects of frequency and duration of training on attrition and incidence of injury. *Medicine and Sciecnce in Sports* 9(1): 31-36, 1977.

13. Tyler, TF, Nicholas, SJ, Mullaney, MJ, and McHugh, MP. The role of hip muscle function in the treatment of patellofemoral pain syndrome. *American Journal of Sports Medicine* 34(4): 630-636. 2006.

14. Waryasz, G, and McDermott, A. Patellofemoral pain syndrome (PFPS): A systematic review of anatomy and potential risk factors. *Dynamic Medicine* 7(9): 2008.

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ROD POPE, PHD

TSAC—REDUCING THE RISK OF INJURY

This article is part of a new, continuing series on practical, evidence-based approaches to reducing the risk of injury while developing tactical strength and conditioning.

RUBBER MATTING AND ARTIFICIAL TURF SHOULD BE AVOIDED ON TRAINING AND SPORTS GROUNDS TO REDUCE THE RISK OF ACL RUPTURES

Non-contact ruptures of the anterior cruciate ligament (ACL) are a major concern in sporting and tactical populations alike because they frequently result in lengthy periods of disability and time off the field or on restricted duties (1,6). In the United States military, approximately seven ACL ruptures are reported for every 1,000 personnel each year, and this rate of ACL rupture in the military is 10 times the rate observed in the U.S. general population (5). ACL ruptures occur most often in the general population when individuals are landing from a jump; suddenly decelerating and changing direction while running; or accelerating to take off for a jump (8). The interaction between the ground surface and the footwear of the individual is a key contributor to ACL ruptures in both sport (2,4) and tactical contexts (6,7), alongside other factors like movement patterns (1,8). For example, ACL injuries have been shown to be up to 67% more likely to occur when sport is played on artificial turf than when it is played on natural grass (4). Furthermore, it has been shown that the strain imposed on the ACL is approximately 50 – 90% higher when a simulated cutting movement is undertaken on artificial turf when wearing turf shoes or shoes with cleats than when such a movement is undertaken on natural grass when wearing shoes with cleats (3). These concerns also extend to the interaction between rubber matting surfaces and the rubber-soled boots commonly worn by tactical operators (6,7).

Tactical personnel commonly wear boots designed for foot protection, stability, and traction. Each of these features is typically addressed in part through the use of rubber soles, which protect the foot from a range of hazards, provide a stable base of support, and help grip the ground surface during movement, even in wet and slippery conditions. While these properties of rubber soled boots are critical for their wearers in tactical environments where hazards often abound, pairing them with rubber surfaces when moving at speed has been shown to cause ACL ruptures in some personnel (6,7). Illustrating this point, two decades ago, a sudden spate of ACL ruptures in Australian Army recruits undertaking basic training was detected by injury surveillance systems at Australia's Army Recruit Training Centre, where ACL ruptures had previously been an extremely rare occurrence (6). Subsequent investigation identified that all of these ACL ruptures occurred at a single obstacle course, the "run dodge jump" course, which involved zig-zagging between obstacles, vaulting over a wall, and jumping across a pit (6). The investigators identified that, just prior to the first in the spate of ACL ruptures, rubber matting had been laid on the ground surfaces around the wall and pit in an effort to improve shock absorption and so reduce impact forces on the legs (6,7). Review of the available literature at that time highlighted the high coefficients of friction (stopping or gripping forces that prevent slipping and sliding) that were generated when rubber tires or boot soles interfaced with a ground surface (6). In fact, this is the reason rubber tires are used on motor vehicles and rubber soles on work boots. The review also highlighted the fact that when two rubber surfaces interfaced together, the coefficient of friction was much, much greater (6). Therefore, it would take a very large force to slide one rubber surface across the other if the two surfaces were pushed together, for example by the force of gravity working on bodyweight. So, this meant that when the recruits landed after jumping across the pit on the run dodge jump course, their feet decelerated to zero immediately upon landing (6). This rapid "braking" effect generated large amounts of torque through the knee joint and ACL, sufficient in some recruits to rupture the ACL (6,7). A similar effect occurred when recruits twisted or turned when preparing to jump the wall or run off after landing following the wall vault—their foot was effectively fixed in one position due to the interface between the rubber sole of their boot and rubber matting, so that rotational forces at the knee were again large and sufficient to rupture the ACL of some recruits (6,7).

The big test of whether this rubber sole and rubber matting interface was causing the ACL ruptures was to remove the matting and continue to monitor ACL rupture rates (6,7). The rubber matting was therefore removed from the landing area after the pit and replaced with deep gravel, which due to its movement underfoot allowed for a more gradual deceleration of the foot after landing (6,7). The ACL ruptures that had been occurring at that part of the run dodge jump course ceased but ACL ruptures continued to occur at other areas of the course, where rubber matting remained (7). Removal of the rest of the rubber matting, replaced with concrete or gravel, brought an end to the spate of ACL ruptures, and on that basis, the researchers were confident of the cause of the ACL ruptures—the rubber matting (7). More detail about these examples can be found in the study reports (6,7).

The lesson in all of this, regarding the prevention of ACL ruptures, is that when tactical operators and athletes are required to move at speed while cutting and turning, accelerating and decelerating, and jumping and landing in rubber-soled boots or in shoes with rubber soles or cleats, rubber matting and artificial turf do not constitute appropriate training and sportsground surfaces, and can be hazardous. These sorts of artificial surfaces should be avoided in favor of natural grass and other surfaces that limit coefficients of friction between the sole of the boot or shoe and the ground

surface, while also maintaining their shape and form to provide a level surface. If ACL ruptures are observed to be common in any particular tactical workforce, training area surfaces and sports ground surfaces traversed by the workforce at speed are key factors that should definitely be considered and addressed as a potential cause of the ACL ruptures.

REFERENCES

1. Beutler, A, de la Motte, S, Marshall, S, Padua, D, and Boden, B. Muscle strength and qualitative jump-landing differences in male and female military cadets: The jump-ACL study. *Journal of Sports Science and Medicine* 8: 663-671, 2009.

2. Dowling, A, and Andriacchi, T. Role of shoe–surface interaction and noncontact ACL injuries. In: Noyes F, and Barber-Westin, S. (Eds.), *ACL Injuries in the Female Athlete*. Springer, Berlin, Heidelberg; 2012.

3. Drakos, M, Hillstrom, H, Voos, J, Miller, A, Kraszewski, A, Wickiewicz, et al. The effect of the shoe-surface interface in the development of Anterior Cruciate Ligament strain. *Journal of Biomechanical Engineering* 132(1): 2009.

4. Hershman, E, Anderson, R, Bergfeld, J, Bradley, J, Coughlin, M, Johnson, R, et al. An analysis of specific lower extremity injury rates on grass and field turf playing surfaces in National Football League games: 2000-2009 seasons. *The American Journal of Sports Medicine* 40(10): 2200-2205, 2012.

5. Owens, B, Mountcastle, S, Dunn, W, DeBerardino, T, and Taylor, D. Incidence of Anterior Cruciate Ligament injury among active duty U.S. military servicemen and servicewomen. *Military Medicine* 172(1): 90-91, 2007.

6. Pope, R. Case report: Injury surveillance and systematic investigation identify a rubber matting hazard for ACL rupture on an obstacle course. *Military Medicine* 167(4): 359-362, 2002.

7. Pope, R. Rubber matting on an obstacle course causes ACL ruptures and it's removal eliminates them. *Military Medicine* 167(4): 355-358, 2002.

8. Shimokochi, Y, and Shultz, S. Mechanisms of noncontact anterior cruciate ligament injury. *Journal of Athletic Training* 43(4): 396-408, 2008.

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MATTHEW MORENO, KARLY CESARIO, ASHLEY BLOODGOOD, AND ROBERT LOCKIE, PHD

CIRCUIT STRENGTH TRAINING WITH ABILITY-BASED MODIFICATIONS FOR LAW ENFORCEMENT RECRUITS

INTRODUCTION

Law enforcement and correctional officers have a job that can incorporate bursts of high-intensity physical activities such as running, sprinting, pushing, dragging, and fighting (12,13). These periods of high-intensity physical activity are extremely important as an officer may be protecting their safety, the safety of colleagues or inmates, or the safety of the general public. Therefore, physical training (PT) should be included in academy programs to ensure that physical capacity is developed to a level that allows recruits to perform their jobs safely and optimizes their health prior to the start of their career.

Circuit training (CT) is a style of training where several resistance exercises are performed in a sequential order with minimal rest (e.g., approximately 30 s, or only as long as it takes to get to the next station) between exercise transitions (2,10). CT is time efficient as both maximal strength and strength endurance can be targeted within a single workout (2,7,10,25). This time efficiency has led to CT being popular with tactical populations who are often short on time when training new recruits and allows for the amount of training stimuli per session to be maximized (11,21,22). Considering the benefits of CT, agencies can be limited in their ability to procure equipment for their academies by their budget. Therefore, it is imperative for practitioners to be able to design appropriate CT programs, within their space and equipment limitations, that can improve the physical capacity of their recruits.

It is also important to note that people who apply for law enforcement jobs come from a variety of athletic backgrounds. As a result, fitness levels and abilities can vary greatly across law enforcement and correctional recruit classes (4,18,19,21,26). However, the current implementation of CT in academy settings often involves a "one-size-fits-all" approach, in which all recruits are expected to perform the same exercise at the same intensity (21,23). As detailed by Moreno et al., this approach may cause recruits of differing ability levels to receive inappropriate training stimuli for the desired training outcome (21). When designing a CT program, practitioners should ideally adopt exercises that are adaptable to the strength and ability levels of individual recruits.

Therefore, this article will detail an example CT workout with ability-based modifications that could be adopted in the academy training setting. The CT session is designed as a full-body workout and should be accompanied by a dynamic warm-up. An example dynamic warm-up that could be used would involve a progression of 4-point calf stretches, Frankenstein walks, standing quadriceps stretches, leg cradles, knee hugs, hip openers, side shuffles with stretch, and ending with progressive intensity speed runs (70%, 80%, 90%, and 100% or perceived maximum speed). This dynamic warm-up is a general warm-up that can be used for many different workouts with an emphasis placed on general mobility and dynamic movements. More information on additional dynamic warm-ups can be found in the following references (1,24).

CIRCUIT STRENGTH TRAINING WORKOUT

The CT session is composed of both upper and lower body exercises for a full-body workout, as is typical of CT-style workouts (9,15). Additionally, agencies that have limited time with which to train their recruits (e.g., 1 – 2 hr sessions, 2 – 3 times per week) will be able to maximize their efficiency by using full-body workouts. The exercises are ordered in an alternating lower body/upper body fashion to ensure that the exercises do not greatly interfere with each other when performed in sequence. The CT session is also designed so that every recruit should ideally have a partner, which is needed for some of the ability-based modifications. The stations are designed with a 1-min work:30-s transition period. The transition period allows recruits time to move to the next station and prepare any required equipment. Additionally, this 30-s transition provides a short active recovery period. After a full rotation (five stations, total time of 7 min) recruits should be allowed a 3-min rest period where they can hydrate. From start to rest, the 10-min period constitutes one set. Four sets are recommended (total training time = 40 min), but the prescribed number of sets can be adjusted depending upon the available time. Depending on the size of the facility and available equipment, this style of circuit can accommodate at least 30 recruits.

The exercise order should be as follows:

1. Squat
2. Ability-based pull-up
3. Step-ups
4. Ability-based push-up
5. Farmer's walk

STRENGTH CIRCUIT EXERCISES AND MODIFICATIONS

SQUAT

The squat is included to develop lower-body strength, an underlying physical characteristic related to several law enforcement job tasks such as running, jumping, and load carriage (12,13). A common application of the squat in academy involves adding more unweighted repetitions (i.e., air squats) instead of adjusting the load for the exercise (21). While doing

an unweighted air squat might be appropriate for untrained individuals, adjustments should be made for the recruits that can proficiently perform the exercise. Adding more repetitions will not be sufficient to induce strength-related adaptations, as National Strength and Conditioning Association (NSCA) guidelines suggest that lower repetition ranges with heavier loads is optimal for strength adaptations (3,8). Another consideration for programming is that recruits with improper squat form should not be burdened with additional load until they have received appropriate coaching from the PT staff to correct their form. Adding load to adhere to the strength guidelines can be done in several ways; utilizing a weighted vest, sandbag, or holding an ammo can are some examples of added load. Additional load is a way to individualize the exercise for the ability levels of the recruits. Figure 1 shows the squat being performed with a sandbag held close to the chest, while Figure 2 shows the exercise being performed with the sandbag held across the shoulders. Holding the implement in front as Figure 1 shows is a similar position to a front squat, while Figure 2 mimics the back squat position.

Equipment Required

- Open space and resistance (e.g., weighted vest, sandbags, ammunition cans).

Starting Position

- The legs are positioned slightly wider than hip-width apart, with the feet slightly turned out.
- The chosen implement (if using one) is positioned held in the hands close to the chest like a goblet (Figure 1A) or held along the upper back similar to a barbell (Figure 2A). If holding an implement in front of the chest, it is important the neck is kept in a neutral position with the recruit facing forwards (Figure 1A).

Descent

- In general, and depending on skill and flexibility, the recruit should descend until the top of the thighs are parallel to the ground; if the recruit can descend below parallel with good form, they can perform the exercise in this manner (Figures 1B and 2B).
- The knees should be tracking in the same direction the toes are pointing and should not collapse inwards.
- The descent should be performed at a controlled speed.

Ascent

- The recruit will begin the phase by extending the knees and hips until they are upright back in the starting position (Figures 1A and 2A).
- This phase should be performed with speed, although locking out of the knees should be avoided.

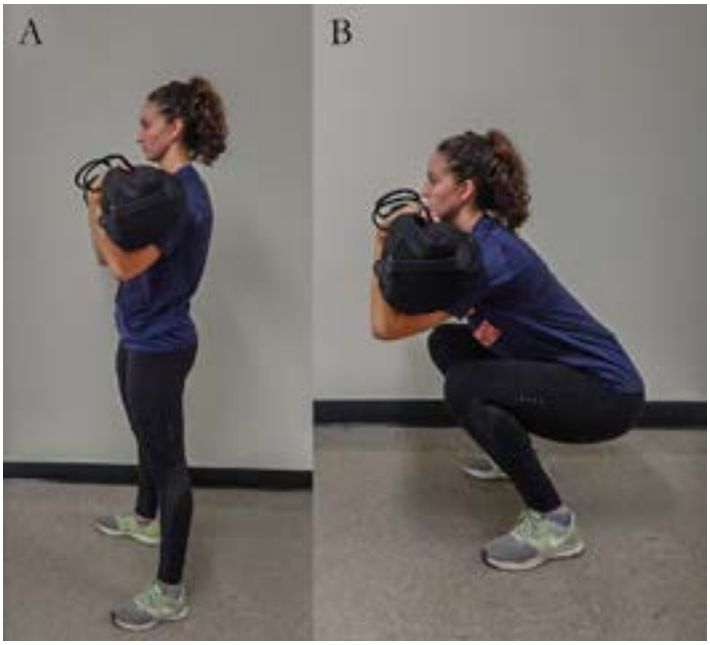

FIGURE 1. SQUAT PERFORMED WITH IMPLEMENT HELD IN FRONT—GOBLET VARIATION

(A) The starting and ascent final position.
(B) Descent final position.

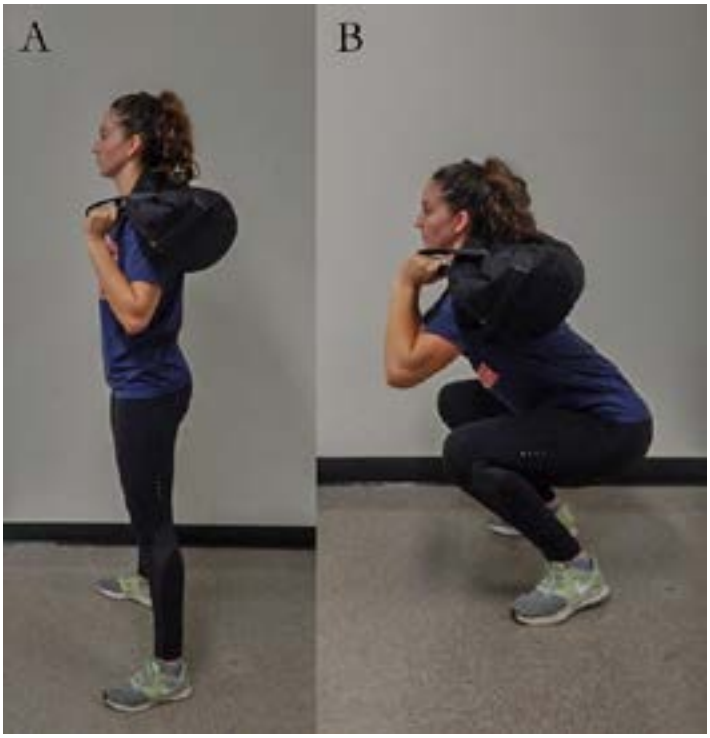

FIGURE 2. SQUAT PERFORMED WITH IMPLEMENT HELD LIKE A TRADITIONAL BARBELL

(A) The starting and ascent final position.
(B) Descent final position.

ABILITY-BASED PULL-UP

The pull-up was chosen to develop upper body pulling strength. Upper body pulling strength is related to job tasks such as scaling obstacles, grappling, and load carriage (12,13). The pull-up station is novel in that the partners will take turns performing the exercises. This can be accomplished in different ways, such as having the partners switch at the 30-s mark or instructing partners to switch every 5 – 10 repetitions for pull-ups. The ability-based modification involves a partner supporting the recruit at the waist and assisting them with the lift (Figure 3). This modification is important, as pull-ups can be a difficult exercise to make progress when the recruit cannot successfully perform a single repetition. The modification ensures that recruits work through the entire range of motion. Conversely, for those recruits that have already developed the ability to do a high number of bodyweight pull-ups (e.g., 10 repetitions or more) without compromising proper form, a weighted vest or another implement held between the legs such as a medicine ball could be used to increase resistance. The weighted vest variation of the pull-up is shown in Figure 4. For maximum strength gains, use of higher loads with fewer repetitions (i.e., 8 – 10 repetitions or less) is recommended (3,8).

Equipment Required

- A bar, a weighted vest, and a partner.

Starting Position

- Begin by either grasping the bar or jumping to grasp the bar with the hands placed comfortably apart (Figures 3A and 4A).
- If the recruit is holding an implement in their legs, have their partner place the implement in an appropriate spot (e.g., held between the thighs for a medicine ball, or between the ankles for a dumbbell).
- For spotting of the assisted version, the spotter should begin by assuming an athletic stance behind the recruit and support their waist using their hands (Figure 3A). The athletic stance ensures that the partner is able to leverage themselves efficiently against the weight of the ecruit.

Ascent

- The recruit should begin with flexion at the elbows and extention at the shoulders simultaneously.
- The recruit should aim to pull themselves up until their chin clears the bar (Figures 3B and 4B).
- The spotter for the assisted version should only apply the necessary assistance for the recruit to do the repetitions, and should not be lifting the partner throughout the whole range of motion.

Descent

- The recruit should then lower themselves in a controlled fashion.
- The spotter for the assisted version should not stop supporting the recruit during this eccentric phase as this may cause the recruit to fall or overstress joints.
- Once the recruit has lowered themselves completely and resumed a straight-arm position, they can begin the next repetition.

FIGURE 3. PARTNER-ASSISTED PULL-UP

(A) The starting and descent final position.
(B) Ascent final position.

FIGURE 4. WEIGHTED PULL-UP

(A) The starting and descent final position.
(B) Ascent final position.

STEP-UPS

Step-ups are an exercise that can be used to develop unilateral leg strength (17,20). Step-ups are also specific to the demands of working in these types of occupations (12,13). While it is hard to recommend an ideal step height due to individual variations in limb lengths and training history, step height should be chosen based upon level of skill, access and ability to accommodate a group of recruits. For example, stadium steps of 12 – 18-in. height will be suitable for most recruits but will be more challenging than typical stairs of 7-in. step heights (Figure 5). Regarding the tempo of the step-ups, the recruits should be instructed to step up and down quickly, but also safely. An example cadence generally used in step tests is 96 steps per min (6); although this can be modified depending on recruit fitness levels. For recruits with lower fitness levels, unweighted stepping can be a good starting point. Recruits with higher fitness levels can use added resistance to make the step-ups harder. What is important to note is that adding resistance can affect the recruit's ability to safely maintain speed. Trainers should be aware that recruits utilizing added resistance may need a subsequent decrease in their cadence to ensure proper form. This added resistance can be in the form of a weighted vest, or an extra load being held in the hands or at the shoulders. Figure 5 displays an example step-up where a sandbag held across the shoulders is used to provide extra resistance. Verbal encouragement should be given to recruits to ensure their stepping frequency is maintained throughout a set.

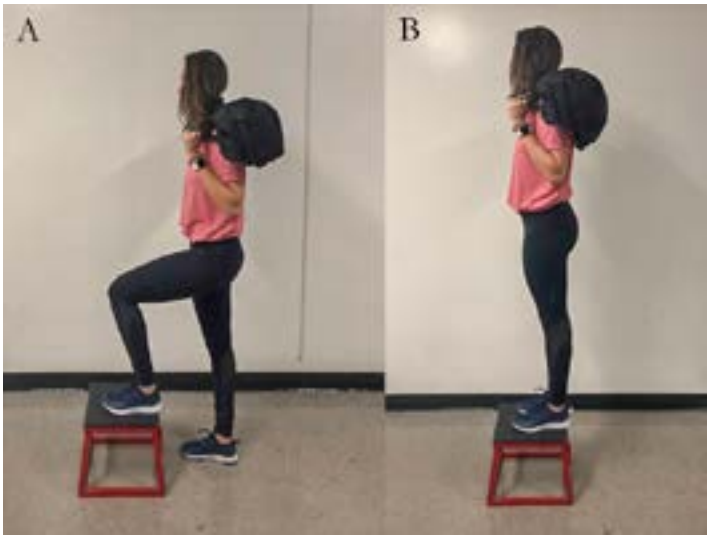

FIGURE 5. STEP-UP PERFORMED WITH SANDBAG HELD ON BACK

(A) The start of the ascent phase.
(B) Ascent final position.

Equipment Required

- Stairs or steps, and resistance (e.g., weighted vest, ammunition cans, sandbags, water jugs).

Starting Position

- The recruit should begin by standing in front of the step.
- If using an implement, the recruit should hold it either across the upper back or in their hands.

Ascent

- Beginning with a slight forward lean of the trunk, the recruit should extend the hip and the knee of the leg placed on the step. Force generation to move the body should be emphasized for the lead leg, and not the trailing leg on the ground.
- The finish position is when the recruit is supported by both feet on the top of the step (Figure 5B).

Descent

- From the finish position, the recruit steps down with the trailing leg by flexing at the hip and knee.
- The other foot is then returned to the ground back to the starting position.
- The exercise is then repeated with the other leg.

ABILITY-BASED PUSH-UP

The push-up is used to develop upper body pushing strength, which has been related to important job tasks such as fighting inmates or suspects (12,13). Further, Shusko et al. found that push-up ability was related to successful academy completion in law enforcement recruits (26). Therefore, upper body strength is an important aspect to develop during the academy period. Similar to the pull-up station, the push-up station involves partners taking turns performing the exercise. Partners can switch at the 30-s mark, or every 10 – 15 repetitions. The ability-based version of the push-up offers two modifications: an assisted version for those who cannot do a single push-up (Figure 6), and a partner-resisted version for increasing load (Figure 7). The assistance allows the recruit to go through the entire range of motion, receiving assistance only when they need it. Additionally, the resisted version allows for a partner to apply extra resistance throughout the range of motion of the push-up. For the purpose of this workout, the added resistance should make a recruit unable to perform more than 5 – 10 repetitions for a strength focus, or 10 – 15 repetitions for an endurance focus (3). As noted, each recruit should be partnered up for this station, as they will complete a set of push-ups and then rotate and continue to do a set and rotate for the entire 1-min period with the goal of completing as many sets as possible.

Equipment Required

- A partner, support towel/strap, and flat ground.

Starting Position

- The recruit should begin on one knee, hands placed on the floor slightly wider than shoulder-width apart.
- The ready position will be in the end position of the push-up, with arms fully extended and both knees off the ground. The recruit should focus on not letting the hips sag to the ground or raising them into the air.
- For spotters that are assisting, they should adopt a balanced stance straddling the recruit. With a towel or similar implement around the recruit's waist, the spotter should keep tension on the towel to support the recruit throughout the range of motion (Figure 6A).
- For spotters that are resisting, they should adopt a staggered stance and place both of their hands on the recruit's upper back to apply resistance throughout the range of motion (Figure 7A).

Descent

- The recruit will lower themselves so that their upper arms are approximately parallel to the ground or to the depth required of the assessment. Excessive depth (i.e., chest to the ground) can place undue strain across the anterior shoulder capsule.
- Spotters providing assistance should be supporting the recruit throughout the full range of motion and not allowing their partner to collapse onto the floor (Figure 6B).
- Spotters providing resistance should not attempt to push the recruit into the floor, but their hands should stay in contact with the recruit throughout the eccentric portion (Figure 7B).

Ascent

- The recruit should push up until the elbows are fully extended.
- Spotters providing assistance should not do the work for the recruit, but only provide what assistance is necessary to allow the recruit to perform the push-up.
- Spotters providing resistance should apply enough force to make the exercise difficult but should not prevent the recruit from successfully completing the repetitions.
- Once the recruit is at the top position, the exercise is repeated.

FIGURE 6. PARTNER-ASSISTED PUSH-UP

(A) The starting and descent final position.
(B) Ascent final position.

FIGURE 7. PARTNER-RESISTED PUSH-UP

(A) The starting and descent final position.
(B) Ascent final position.

FARMER'S WALKS

Farmer's walks involve an individual picking up a heavy load in one or two hands and carrying the load for a set distance or time (14,16,27,28). The farmer's walk was included due to the incorporation of grip strength, in addition to the involvement of major trunk and leg musculature (14,16,27,28). Grip and trunk strength are also related to important job tasks, such as grappling, fighting, and controlling inmates or suspects (12,13). While distances as low as 20 m and high as 50 m have been recommended for training (14,27,28), the distance selected by practitioners for the exercise should be related to the space available such that it can accommodate all the recruits of the circuit. The circuit is designed for 1-min workout stations which is another consideration; for the purposes of the workout, recruits should be expected to continuously carry the load for the full minute. A short distance should be utilized to allow recruits to walk back and forth, which ensures proximity to other stations for the transition period. Recruits should alternate the direction of turning each lap (e.g., if they turn to the right on the first lap, they should turn to the left on the second) to prevent asymmetries from developing.

Modifying the farmer's walk can occur in several ways. First, the weight of the implement (e.g., dumbbells, sandbags, weight plates) can be increased to further tax the recruit's grip and core strength. Figure 8 displays the farmer's walk being performed with weight plates. An element of instability can also be added by using water jugs instead of traditional solid implements that will place more of an emphasis on dynamic trunk stability. An alternative is to also use a single hand (suitcase-style farmer's walks) which loads the trunk unilaterally. If using single-hand farmers walks, the practitioner should ensure recruits switch arms at the 30-s mark.

Equipment Required

- Open space, and resistance (e.g., dumbbells, weight plates, sandbags, water jugs, ammunition cans).

Starting Position

- Set the distance that the recruits are supposed to walk.
- Recruits should pick up the implements they are using and hold them at their sides with their arms fully extended (Figure 8A).
- The trunk should remain upright, with the head and chest up.
- A closed grip should be used (thumb and fingers wrapped around the implement) to maintain control of the load.

Walking Phase

- Keeping the elbows extended (i.e., not attempting to lift the load up with the arms/shoulders) the recruit should begin to walk with the load (Figure 8B).
- The arms should remain held at the sides and elbows extended throughout the duration of the walk.
- Recruit should try to not swing the load.
- The recruit should attempt to cover the set distances as quickly as possible. However, recruits should not take extremely long strides to increase their pace, nor should they be encouraged to take much more frequent smaller steps. Rather, they should use a stride length and frequency appropriate for their walking pace.

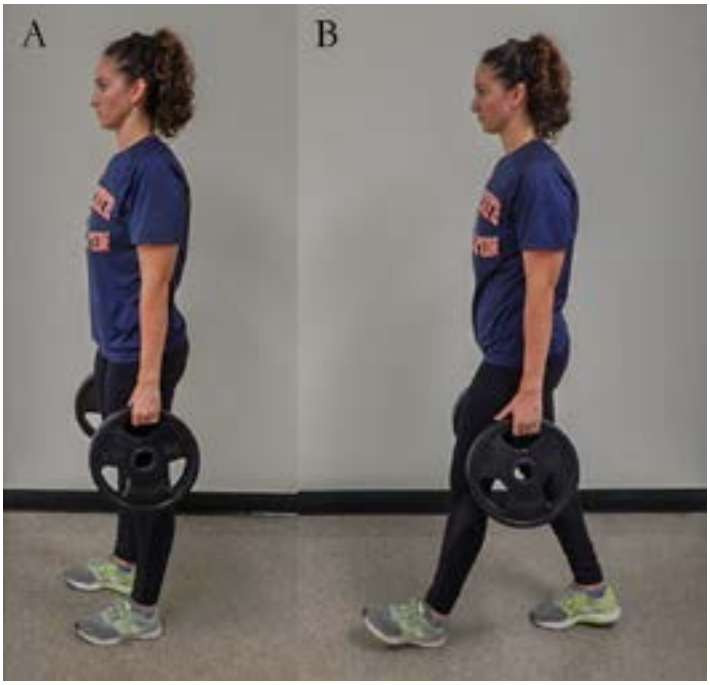

FIGURE 8. FARMER'S WALK

(A) Starting position.
(B) Mid-walking phase.

CONCLUSION

In summary, this CT session has provided an example of how to add ability-based modifications to a physical training session for law enforcement recruits. While this CT session is not a complete training plan, it does provide a template for training sessions that can be modified to work within a law enforcement physical training program. Furthermore, consistent use of the exercises within this session (or similar exercises modified from this template) should lead to improvements in strength and endurance in law enforcement recruits, especially if a periodized program is consistently followed (5,9,11,22).

REFERENCES

1. Aguilar, AJ, Distefano, LJ, Brown, CN, Herman, DC, Guskiewicz, KM, and Padua, DA. A dynamic warm-up model increases quadriceps strength and hamstring flexibility. *The Journal of Strength and Conditioning Research* 26(4): 1130-1141, 2012.

2. Alcaraz, PE, Perez-Gomez, J, Chavarrias, M, and Blazevich, AJ. Similarity in adaptations to high-resistance circuit vs. traditional strength training in resistance-trained men. *The Journal of Strength and Conditioning Research* 25(9): 2519-2527, 2011.

3. Alvar, BA, Sell, K, and Deuster, PA. *NSCA's Essentials of Tactical Strength and Conditioning*, 2017.

4. Cesario, KA, Moreno, MR, Bloodgood, AM, Dulla, JM, and Lockie, RG, *Heart rate responses of a custody assistant class to a formation run during academy training*, presented at Southwest American College of Sports Medicine's 37th Annual Meeting: Long Beach, CA; 2017.

5. Chtara, M, Chaouachi, A, Levin, GT, Chaouachi, M, Chamari, K, Amri, M, and Laursen, PB. Effect of concurrent endurance and circuit resistance training sequence on muscular strength and power development. *The Journal of Strength and Conditioning Research* 22(4): 1037-1045, 2008.

6. Golding, L. *YMCA fitness testing and assessment manual*. Champaign, IL: Human Kinetics, 2000.

7. Gotshalk, LA, Berger, RA, and Kraemer, WJ. Cardiovascular responses to a high-volume continuous circuit resistance training protocol. *The Journal of Strength and Conditioning Research* 18(4): 760-764, 2004.

8. Haff, GG and Triplett, NT. *Essentials of Strength Training and Conditioning* (4th edition). Champaign, IL: Human Kinetics; 2015.

9. Haltom, RW, Kraemer, RR, Sloan, RA, Hebert, EP, Frank, K, and Tryniecki, JL. Circuit weight training and its effects on excess postexercise oxygen consumption. *Medicine and Science in Sports and Exercise* 31(11): 1613-1618, 1999.

10. Harber, MP, Fry, AC, Rubin, MR, Smith, JC, and Weiss, LW. Skeletal muscle and hormonal adaptations to circuit weight training in untrained men. *Scandinavian Journal of Medicine and Science in Sports* 14(3): 176-185, 2004.

11. Heinrich, KM, Spencer, V, Fehl, N, and Poston, WSC. Mission essential fitness: Comparison of functional circuit training to traditional Army physical training for active duty military. *Military Medicine* 177(10): 1125-1130, 2012.

12. Jamnik, VK, Thomas, SG, Burr, JF, and Gledhill, N. Construction, validation, and derivation of performance standards for a fitness test for correctional officer applicants. *Applied Physiology, Nutrition and Metabolism* 35(1): 59-70, 2010.

13. Jamnik, VK, Thomas, SG, Shaw, JA, and Gledhill, N. Identification and characterization of the critical physically demanding tasks encountered by correctional officers. *Applied Physiology, Nutrition and Metabolism* 35(1): 45-58, 2010.

14. Keogh, JW, Kattan, A, Logan, S, Bensley, J, Muller, C, and Powell, L. A preliminary kinematic gait analysis of a strongman event: the farmers walk. *Science Periodical on Research and Technology in Sport* 2(1): 24-33, 2014.

15. Klika, B and Jordan, C. High-intensity circuit training using body weight: Maximum results with minimal investment. *Health & Fitness Journal* 17(3): 8-13, 2013.

16. Lockie, RG and Lazar, A. Exercise technique: applying the hexagonal bar to strength and power training. *Strength and Conditioning Journal* 39(5): 24-32, 2017.

17. Lockie, RG. A 6-week base strength training program for sprint acceleration development and foundation for future progression in amateur athletes. *Strength and Conditioning Journal* 40(1): 2-12, 2018.

18. Lockie, RG, Dawes, JJ, Orr, RM, Stierli, M, Dulla, JM, and Orjalo, AJ. An analysis of the effects of sex and age on upper-and lower-body power for law enforcement agency recruits prior to academy training. *The Journal of Strength and Conditioning Research* Published ahead of print; 2018.

19. Lockie, RG, Orr, RM, Stierli, M, Cesario, KA, Moreno, MR, Bloodgood, AM, Dulla, JM, and Dawes, JJ. The physical characteristics by sex and age for custody assistants from a law enforcement agency. *The Journal of Strength and Conditioning Research* Published ahead of print; 2018.

20. Mccurdy, KW, Langford, GA, Doscher, MW, Wiley, LP, and Mallard, KG. The effects of short-term unilateral and bilateral lower-body resistance training on measures of strength and power. *The Journal of Strength and Conditioning Research* 19(1): 9, 2005.

21. Moreno, MR, Cesario, KA, Bloodgood, AM, Dulla, JM, and Lockie, RG, *Heart rate response of a custody assistant class to circuit training during the academy period*, presented at Southwest American College of Sports Medicine's 37th Annual Meeting: Long Beach, CA; 2017.

22. Norvell, N and Belles, D. Psychological and physical benefits of circuit weight training in law enforcement personnel. *Journal of Consulting and Clinical Psychology* 61(3): 520, 1993.

23. Orr, RM, Ford, K, and Stierli, M. Implementation of an ability-based training program in police force recruits. *The Journal of Strength and Conditioning Research* 30(10): 2781-2787, 2016.

24. Perrier, ET, Pavol, MJ, and Hoffman, MA. The acute effects of a warm-up including static or dynamic stretching on countermovement jump height, reaction time, and flexibility. *The Journal of Strength and Conditioning Research* 25(7): 1925-1931, 2011.

25. Petersen, S, Haennel, R, Kappagoda, C, Belcastro, A, Reid, D, Wenger, H, and Quinney, H. The influence of high-velocity circuit resistance training on VO_2max and cardiac output. *Canadian Journal of Sport Sciences* 14(3): 158-163, 1989.

26. Shusko, M, Benedetti, L, Korre, M, Eshleman, E, Farioli, A, Christophi, CA, and Kales, SN. Recruit fitness as a predictor of police academy graduation. *Occupational Medicine* 67(7): 555-561, 2017.

27. Winwood, PW, Keogh, JW, and Harris, NK. The strength and conditioning practices of strongman competitors. *The Journal of Strength and Conditioning Research* 25(11): 3118-3128, 2011.

28. Winwood, PW, Cronin, JB, Brown, SR, and Keogh, JWL. A biomechanical analysis of the farmers walk, and comparison with the deadlift and unloaded walk. *International Journal of Sports Science & Coaching* 9(5): 1127-1143, 2014.

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TACTICAL FITNESS RESEARCH 2018

The views expressed in this article are those of the author, and do not necessarily reflect the official position or policy of the NSCA, the Department of Defense, the Air Force, or the U.S. Government.

The American College of Sports Medicine (ACSM) 65th Annual Meeting was held in Minneapolis, MN May 29 – June 2, 2018. Overall, there were more than 50 presentations with a military focus, which included a poster session on military physiology, a thematic poster session on military energy expenditure, a tutorial lecture on Special Operations Forces (SOF), two lectures on the challenges of feeding active duty while deployed, and a presentation discussing an intervention for treating post-traumatic stress disorder (PTSD) in military retirees.

Military nutrition strategies were an important theme at the meeting. One such study attempted to generate a prediction equation which would accurately estimate daily energy expenditure of individual SOF in a field setting (13). The authors used a retrospective analysis of SOF energy expenditure while engaged in 12 different training scenarios. Energy use and total body water were determined by the doubly labeled water (DLW) technique (13). Physical activity level was defined as daily energy expenditure divided by resting metabolic rate. Physical activity level was broken into quartiles (0 = mission prep, 1 = common warrior tasks, 2 = battle drills, and 3 = specialized intense activity) in order to generate a physical activity factor (PAF). Regression was used to construct two predictive equations (Model A: body mass and PAF; Model B: fat-free mass and PAF). Measured daily energy expenditure ranged from 3,700 – 6,300 kcals/day, with an average of 4,468 kcals/day per soldier. Regression analysis revealed that physical activity level ($r = 0.91$; $p < 0.05$) and body mass ($r = 0.28$; $p < 0.05$; Model A), or fat-free mass (FFM; $r = 0.32$; $p < 0.05$; Model B) were the factors that most highly predicted energy expenditures. Model A and Model B predicted energy expenditure comparably well ($r = 0.74$ and $r = 0.76$, respectively) with no significant differences (mean + SEM: Model A; 4463 + 65 kcals/day, Model B; 4462 + 61 kcals/day) from DLW derived expenditures. As both models predicted energy expenditure equally well, this indicates body composition does not have to be known to use the equation. Practical applications of this research will permit the design of SOF food plans specific to their mission profiles.

Military personnel frequently train and/or deploy to locations with hot, humid environments. Active duty members also frequently consume caffeine, and research indicates 13 – 14% of personnel are "high utilizers" of caffeine (defined as > 400 mg per day caffeine for men, and > 300 mg for women) (9). It has been heavily debated over the last few years whether the diuretic effect of caffeine would inhibit the tactical performance of personnel in hot environments (1). This study investigated the effect of caffeine ingestion (CAFF) on core temperature during exercise in a hot, humid environment (1). Twenty-one physically active male subjects performed a maximal graded exercise test (GXT) and two endurance exercise tests (EET), separated by at least 48 hr. Subjects were randomly assigned to consume either 6 mg/kg body mass of a placebo (PLAC) or CAFF supplement for one EET and the opposite substance for the second test. The subjects also ingested a core temperature sensor to measure core body temperature during each test. Each EET consisted of cycling on a cycle ergometer at 65% of VO_2max for 40 min in a controlled hot (36.37+0.58C) humid environment (59.46+5.14% RH). The results indicated no significant difference between groups for core body temperature or heart rate at any time point, except for an elevated heart rate (HR) five minutes post-exercise in the CAFF group when compared to PLAC. A significant increase in HR from pre-exercise to 40 min was observed in both groups, but CAFF consumption elicited no synergistic effects on HR or core body temperature before, during, or after exercise. This study suggests that caffeine consumption does not impair thermoregulation in a hot, humid environment. Caffeine consumption did result in a blunted HR recovery for the first five minutes post-exercise test, possibly indicating a greater degree of heat stress in the CAFF group. Future directions for research could involve cycling for longer durations (> 60 min) to examine if the diminished HR recovery in the CAFF subjects would become more pronounced. In addition, comparing subjects who were regular users of caffeine versus subjects who were caffeine naïve might be useful, as caffeine tolerance could affect responses.

Body composition was also addressed in various studies. Like the United States Air Force, (USAF) the United States Navy (USNAV) now uses abdominal circumference (AC) measurements, rather than Department of Defense-determined anthropomorphic body fat equations to assess body composition. One study tested whether differing AC measurement sites could be used with equivalent accuracy or not (18). The USAF and USNAV currently assess AC by using the iliac crest (IC) as a marker. This study tested the validity of measuring AC at the umbilicus (UMB) compared to the IC. UMB and IC measurements were taken on 115 subjects (79 males and 36 females) using a retractable tape measure. Three measurements were taken at both sites by the same researcher. Results indicated a high correlation between UMB and IC measurements in both males and females, and supports the use of the UMB as an alternate (and easier to locate) AC measuring site. Though this study did find that the UMB is a valid measuring site for AC, it did not address other problems with the AC test, which render the results invalid. The upper standards for passing are very lenient; previous research indicates that 95% of Air Force males with an AC > 35 in. and 98% of Air Force females who have an AC > 35.5 in. have unhealthy levels of body fat (11).

The second major problem with the AC test is that for it to have any validity, AC must be independent of skeletal height (8). Recent research demonstrates this assumption is incorrect; when adjusted for age and ethnicity, AC significantly correlates with height in males and females (8). Taller males/females have wider AC measurements because they are taller, not because they are fatter. In this case, assuming a single AC cutoff standard independent of height would result in subjects being misclassified as unhealthy when they are not. In addition, taller subjects might unfairly fail a fitness test component. Future research directions include directly comparing AC measurements with indices of cardiometabolic disease (cholesterol, fasting glucose, etc.) to more accurately determine AC cutoffs, which are indicative of a need for lifestyle intervention.

Another study examined relationships between various body composition ratios as determined via air displacement plethysmography and self-reported physical activity (10). Subjects consisted of males (n = 604) and females (n = 343) in the Air Force. Bod Pod® results were used to identify fat mass (FM), fat-free mass (FFM) and %fat. Subjects were stratified into four age groups, and into four activity groups (sedentary, low active, active, and very active). In addition to body mass index (BMI), fat-free mass index (FFMI) and fat mass index (FMI) were determined by evaluating each component relative to height (kg/m^2). Regardless of sex, BMI, FMI, and %fat were significantly higher in those groups reporting lower levels of physical activity than those groups which reported higher levels of physical activity. In addition, among age groups, FFMI and %fat were significantly different, and were higher/lower in the youngest age group compared with the oldest. An activity by age group (4 x 4) multivariate analysis of variance (MANOVA) was performed on each sex. In men, BMI, FMI and %fat were significantly different ($p < 0.001$) among activity and age groups. In women, BMI, FMI, and %fat were significantly different ($p < 0.007$) among activity groups.

Discriminant analysis identified FMI as the best discriminator of activity group in each sex. Interestingly, though FFMI differed by age, FFMI did not differ by activity group. This may indicate that Air Force personnel are engaging in suboptimal levels of resistance training, which would explain the independence of FFMI relative to activity group. This result is consistent with previous data indicating that a significant number of Air Force males and females have lower than desired amounts of FFM relative to BMI and abdominal circumference and might therefore be classified as "skinny fat" (11).

One study tested the use of heart rate reserve (the difference between resting heart rate and maximal heart rate, or HRR) as an objective measure of United States Army soldiers' physical exertion during field operations (5). Thirty-eight Army male soldiers volunteered for the six-session study. While wearing a HR monitor, they participated in three trials (one trial per session) of an experimenter-paced, 4.83-km foot march (FM) at a 4.83 km/h-1 speed and three trials (one trial per session) of a self-paced, maximum effort run of an obstacle course (OC) while carrying various military loads, which were randomized on each trial. In addition, maximum heart rate (MHR) was obtained in the last 20 s of VO_2peak testing. Resting heart rate (RHR) was recorded in the final 20 s of a five-minute period of sitting prior to trial initiation. The highest HR in a trial (MHRtrial) was also identified, and %HRR was calculated: ([MHRtrial-RHR]/[MHR-RHR]) x 100. On the FM, completion time was not significantly affected by load, though %HRR increased significantly with each load increase. On the OC, completion time increased significantly with each load increase, but HRR did not show a specific load effect. Based on this research %HRR could be utilized as a way to track operational performance in a downrange setting.

A related study examined factors which predict field march performance (FMP) (4). Two hundred and thirty relatively fit subjects participated in a one-day military school selection tryout that culminated with an approximate 8.5-mile FMP carrying a load of approximately 35 lb on terrain including several elevation changes each of at least 500 ft. Analysis revealed that service academy career two-mile run time (2MR) was the most potent factor impacting FMP; multiple R = .79, adjusted R2 = .62. Threshold measures appeared to be present; 12:30 or faster 2MR (13 vs. 0 subjects) and 2:38 or faster on an indoor obstacle course test (IOCT; 15 vs 2 subjects) resided in the top 10% fastest FMP group (4). Neither body mass or number of pull-ups impacted FMP. With an adjusted R2 = .62, that leaves 38% of the variance in FMP unaccounted for (4).

Multiple presentations addressed various aspects of physical training. One study described kinematic changes over a two-minute continuous push-up assessment (7). Video recordings were made of 26 males from a military service academy to investigate changes in body positioning throughout the push-up test. The researchers focused on hand height (HH), distance the hand was in position relative to the shoulder; hand width (HW), distance between the 3rd metacarpophalangeal joint of each hand; and torso angle (TOR), angle of the torso to the horizontal axis. Three consecutive repetitions at the start/end of the bout were averaged for HH, HW, and TOR and analyzed. Both HH and TOR significantly decreased at the end of the bout, while HW significantly increased. The authors concluded that, "as participants became tired, they assumed a body position that likely allowed for a greater percentage of their body weight to be supported by their lower body (i.e., hands wider and closer to the shoulder with greater hip flexion)," (7). The authors suggested that strengthening the primary muscles (e.g., pectoralis, triceps brachii, and abdominals) used in this test might correct the kinematic changes observed (7). Future research could investigate female subjects, as it is possible there are gender-specific kinematic compensation patterns.

Another study looked at training strategies relative to United States Marines completing an Assessment and Selection (A&S)

course prior to becoming a United States Marine Corps Special Operations (MARSOC) Raider, as well as training for a nine-month Individualized Training Course (ITC) post-MARSOC selection (15). FFM, FM, anaerobic power (AP), anaerobic capacity (AC), aerobic capacity (VO_2max), knee flexion (KF), knee extension (KE), shoulder internal rotation (SIR), shoulder external rotation (SER), trunk extension (TE), and trunk flexion (TF) isokinetic strength were collected in a sample of 27 Marines at two time points: following A&S and directly prior to ITC. The results indicated no significant differences in any of these measures between A&S and the start of ITC. From this, the authors concluded that "performance characteristics were similar following selection and prior to the start of ITC, suggesting the current training strategies, as implemented and adopted for the varying time gaps post A&S, were effective at maintaining performance between courses," (15). Follow-up studies might wish to address potential differences in injury rates prior to MARSOC and the ITC.

In January 2017, the Uited States Army employed the Occupational Physical Assessment Test (OPAT) to determine the physical readiness of recruits (RCs) prior to initial entry training (IET). The OPAT consists of the standing long jump (SLJ), seated power throw (SPT), strength deadlift (SDL) and an interval aerobic run (IAR). This study attempted to discern whether performance on the OPAT was correlated to measures of psychological hardiness, as the former has been documented to predict recruit success (3). 945 United States Army male combat arms RCs performed the OPAT and completed the Dispositional Resilience Scale-Military (DRS-II-M) questionnaire, a validated 24-item, 5-point Likert scale (1 = definitely false to 5 = definitely true) measure. Both were completed within the first week of IET. The DRS-II-M provides three positive (control, commitment, and challenge) and three negative (alienation, powerlessness, and rigidity) hardiness dimensions. RCs were divided into two groups: one who achieved the OPAT black level score (n = 636) and those that did not (n = 309). RCs who scored at the black level on the OPAT scored higher on positive hardiness dimensions and significantly lower on negative hardiness dimensions relative to those that did not. This research suggests that RCs who score high on the OPAT also have increased hardiness, suggesting they will be successful in meeting the physical and psychological demands of combat arms positions. It would be interesting to replicate this with other tactical populations, to see if this relationship holds for other groups (Navy SEALs, Air Force Special Operations, etc.).

Predicting injury risk is of paramount importance in military populations, as injuries have significant effects on readiness (14). One study assessed injury risk in United States Navy Explosive Ordnance Disposal (EOD) operators (6). Fifty-one active duty men (age 35.6 + 1.0 yr) were evaluated for body fat percentage (BF%) using dual-energy x-ray absorptiometry, maximum oxygen consumption (VO_2max), muscular strength (one-repetition max [1RM] back squat and bench press), and injury risk assessments (Functional Movement Screen [FMS™] and Y-balance test [YBT]). A quartile split for VO_2max established the bottommost, low, high, and topmost VO_2max groups. Analysis of variance (ANOVA) and Pearson product-moment correlations were used to evaluate fitness and injury risk associations. Results indicated that FMS and YBT scores significantly ($p = < .01$) differed by quartiles, with the bottommost VO_2max group having the lowest scores. BF% was associated with FMS ($r = -.33$, $p < .05$) and YBT scores ($r = -.37$, $p < .01$). No associations were observed with 1RM. The authors concluded that "this study is consistent with accruing data that indicate more fit individuals have a lower injury risk," (16).

Research presented at conferences such as the National Strength and Conditioning Association (NSCA) and ACSM provide the scientific foundation for evidence-based training and nutrition of military personnel. It is exciting to see more and more presentations with this focus. The ever-widening scope of this research also enables the fine tuning of operational performance to a degree not possible even five years ago. This type of information is critical in enabling tactical populations to successfully accomplish their missions.

REFERENCES

1. Bach, CW, and Ransone, JW. Caffeine does not increase heat stress during endurance exercise in a hot, humid environment. *Medicine and Science in Sports and Exercise* 50(5): S599, 2018.

2. Bushman, TT, Grier, TL, Canham-Chervak, M, et al. The Functional Movement Screen: Association and predictive value in active men. *American Journal of Sports Medicine* 44(2): 297-304, 2016.

3. Cohen, B, Foulis, S, Canino, M, et al. Psychological hardness and success on the occupational physical assessment test in Army combat arms soldiers. *Medicine and Science in Sports and Exercise* 50(5): S733, 2018.

4. Crowder, TA, and Rapuano, SK. Factors impacting field march performance of U.S. service academy cadets. *Medicine and Science in Sports and Exercise* 50(5): S734, 2018.

5. Hasselquist, L, Hancock, CL, and Bensel, CK. Heart rate reserve: An objective measure of soldiers' physical exertion during field operations. *Medicine and Science in Sports and Exercise* 50(5): S732, 2018.

6. Hernandez, LM, Coffin, SD, and Taylor, ML. Greater fitness is associated with reduced injury risk in specialized military men. *Medicine and Science in Sports and Exercise* 50(5): S730, 2018.

7. Hewit, J. Altered kinematics over a 2-minute continuous push-up assessment. *Medicine and Science in Sports and Exercise* 50(5): S613, 2018.

8. Heymsfield, SB, Heo, H, and Pietrobelli, A. Are adult body circumferences associated with height? Relevance to normative ranges and circumferential indices. *American Journal of Clinical Nutrition* 93: 302-307, 2011.

9. Knapik, JJ, Austin, KG, and McGraw, SM, et al. Caffeine consumption among active duty United States Air Force personnel. *Food Chemistry and Toxicology* 105: 377-386, 2017.

10. Leahy, GD, Crowder, TS, and Mayhew, JL. Body composition indices to classify activity levels in Air Force men and women. *Medicine and Science in Sports and Exercise* 50(5): S736, 2018.

11. Leahy, G, Friederich, D, Crowder, T, et al. Relationship of abdominal circumference and body mass index to body composition in Air Force men and women. *Journal of Strength and Conditioning Research* 28(Supp 2): S104-S105, 2014.

12. Leahy, G. Functional movement screening and the tactical athlete. *TSAC Report* 26: 9-12, 2013.

13. Margolis, LM, Barringer, ND, McClung, HL, et al. Prediction equation for estimating total daily energy requirements of Special Operations personnel. *Medicine and Science in Sports and Exercise* 50(5): S638, 2018.

14. Molloy, JM, Feltwell, DN, Scott, SJ, et al. Physical training injuries and interventions for military recruits. *Military Medicine* 177(5): 553-558, 2012.

15. Royer, SD, Winters, JD, Poploski, K, et al. Training strategies maintain performance characteristics for Marine Corps Special Operations individualized training course. *Medicine and Science in Sports and Exercise* 50(5): S781, 2018.

16. Savonen, K, Krachler, B, Hassinen, M, et al. The current standard measure of cardiorespiratory fitness introduces confounding by body mass: the DR's EXTRA study. *International Journal of Obesity* 36: 1135-1140, 2012.

17. Smith, CA, Chimera, NJ, and Warren, M. Association of Y-balance test reach asymmetry and injury in Division I athletes. *Medicine and Science in Sports and Exercise* 47(1): 136-141, 2015.

18. Wilson, KM, Jones, DM, Mandel, MP, et al. Abdominal circumference measurements in an U.S. Navy Active Duty population. *Medicine and Science in Sports and Exercise* 50(5): S735, 2018.

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