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BOOTS ON THE GROUND

WHAT HAVE WE LEARNED? A RETROSPECT ON THE PAST 10 YEARS WORKING AS A TSAC-F

The tactical strength and conditioning field is evolving each year. Over a decade ago, we based much of our knowledge and experience from those working in athletics and/or performance training. We are seeing more jobs and opportunities, as well as more studies on tactical research. Because of the experience of those in the field, we are gaining a better understanding of what it actually means to work within the tactical field. I have had many learning experiences over the past decade working as a Tactical Strength and Conditioning Facilitator® (TSAC-F®) and this article summarizes some of the lessons I have learned.

In 2007, I had my first opportunity to work full time as a tactical facilitator for a fire department with roughly 600 members. Like many young coaches starting out, I was ambitious and eager. I had the qualifications on paper and all the credentials after my name. I thought I was ready to help the firefighters become athletes. What I did not realize at the time was how ignorant and naive I was.

THEY ARE NOT ATHLETES, THEY ARE TACTICAL ATHLETES

My first mistake came from thinking the firefighters were just athletes. After a few months on the job, I had my first opportunity to create an exercise program for a probationary firefighter. I was excited and went back to all my books and research. I developed what I felt to be the best program for the firefighter. It included everything: a dynamic warm-up, core exercises, and functional strength and conditioning exercises. When I was done, I looked at the program as my masterpiece and could not wait for him to praise me; I was so wrong. The firefighter looked at the workout and proceeded to give me an odd look and say, “what is this?” and I replied, “your workout.” Then he just said, “whatever” and left my office. I was crushed and disappointed that I missed my opportunity to help him.

What did I do wrong? I misunderstood the phrase “tactical athlete.” I focused on the word “athlete” and not the entire phrase. According to the Merriam-Webster Dictionary, the definition of an athlete is “a person who is trained or skilled in exercises, sports, or games requiring physical strength, agility, or stamina,” (1). Yet, not all tactical athletes require these same skill sets throughout their career. For example, a firefighter may require more athletic skills on a fire, but a division chief of training may require more wellness or nutrition. In other words, I was too narrow minded and realized my skill set as a coach was very limited. I did not understand that firefighters have a normal life outside of their occupation, often consisting of family commitments, second jobs, and extracurricular activities that can impact their strength and conditioning program.

This was an important lesson and it changed my perspective. I had to change my approach from only a performance-based model to an all-inclusive model that also encompassed health, wellness, and injury prevention components. I realized it was not always about getting bigger, faster, or stronger, but rather developing a systematic approach that focused on performance during the early stages of their career and improved wellness for longevity for when they transition into the latter stages of their careers.

IT IS ABOUT PERFORMANCE AND MORE

As previously stated, performance is one requirement, but it also depends on the specific tactical population. If you are working with an individual who is in the military or law enforcement, they may want to try for a specialized unit; in this case, you should focus your performance program on the assessments required of that specific specialized unit. In addition, you may need to maintain their fitness levels so that they can remain on that specialized unit. However, not all tactical athletes are in need of this type of performance training, some tactical athletes just need something that will get them moving again. What I started to understand was that there are subgroups within the tactical population, and not everyone requires the same training methods. A Certified Strength and Conditioning Specialist® (CSCS®) will incorporate all aspects of performance (e.g., recovery, mobility, flexibility) to optimize the athlete’s abilities on the field, but some tactical subgroups may just need one aspect to help improve their wellbeing, not performance. For example, a law enforcement officer working in cyber-crime may need more nutritional help on selecting better food choices while a helicopter pilot may require more mobility to offset the amount of time spent in a crouched position. Overall, I learned that performance and exercise may not always be the highest priority for all tactical athletes; therefore, I had to develop a method that provided priorities based on their needs without overwhelming them.

SCIENCE IS STILL THE FOUNDATION

One enormous mistake I made in the beginning of my career was not looking at tactical athletes’ job tasks appropriately. When I watched a law enforcement officer or firefighter, I just assumed everything was done with 100% effort. Therefore, I made a lot of high-intensity power training workouts. Over time, I realized that I neglected their strength. My programming was poor and I was not applying the basic scientific principles associated with performance training. Another issue associated with my poor programming was that the high-intensity power workouts became a "test of heart" instead of science. This created a ripple effect throughout the department and extreme conditioning programs were being implemented by unqualified professionals. The tactical athletes were beginning to think that the harder the workout, the better you are as a "tactical athlete," but this is not always the case. I realized that I was being irresponsible by not apply scientific programming, which lead me to often hear, "well that's what you did coach." I came to understand that if I did it, it was assumed that it was safe and effective; so I had to come back to the basic principles of exercise science.

IT IS ALSO ABOUT HEALTH, WELLNESS, AND INJURY PREVENTION

A decade ago, we focused a lot of our efforts on performance. Now we are coming to understand the value of other areas too, such as heart disease, sleep disorders, stress, type 2 diabetes, and mental health. Although these areas are important in the athletic field, they have a slightly different role in the tactical setting. In defense of those working a decade ago, we had only one place to gain our knowledge and that was from working with athletes. Present day, our role as TSAC-Fs has grown from a performance-based model to a more holistic approach. We are coming to understand the job for the tactical athlete much better and realize it is difficult on multiple fronts (e.g., sleep disruptions, exposure to constant negatives, hormonal imbalances, aging, family). As TSAC-Fs, we are trying to educate ourselves on the other previously mentioned areas while still maintaining our base of strength and conditioning.

CONCLUSION

I have been involved with the National Strength and Conditioning Association (NSCA) TSAC Program since 2008, spent 10 years working in the tactical field, and have met many knowledgeable subject matter experts who have contributed significantly to the tactical field by sharing their knowledge and experience. Learning from others and sharing this knowledge is what allows for the entire industry to improve as a whole. Our future has an amazing road ahead. We need to remember where we came from so we do not lose focus of where we are going. In the end, I foresee all this experience and research that has been accumulated over the past decade will help continue our success, along with the continued collaboration between researchers and practitioners, and an open network of professionals sharing ideas will allow for all TSAC-F to help those serving in tactical occupations.

REFERENCES

1. Athlete. Merriam-Webster Dictionary. Retrieved 2018 from https://www.merriam-webster.com/dictionary/athlete.

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John Hofman is one of the leading experts in the field of firefighter health and wellness and currently serves as the Tactical Strength and Conditioning Specialist at Southern California University Health System (SCU). Prior to going SCU, Hofman spent 10 years as the Strength and Conditioning Coach for the Sacramento Fire Department, where he oversaw the Wellness Centre; coordinated the department's medical and fitness assessments; developed recruit fitness training, pre-employment medical, and fitness evaluations; and assisted with the department's 20-certified Peer Fitness Trainers. Hofman was named the 2018 TSAC Facilitator of the Year by the NSCA.

CONFLICT OF INTEREST STATEMENT

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

PRACTICAL ASSESSMENTS OF POWER FOR LAW ENFORCEMENT POPULATIONS

INTRODUCTION

Upper- and lower-body power are essential qualities for law enforcement officers (LEOs). The foundations for power are force (which relates to maximum strength) and velocity (or movement speed), with jumping a fence during a foot pursuit being an example of a job duty task. When on-duty, LEOs may be required to push, pull, lift, drag, jump, vault, sprint, and use force during their shift (6). Tasks, such as carrying or dragging an object or person to safety, jumping or vaulting a fence, and pursuing a suspect, all depend at least partially on power. Power is the ability to generate force over a short duration of time (8). Specific training programs, such as those that incorporate strength training, Olympic lifting, plyometrics, and sprint training, can be utilized to enhance both upper- and lower-body power (10,13,16). Training programs that use heavy resistance can help build a foundation of strength. Exercises that place a greater emphasis on movement speed (e.g., plyometrics) help develop the ability to express strength and force generation quickly, which can encourage power improvements.

Appropriate assessments are important to incorporate within training programs as well. The correct and valid assessment of certain physical qualities guides exercise prescription, establishes training goals, and serves as a motivational tool for the individual (11). Crawley et al. highlighted the need to evaluate the physical fitness of LEOs prior to training, and this included the assessment of power (3). A challenge for training physical fitness of LEOs, whether at the recruit level or for seasoned incumbents, is the lack of available training time individuals have due to either job-specific training or occupational demands (25). As a result, implementing regular physical assessments can be difficult, as it may take away from time otherwise used for training. It is suggested it could be useful for the tactical facilitator to adopt assessments that are relatively quick to perform, and could, in some instances, be incorporated into the training program as an exercise. This allows the tactical facilitator to not only assess a measure of power, but also to simultaneously train this capacity within the context of the current program.

This article will detail several different indirect assessments of power that could be adopted by the tactical facilitator in the programming of LEOs. For these assessments, jump height and distance, or throw distance, are used as the surrogate measure for power. The focus for this article will be on jump or throw assessments, as opposed to running assessments. The following are five assessments that will be presented:

1. Vertical jump (VJ)
2. Standing broad (or long) jump (SBJ)
3. Lateral jump (LJ)
4. Seated medicine ball throw (MBT)
5. Backwards overhead medicine ball throw (BOMBT)

The specific capacity measured by each assessment, the potential value of the assessment and how it relates to physical performance, and the execution of each assessment will be described. Furthermore, as minimal equipment is required for the SBJ, LJ, MBT, and BOMBT, these assessments could be programmed as exercises, with the assessment taking place within the first 2 – 3 repetitions of the exercise. This will save time for tactical facilitators and LEOs that may not have the luxury of scheduling assessment-only days.

VERTICAL JUMP

The VJ is arguably the most popular power assessment used for LEOs (3,5,7,19,23,24). This may, in part, be due to it having high test-retest reliability (intra-class correlation coefficient [ICC] > 0.99) (2). This assessment is commonly used to indirectly assess power in the vertical plane, and better VJ performance has been related to faster running speeds in both men and women (correlation coefficient [r] = -0.56) (4,5,29). Specific to law enforcement, Dawes et al. found that superior VJ performance related to faster 20-m sprint performance in part-time Special Weapons and Tactics (SWAT) officers (r = -0.36 to -0.62), which could influence how effective an officer will be during the pursuit of a suspect (5). The VJ can be measured by markings on a wall, a jump mat, or a Vertec apparatus (2,5,16,17,18,28). A jump mat, such as that utilized by Dawes et al. in the assessment of part-time SWAT officers, costs approximately USD $600 and Vertec devices generally cost between USD $600 – 700 (5). The tactical facilitator should consider the long-term use of the devices if they are considering purchasing either for their facility.

The description of the VJ assessment provided here relates to the use of a Vertec. Figure 1 demonstrates the VJ being measured with a Vertec device, including the measurement of standing reach height, the preparatory countermovement position, and the measurement of maximum jump height. Nonetheless, similar instructions can be provided with a jump-and-reach style test when performed with wall markings or a jump mat (5,28). The VJ assessment should be performed as follows (16,17,18):

- The individual should stand side-on to the Vertec (on the individual's dominant side so they can reach with their preferred arm). While keeping their heels on the floor, they are instructed to reach upward as high as possible, fully elevating the shoulder, and displacing as many vanes as possible. The last vane moved becomes the zero reference (Figure 1A).

- The individual should then jump as high as possible using a countermovement, arm swing, and two-foot take-off with no preparatory step (Figure 1B) and displace the highest vane possible (Figure 1C). If the individual has never performed this type of jump before, the tactical facilitator should consider using an instruction or familiarization session prior to administering the assessment. The individual does not have to hit the vanes hard, they just need to tap them hard enough to displace the vanes. Generally, no restrictions are placed on the range of countermovement and arm swing, especially if the individual is instructed to jump for maximum height. One major difference for jump testing with Vertec when compared to a jump mat is that the individual will need to sight the vanes by looking up to view their target. When testing with a jump mat, the individual will have a more neutral cervical spine as they will face forwards the whole time during the jump.
- Height is recorded in centimeters or inches (depending on the make and model of the Vertec device) from highest vane moved. VJ height is calculated by subtracting the standing reach height from the jump height.

STANDING BROAD JUMP

The SBJ is primarily used as an assessment of power in the horizontal plane as it is a reliable test (ICC = 0.95) (16,17,18,21). Although this test has similarities to the VJ, the SBJ places a greater emphasis on horizontal projection. Indeed, better performance in this test has also been linked to faster running speeds in trained individuals, which could again influence how well a LEO can complete a task such as the pursuit of a suspect (1,13). Horizontal power can also assist within the actions required for a body drag, tackling a suspect, or performing a door breach. Lower-body power can also be directionally-specific (just because an individual can generate high power vertically does not always mean they can do so horizontally), so if the tactical facilitator has the time and resources, they may consider assessing both the VJ and SBJ (22). A specific SBJ mat can be used for this test, although the cost for this type of equipment can range anywhere from USD $70 – 400. In lieu of this expense, the tactical facilitator can affix a tape measure to the ground (approximately USD $20 in cost) and use that to measure the jump. This version of the test is shown in Figure 2, which displays the starting countermovement position, the landing position, and how the measurement is taken from the rearmost heel. The SBJ should be performed as follows (16,17,18):

- The individual should place the toes of both feet on the back of the start line.
- With a simultaneous arm swing and countermovement (Figure 2A), the individual should then leap as far forward as possible and land with two feet. The individual needs to “stick” the landing (i.e., not overbalance) in order for the attempt to be counted (Figure 2B).

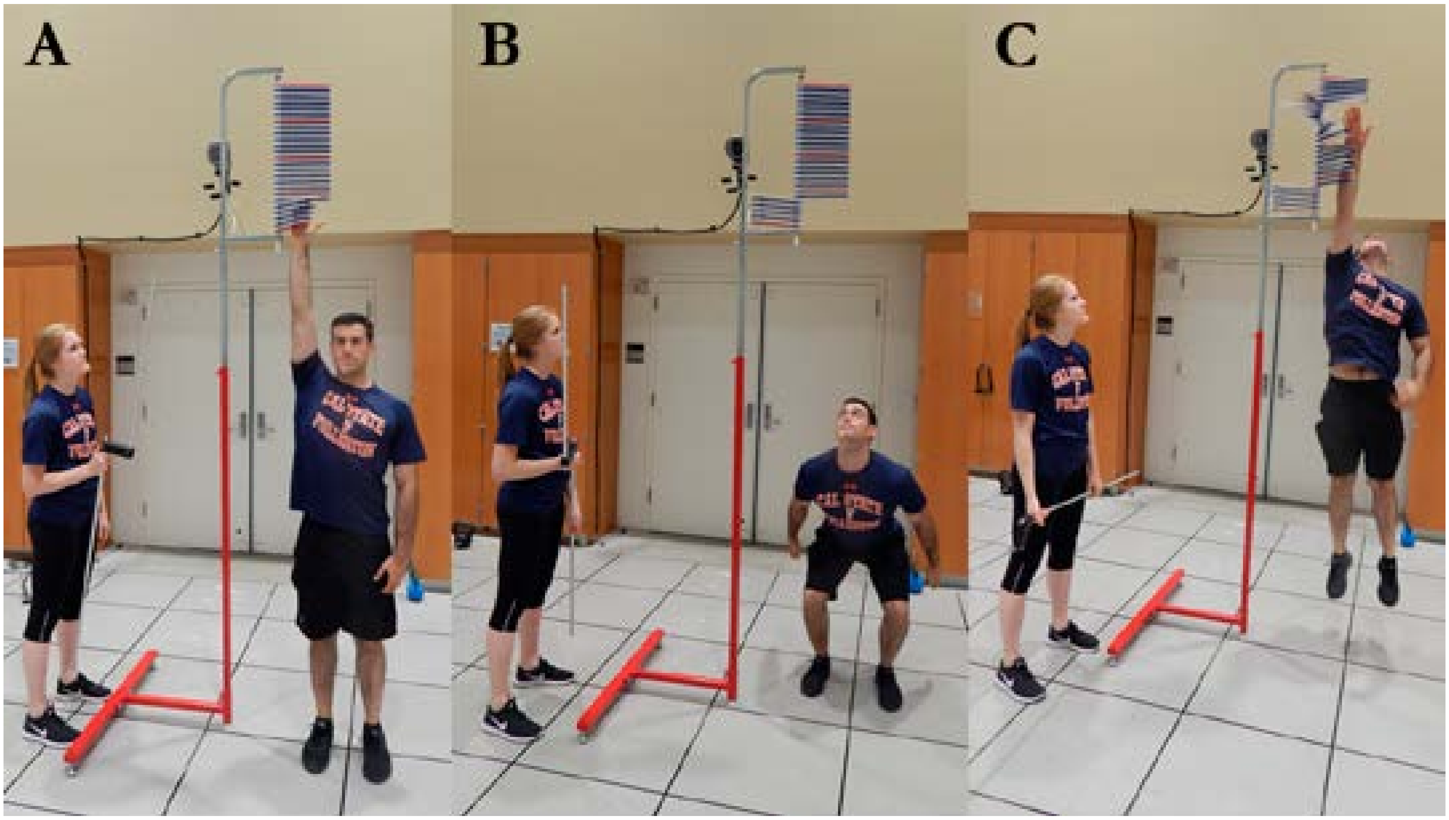

FIGURE 1. VERTICAL JUMP PERFORMED WITH A VERTEC DEVICE

- The distance is measured perpendicularly from the front of the start line to the back of the rearmost heel at landing (Figure 2C).

LATERAL JUMP

The LJ is a less frequently used assessment of power, especially when compared to the VJ and SBJ. However, this assessment affords a measure of power in the lateral plane, is reliable (ICC = 0.91-0.97), and better performance in this test has been related to faster multidirectional (i.e., linear and change-of-direction) running speed (r = -0.45 – 0.72) (15,22). Law enforcement agencies often use some form of a change-of-direction and agility test in their screening process, so better LJ performance could influence performance on that type of task (19). The assessment is typically performed from a unilateral stance, and performance can be measured via a tape measure affixed to the ground. Figure 3 displays the preparatory countermovement starting position, and the subsequent landing position and jump measurement. The LJ should be performed as follows (16,17,18):

- The individual should start by standing on the testing leg with the inside of the foot at the start line (for example, for a left-leg jump, the inside of the left foot should be placed on the start line) (Figure 3A).
- The individual should then perform a countermovement before jumping laterally inside as far as possible, and landing on two feet. The individual must "stick" the landing and not overbalance for the attempt to be counted (Figure 3B).
- The distance jumped is measured perpendicularly from the start line to the outside of the take-off leg (i.e., for a left-leg jump, this is the outside of the left foot) (Figure 3B). The tactical facilitator should assess both legs.

SEATED MEDICINE BALL THROW

The MBT isolates upper-body power, has been utilized to assess the upper-body power of law enforcement agency recruits prior to academy training, and has high test-retest reliability (ICC > 0.95) (9,20). Better upper-body power as measured by the MBT could prove beneficial when a LEO has to physically engage with a suspect, and has been used to delineate between recruits by sex and age (6,20). In their study of law enforcement agency recruits, Lockie et al. utilized a two-kilogram ball (20). Hand chalk can be useful for this test, so that the ball can be lightly dusted to aid with grip and to indicate the landing spot of the ball. The MBT is performed with the individual seated against a wall. A tape measure is run from the wall against the ground (the zero point is level with the wall). The assessment is displayed in Figure 4, which displays the start and finish positions for the MBT. The MBT should be performed as follows (14,20):

- The individual should sit on the ground with their head, shoulders, and lower back against a wall. Their legs should then be extended horizontally on the floor in front of the body. This position should be maintained throughout the throw.
- The ball should be gripped with two hands (similar to a chest pass in basketball). The ball should then be brought to the chest such that the elbows are at the sides of the body (Figure 4A). The individual should then project the ball at an approximate 45° angle as far as possible by extending the arms; the head, shoulders, and lower back should not move from the wall (Figure 4B). If the head, shoulders, or lower back does lose contact with the wall, the trial should be reattempted.
- The measurement is taken as the perpendicular distance from the wall to the chalk-marking closest to the wall made by the ball.

BACKWARDS OVERHEAD MEDICINE BALL THROW

The BOMBT is used as a measure of total-body power, and has high test-retest reliability (ICC > 0.99) (26). Better performance has been stated to indicate greater coordination between the lower- and upper-body in the generation of power, and this could be of benefit to multidirectional speed due to the need to generate lower-body power (12,27). The movement patterns required in the BOMBT, while incorporating some aspects similar to the VJ and MBT, provide a different measure of power. A three-kilogram ball has been used in the analysis of athletic populations, and would also have application for LEOs, as it can indicate how well an individual can coordinate the lower- and upper-body in

FIGURE 2. STANDING BROAD JUMP

FIGURE 3. LATERAL JUMP

the generation of power (12,27). This can relate to tasks such as a body drag, pushing or tackling a suspect, or breaching a door using a battering ram. Like with the MBT, the ball can be lightly dusted with chalk to assist with grip and to mark the landing spot for the distance measurement. A tape measure can be affixed to the ground and run from the start line to measure the throw distance. Figure 5 exhibits the BOMBT, including the start, countermovement, and ball release position. While this assessment may have great application to LEOs, the tactical facilitator should be aware that certain individuals and their requisite job duties may not require the specificity of the movements in the BOMBT, and certain physical limitations (e.g., pre-exiting shoulder injuries) may preclude their ability to complete this assessment. The BOMBT should be performed as follows (12):

- The individual should stand with their back to the throwing area, their feet shoulder-width apart, and heels on the start or zero line. To start the throw, the medicine ball is held in front of the body, with the arms extended at shoulder height (Figure 5A).
- In one continuous movement, the individual should flex at the hips, knees, and trunk, lowering the ball below waist height (Figure 5B). The individual should then extend the hips, knees, and trunk, and thrust the hips forwards while flexing the shoulders and elevating the ball above shoulder height to throw it back over their head as far as possible. The individual's feet can leave the ground at the end of the throw, as would happen with a jumping action (Figure 5C).
- The measurement is taken as the perpendicular distance from the start/zero line to the chalk-marking closest to the start/zero line made by the ball.

CONCLUSION

This article conists of five assessments that could be utilized by the tactical facilitator to measure upper- (MBT), lower- (VJ, SBJ, and LJ), and total-body (BOMBT) power in LEOs. Although the focus of this article is LEOs, the assessments could also be used for other tactical populations. It should also be acknowledged that these assessments are not the only ones that could be used to assess power, and there are other variations that may be applicable for different individuals. For example, the VJ, SBJ, and MBT can be adapted to become unilateral assessments, in addition to the bilateral versions presented in this article (14,15,22). Nonetheless, the information contained will allow the tactical facilitator to make better decisions with specific assessments that are appropriate for their program, considering the desired training outcomes, time constraints, and available equipment.

REFERENCES

1. Baker, JS, and Bell, W. Anaerobic performance and sprinting ability in elite male and female sprinters. *Journal of Human Movement Studies* 27(5): 235-244, 1994.

2. Beck, AQ, Clasey, JL, Yates, JW, Koebke, NC, Palmer, TG, and Abel, MG. Relationship of physical fitness measures vs. occupational physical ability in campus law enforcement officers. *Journal of Strength and Conditioning Research* 29(8): 2340-2350, 2015.

3. Crawley, AA, Sherman, RA, Crawley, WR, and Cosio-Lima, LM. Physical fitness of police academy cadets: Baseline characteristics and changes during a 16-week academy. *Journal of Strength and Conditioning Research* 30(5): 1416-1424, 2016.

4. Cronin, JB, and Hansen, KT. Strength and power predictors of sports speed. Journal of Strength and Conditioning Research 19(2): 349-357, 2005.

5. Dawes, JJ, Orr, RM, Elder, CL, Krall, K, Stierli, M, and Schilling, B. Relationship between selected measures of power and strength and linear running speed amongst Special Weapons and Tactics police officers. *Journal of Australian Strength and Conditioning* 23(3): 23-28, 2015.

6. Dawes, JJ, Orr, RM, Siekaniec, CL, Vanderwoude, AA, and Pope, R. Associations between anthropometric characteristics and physical performance in male law enforcement officers: A retrospective cohort study. *Annals of Occupational and Environmental Medicine* 28(26): doi:10.1186/s40557-40016-40112-40555, 2016.

7. Dawes, JJ, Orr, RM, Flores, RR, Lockie, RG, Kornhauser, C, and Holmes, R. A physical fitness profile of state highway patrol officers by gender and age. *Annals of Occupational and Environmental Medicine* 29: doi:10.1186/s40557-40017-40173-40550, 2017.

8. Haff, GG, and Nimphius, S. Training principles for power. *Strength and Conditioning Journal* 34(6): 2-12, 2012.

9. Harris, C, Wattles, AP, Debeliso, M, Sevene-Adams, PG, Berning, JM, and Adams, KJ. The seated medicine ball throw as a test of upper body power in older adults. *Journal of Strength and Conditioning Research* 25(8): 2344-2348, 2011.

10. Hoffman, JR, Cooper, J, Wendell, M, and Kang, J. Comparison of Olympic vs. traditional power lifting training programs in football players. *Journal of Strength and Conditioning Research* 18(1): 129-135, 2004.

11. Hoffman, JR. Athlete testing and program evaluation. In: Hoffman, JR (Ed.), *NSCA's Guide to Program Design*. Human Kinetics: Champaign, IL; 23-49, 2012.

12. Lockie, RG, Jeffriess, MD, Schultz, AB, and Callaghan, SJ. Relationship between absolute and relative power with linear and change-of-direction speed in junior American football players from Australia. *Journal of Australian Strength and Conditioning* 20(4): 4-12, 2012.

13. Lockie, RG, Murphy, AJ, Schultz, AB, Knight, TJ, and Janse De Jonge, XA. The effects of different speed training protocols on sprint acceleration kinematics and muscle strength and power in field sport athletes. *Journal of Strength and Conditioning Research* 26(6): 1539-1500, 2012.

14. Lockie, RG, Callaghan, SJ, Jordan, CA, Luczo, TM, and Jeffriess, MD. Does the trunk stability push-up provide an effective measure of upper-body function specific to male team sport athletes? *Journal of Athletic Enhancement* 2(4): doi:10.4172/2324-9080.1000120, 2013.

15. Lockie, RG, Callaghan, SJ, Berry, SP, Cooke, ER, Jordan, CA, Luczo, TM, and Jeffriess, MD. Relationship between unilateral jumping ability and asymmetry on multidirectional speed in team-sport athletes. *Journal of Strength and Conditioning Research* 28(12): 3557-3566, 2014.

16. Lockie, RG, Schultz, AB, Callaghan, SJ, and Jeffriess, MD. The effects of traditional and enforced stopping speed and agility training on multidirectional speed and athletic performance. *Journal of Strength and Conditioning Research* 28(6): 1538-1551, 2014.

17. Lockie, RG, Schultz, AB, Callaghan, SJ, Jordan, CA, Luczo, TM, and Jeffriess, MD. A preliminary investigation into the relationship between functional movement screen scores and athletic physical performance in female team sport athletes. *Biology of Sport* 32(1): 41-51, 2015.

18. Lockie, RG, Schultz, AB, Jordan, CA, Callaghan, SJ, Jeffriess, MD, and Luczo, TM. Can selected functional movement screen assessments be used to identify movement deficiencies that could affect multidirectional speed and jump performance? *Journal of Strength and Conditioning Research* 29(1): 195-205, 2015.

19. Lockie, RG, Dawes, JJ, Kornhauser, CL, and Holmes, RJ. A cross-sectional and retrospective cohort analysis of the effects of age on flexibility, strength endurance, lower-body power, and aerobic fitness in law enforcement officers. Published ahead of print. *Journal of Strength and Conditioning Research* doi:10.1519/jsc.0000000000001937.

20. 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. Published ahead of print. *Journal of Strength and Conditioning Research* doi:10.1519/jsc.0000000000002469.

21. Markovic, G, Dizdar, D, Jukic, I, and Cardinale, M. Reliability and factorial validity of squat and countermovement jump tests. *Journal of Strength and Conditioning Research* 18(3): 551-555, 2004.

22. Meylan, C, Mcmaster, T, Cronin, J, Mohammad, NI, Rogers, C, and Deklerk, M. Single-leg lateral, horizontal, and vertical jump assessment: reliability, interrelationships, and ability to predict sprint and change-of-direction performance. *Journal of Strength and Conditioning Research* 23(4): 1140-1147, 2009.

23. Orr, R, Pope, R, Peterson, S, Hinton, B, and Stierli, M. Leg power as an indicator of risk of injury or illness in police recruits. *International Journal of Environmental Research and Public Health* 13(2): doi:10.3390/ijerph13020237, 2016.

24. Orr, R, Dawes, JJ, Pope, R, and Terry, J. Assessing differences in anthropometric and fitness characteristics between police academy cadets and incumbent officers. Publish ahead of print. *Journal of Strength and Conditioning Research* doi:10.1519/JSC.0000000000002328.

25. Rossomanno, CI, Herrick, JE, Kirk, SM, and Kirk, EP. A 6-month supervised employer-based minimal exercise program for police officers improves fitness. *Journal of Strength and Conditioning Research* 26(9): 2338-2344, 2012.

26. Stockbrugger, BA, and Haennel, RG. Validity and reliability of a medicine ball explosive power test. *Journal of Strength and Conditioning Research* 15(4): 431-438, 2001.

27. Stockbrugger, BA, and Haennel, RG. Contributing factors to performance of a medicine ball explosive power test: A comparison between jump and nonjump athletes. *Journal of Strength and Conditioning Research* 17(4): 768-774, 2003.

28. Verbrugge, JD. The effects of semirigid air-stirrup bracing vs. adhesive ankle taping on motor performance. *Journal of Orthopaedic and Sports Physical Therapy* 23(5): 320-325, 1996.

29. Vescovi, JD and Mcguigan, MR. Relationships between sprinting, agility, and jump ability in female athletes. *Journal of Sports Sciences* 26(1): 97-107, 2008.

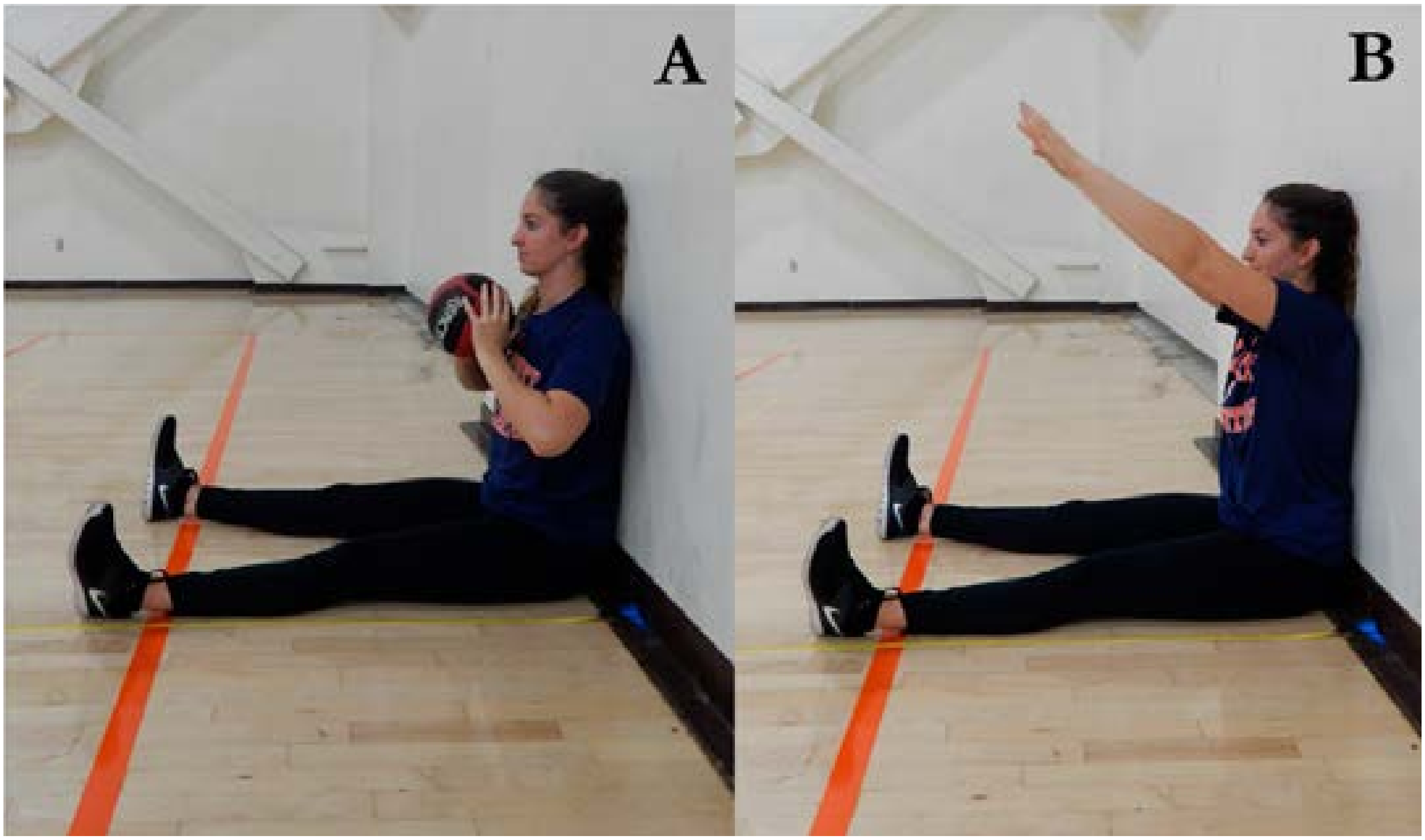

FIGURE 4. SEATED MEDICINE BALL THROW

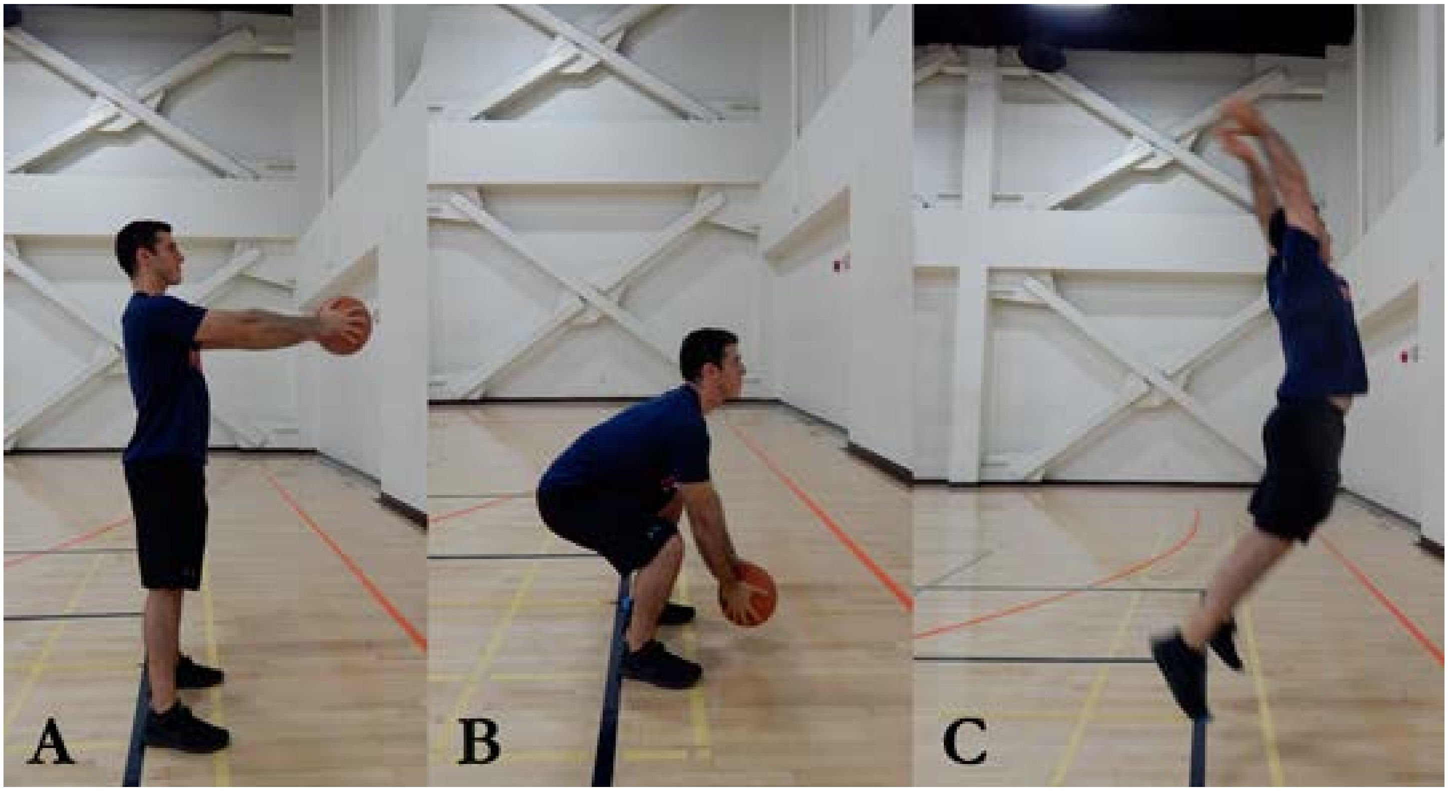

FIGURE 5. BACKWARDS OVERHEAD MEDICINE BALL THROW

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CHARLIE KORNHAUSER, TSAC-F

PROGRAMMING CONSIDERATIONS FOR THE TACTICAL OFFICER IN LAW ENFORCEMENT – FOCUSING ON FUNDAMENTALS

Efficient and effective exercise programming will forever be part of the foundational basis for improving performance. Program design is key to progression, reconditioning, and rehabilitation with the ultimate goal of a tactical officer operating at peak performance. With this in mind, it can become easy to lose sight of the end goal by skipping fundamental aspects of programming and going directly to periodization and exercise specifics. Many coaching conversations revolve around the pros and cons of linear, blocked, or undulating programs; bilateral or unilateral movements; or the importance of spinal stability through pelvic floor strengthening. When in reality, the conversations about the appropriateness of a specific program should happen long before discussing periodization of specific exercises. It can be easy to focus a conversation on esoteric knowledge without ever focusing on the real task at hand, which is helping the tactical officer who needs a qualified physical trainer, coach, specialist, or facilitator. By examining a practical approach to programming fundamentals based on a needs analysis and training objectives relative to the program, a foundational plan can be laid that may lead not only to the appropriate progression of a given officer but also to the mutual satisfaction of the trainer and trainee alike.

PERFORMING A NEEDS ANALYSIS

To design an appropriate program for any individual tactical officer, a tactical facilitator must first have a clear understanding of who they are working with and the limitations and abilities of those officers, whether perceived or real (4). Limitations may manifest in the form of pre-existing injuries, mobility constraints, medical conditions, health concerns, fatigue, or on-call status. Many other variables that may not cause physical restriction but may be impractical from an environmental or situational standpoint, such as time restrictions, personal obligations, and professional schedules, should also be taken into account. Having a comprehensive picture of what an officer is either unable or unwilling to do gives an idea of how to design their program. It may be easy to believe a tactical officer is healthy and able to participate in an exercise program simply because of their active-duty job status, but that should be determined through a physical activity readiness questionnaire (PAR-Q) or another medical pre-qualification process. Granted, the department, agency, or branch that the tactical officer is associated with, and their active-duty status within that group may appear to medically pre-qualify them for an exercise program. However, their job status does not absolve the tactical facilitator morally or legally from ramifications that may be incurred by hastily assuming health status and designing a program that proves to be a detriment when a refferral to a quaified health or medical professional should have been made at the outset.

When assessing a tactical officer's abilities, considering their exercise experience along with their related job functions, whether they are extremely complex and physically demanding or something more administrative in nature, will be a key component to successful program design. Considering whether or not the officer's current training program focus is on mobility, cardiovascular health, muscular strength, coordination and balance, speed and agility, and/or any other specific component of their fitness will aid in comprehensive program design. This will help identify weaknesses that can be worked on over the course of the program.

IMPORTANCE OF JOB DUTIES AND INDIVIDUAL TRAINING GOALS

While the general day-to-day duties of a patrol-level law enforcement officer are generally similar across agencies and jurisdictions, an individual officer's history may certainly be very different from one to another. There is a big difference between working with a former Division I collegiate athlete who is now a patrol officer and working with an officer who has no prior athletic experience whatsoever (other than what physical training was demanded within their respective academy or basic training process). While their job duties are similar, or even the same in many respects, their programs may be substantially different based simply on their current or former abilities.

Understanding the tactical officer's training priorities is another key component that may help make the program a success. While a tactical officer's training priorities may take a backseat to the required performance of their job duties, a facilitator would be remiss if they did not take these priorities into account. The program will be for naught if the tactical officer despises what they are being asked to do and chooses not to participate. An ability to merge what an officer needs professionally with what they want (e.g., being better at their job, improved overall health and wellness, or increasing muscle mass) is a testament to any tactical facilitator's programming abilities. There is an obvious possibility that the tactical officer in question has been referred to the tactical facilitator by their agency, department, or branch command and that referral may carry with it a sense of irrelevance from the tactical officer. The tactical facilitator's mission may simply be to bring the tactical officer up to specific levels of performance and this is exactly what should be done; however, this does not mean that the opinion or goals of the tactical officer carry no importance. Understanding the tactical functions of the tactical officer's job will provide a vast amount of information that will aid program design (2).

Understanding the differences between a Special Weapons and Tactics (SWAT) operator, patrol officer, corrections officer, and traffic investigator, whether they are full time or part time, is key to a successfully designed program for any tactical officer. For example, load carriage is a very real concern for the tactical officer that wears rifle-grade body armor, and is a lesser priority for the plainclothes detective. Agility and sprint speed may be a major priority for the patrol officer who engages in foot pursuits while the traffic investigator may be less concerned with straight-line speed. Most functions across the broad demographic of tactical officers differ drastically from job to job. By gaining knowledge of goals such as fitness for duty tests and requisite minimum standards, job tasks, officer-specific goals and accompanying abilities and limitations, a clear program direction can be ascertained by the facilitator.

By first performing a comprehensive interview and evaluating the tactical officer's needs based upon their limitations, abilities, history, goals, desires, relative job functions, and potentially minimum standards, a tactical facilitator will have a clearer picture of who they are designing a program for. Understanding that it is more appropriate to preclude a person from specific movements based upon injuries or limitations rather than generally contraindicating exercises and movements altogether may broaden programming potential and allow the tactical officer to be a part of officer-specific program design and move away from a "cookie-cutter" approach to programming.

Once the requirements of the individual tactical officer are ascertained, the tactical facilitator should be cognizant of remaining within their own scope of practice and should not overestimate their own abilities. A tactical facilitator should realize when it is in the tactical officer's best interest to refer to another allied health or medical professional. Most coaches and facilitators understand and operate within clear-cut scopes of practice; however, there may be more "gray areas" in which they feel uncomfortable yet compelled to answer or provide advice. If overwhelming concerns exist about a specific issue, such as health or an injury, and the tactical facilitator still forces an answer or gives advice, then they may be pushing the lines of their professional boundaries. In addition to being knowledgeable, trained, certified, or licensed, a qualified professional must be completely comfortable with the topic in question. In this way, scopes of practice are recognized and respected and the tactical facilitator can more completely provide a program that addresses the individualized needs of the tactical officer.

PROGRAMMING TO FIT NEEDS

Now that there is a realistic profile of the person and the organization that will be programmed for, and all relevant information has been discussed, a tactical facilitator can begin to customize a program while taking into account a few more variables. The first piece of information that must be examined is how much of the program the tactical facilitator will be required to coach one-on-one. Ideally, a tactical facilitator would spend 100% of every training session with every tactical officer (3,5). However, knowing that a facilitator may potentially spend progressively less time with an officer once the fundamentals are taught, a reduced individual contact time will influence the program's effectiveness. In some instances, a tactical facilitator may simply write a program and never set eyes on the actual performance of a single exercise. There are an infinite number of scenarios involving coaching contact, and as such, there is no single correct practical application; however, that does not mean that these programming considerations should not be taken into account.

If large amounts of time are going to be invested, and both the tactical facilitator and the tactical officer are able to mutually commit such time to a one-on-one coaching environment, an aggressive approach to progress may be considered. Whereas, if a tactical facilitator knows there will be little to no time spent coaching movement patterns, then a more conservative approach may be viable. Acknowledging that exercise progression can play a key role in program progression, and realizing that safety is paramount in any program, may influence the prioritization of one exercise over another. Also, the availability of a tactical facilitator may dictate whether or not a particular progression throughout a program will be appropriate or not.

One constant is that exercise frequency plays a large role in potential progress (6). With this information, considered alongside dedication to investing in the tactical officer, a tactical facilitator can begin to create a frequency schedule that fits with the demands existing within the tactical officer's schedule.

Access to facilities and resources can impact the program and will likely influence the design of the program from the outset. If the workouts are to be performed with a hands-on approach, within familiar facilities, then there is little guessing to be done as to what equipment or resources are available. However, if the tactical facilitator is unfamiliar with where the tactical officer will be training, this will present questions that will need to be asked to clarify the situation, and ultimately guide design of the program. Doing so will prevent the tactical officer from having to substitute one exercise over another or even potentially cut exercises altogether because access to resources and equipment was not taken into account initially.

Obviously, a tactical facilitator prefers to guide a tactical officer through each workout with absolute control over each piece of the program to include movement mechanics, intensity, rest periods, volume, and all applicable safety concerns, but as a matter of practicality, it is highly likely that someone somewhere is attempting to follow a program that was simply written for them with no consideration given to access and familiarity of the equipment or facility. A tactical officer may have no knowledge of what machine or movement is being referenced. It is incumbent upon qualified tactical facilitators to understand that the reality of the tactical population is based on doing whatever it takes to get the mission accomplished. If an exercise is prescribed and the equipment is not available in that facility, then the tactical officer will adapt to perform the exercise prescribed in a manner different to how the tactical facilitator intended. As such, if a program is designed for someone who will not be supervised throughout the program, then a tactical facilitator must ensure a thorough and comprehensive educational component exists early in their dealings with the tactical officer so as to most efficiently utilize their self-guided time and potentially avoid injury.

THE PROGRAM

Now that a complete and clear understanding of a tactical officer's situation, familiarity, and availability has been addressed, the tactical facilitator can begin to program specific exercises in a periodized program that best accomplishes the mutually established goals (1). It may be an important realization that a specifically periodized program that would best suit tactical officer A, may be completely unreasonable for tactical officer B, even though they are both patrol officers of generally similar levels of fitness. It may be that once a tactical facilitator delves into the foundational components of a needs analysis that a once domineering logistics and specifics approach now will take a backseat to the newly constructed and relevant purpose-driven program. It is completely justifiable to build a program around the central question of "why?" However, if a tactical facilitator attempts to arbitrarily plug a "why" into a program, then they will be constantly searching for a rationalization that will continually make less sense as they witness the tactical officer tread figurative water with little to none of the progress initially desired.

With the knowledge and realization that tactical officers are real people with real challenges and real goals, qualified tactical facilitators can proficiently design programs that will keep the tactical population physically capable, thereby keeping them, and those they protect, safe from the perils they strive to contain.

REFERENCES

1. Hartmann, H, Wirth, K, Keiner, M, Mickel, C, Sander, A, and Szilvas, E. Short-term periodization models: Effects on strength and speed-strength performance. *Sports Medicine* 45(10): 1373-1386, 2015.

2. Hertzler, S, and Carlson-Phillips, A. Basic nutrition for tactical populations. In: Alvar, B, Sell, K, and Deuster, P (Eds.), *NSCA's Essentials of Tactical Strength and Conditioning.* Champaign, IL: Human Kinetics; 69-99, 2017.

3. Johnson, S, Wojnar, P, Price, W, Foley, T, Moon, J, Esposito, E, and Cromartie, F. A coach's responsibility: Learning how to prepare athletes for peak performance. *The Sport Journal*. 2011. Retrieved from http://thesportjournal.org/article/a-coachs-responsibility-learning-how-to-prepare-athletes-for-peak-performance.

4. Kraemer, WJ, Comstock, BA, Clark, JE, and Dunn-Lewis, C. Athlete needs analysis. In: Hoffman, J (Ed.), *NSCA's Guide to Program Design*. Champaign, IL: Human Kinetics; 1-21, 2012.

5. Losch, S, Traut-Mattausch, E, Mühlberger, MD, and Jonas, E. Comparing the effectiveness of individual coaching, self-coaching, and group training: How leadership makes the difference. *Frontiers in Psychology* 3(7): 629, 2016.

6. Thomas, M, and Burns, S. Increasing lean mass and strength: A comparison of high frequency strength training to lower frequency strength training. *International Journal of Exercise Science* 9(2): 159-167, 2016.

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JOE SWINFEN, MS

THORACIC MOBILITY FOR THE TACTICAL OPERATOR

Musculoskeletal disorders are a significant concern for tactical operators due to the physical requirements of many tactical operators and the high risk environments in which they work. This can be particularly true in the military, as they are often in areas where access to adequate healthcare can be limited, although several militaries do forward deploy physical therapists to forward operating bases.

Although there continues to be advances in military medicine, the rates of disability cases within the United States military continues to rise (1). In 2010, approximately 2.5 million ambulatory visits for musculoskeletal injuries were recorded, accounting for $548 million in direct patient care costs (6). During this period, musculoskeletal injuries seen in all military healthcare facilities around the world, principally in the United States, represented 67% of all limited duty profiles (adjusted physical work requirements) (6). Additionally, more than 80% of all musculoskeletal injuries were overuse injuries, with lower extremity overuse injuries listed as the number one cause of lost and limited days (6). From 2006 – 2010, there were increases in the number of visits in all major diagnostic categories, except infectious and parasitic diseases (1). Visits for musculoskeletal and connective tissue disorders increased by 53% during this time (1). Although tactical operators experience a multitude of musculoskeletal disorders, this article focuses on how a lack of thoracic mobility can affect tactical operators and presents ways to evaluate and correct those issues.

LIMITING FACTORS IN THORACIC MOBILITY

When looking at the thoracic spine, the orientation to the facets joint change to allow for rotational movements to occur more easily than flexion and extension. Flexion and extension movements can also be limited by the ribs because the ribs connect with the spine and run anteriorly to connect with the sternum to form the bony structure of the thorax. If a kyphotic posture has developed, due to anatomy or lifestyle, it will affect the ability to flex and extend properly (7). There are many factors that can affect optimal thoracic mobility including (7):

- Poor thoracic spine mobility in flexion, extension, lateral flexion and rotation
- Lack of scapular upward rotation
- Limited shoulder external rotation
- Limited shoulder flexion

When thinking about all the elements of fitness, cardiovascular endurance, flexibility, and strength often come to mind. Yet, one critical component to all tactical operators' performance that tends to be forgotten is mobility. The loss of required thoracic mobility can be problematic for tactical operators. For example, these professionals require the ability to access the transverse plane in order to produce power and excel in various job-related situations. Limitations in mobility can occur for a number of reasons, including bony impingement, hypertonicity, motor control deficits, soft tissue restrictions, as well as pain or reduced tolerance for physiological stress.

Tactical operators frequently perform occupational tasks that require optimal shoulder range of motion (e.g., climbing, lifting, carrying heavy equipment). It is essential that tactical operators are able to perform the motions associated with their job in order to avoid injury. For this reason, it is essential for tactical operators to have the ability to demonstrate adequate shoulder range of motion, as well as optimum shoulder stability. The mobility exercises discussed in the latter part of this article can help to create useful, coordinated, athletic patterns of strength and stamina in the upper body.

TABLE 1. MUSCULOSKELETAL INJURY BY BODY PART MANAGED BY BRIGADE COMBAT TEAM PHYSICAL THERAPISTS (5)

LOCATION OF INJURY	NUMBER OF PATIENTS (N = 118,927)	PERCENTAGE OF TOTAL
Knee	25,332	21.3
Lumbar spine	24,618	20.7
Leg/ankle/foot	22,358	18.8
Cervical spine	14,747	12.4
Shoulder	12,131	10.2
Thoracic spine	8,206	6.9
Hip/pelvis	6,184	5.2
Elbow/wrist/hand	5,351	4.5

In order for these tactical operators to be able to demonstrate good shoulder mechanics, the thoracic segment needs to be mobile. Research has demonstrated the critical role of scapula-thoracic rhythm in optimal shoulder movement (3).

SCAPULO-HUMERAL RHYTHM

Scapula-humeral rhythm is fundamental to maintaining the subacromial space. The linear ratio of scapular rotation to arm adduction has been long accepted as 1:2 in a very general sense with this ratio changing through the movement arc. Although, the true interaction is more curvilinear as opposed to truly linear. There is very little scapular rotation in the first 60 degrees of arm abduction; then, as the arm travels to a full overhead position, the scapula progressively begins to rotate (6).

The thoracic spine should be able to flex, extend, bend, and rotate to varying degrees. In overhead athletic activities, thoracic mobility becomes even more important. The more overhead motion is required by a tactical operator, the more thoracic motion is needed from the thoracic spine in order for that individual to maintain the proper relative shoulder alignment. If the thoracic spine does not extend properly during overhead activities, it will be difficult to perform adequate shoulder flexion. This dysfunctional movement pattern can increase lumbar extension and place unwanted stress through the cervical spine (4,5).

With today's prevalent sedentary lifestyle, the typical body posture (even those of tactical operators) can see the body in thoracic flexion (i.e., in positions enabled by decreasing the angle of joints). Most of these issues begin with poor postural habits, which include sitting at desks for prolonged periods, driving for long amounts of time, and poor training techniques and exercise postures.

OTHER AREAS AFFECTED BY LIMITED THORACIC MOBILITY

- The ability for the thoracic spine to move may be one of the most overlooked aspects of injury prevention. It is an important consideration for a variety of reasons, including the mobility impacts on segments above and below, the effect on breathing, and the potential to induce long-term poor posture.
- Lack of mobility or weakness in the upper spine means that other areas will have to compensate, therefore having to move more. This could possibly lead to injuries or pain in other areas, such as the neck, shoulders, and lower back.
- Breathing can be affected given that the ribs attach to the thoracic spine. If there is a lack of mobility in the spine, then the ribs will not be able to move correctly. This can lead to a lower breathing capacity and less ability to expand the lungs.
- Displaying a hunched posture (generally due to sitting for extended periods of time while driving, sitting at a desk, etc.) may cause the shoulders to rotate inwardly and translate forward, and the head to shift forward and tilt upward. These postural changes can increase the risk of subacromial damage, and even lead to headaches and neck pain as well.

QUICK THORACIC MOBILITY ASSESSMENT

The following is a quick way to determine the extent of thoracic mobility:

1. Lie down flat on the floor.
2. Keep knees bent with feet and glutes flat on the floor.
3. Extend arms overhead with elbows locked and bring arms directly overhead. Attempt to touch both wrists to the floor above the head.
4. Attempt to maintain contact between the lower back and the floor throughout the entire motion. Avoid arching the back to get the arms into place.

The following exercises are intended to assist with improving thoracic mobility. If tactical operators find it difficult to get into the position during the assessment to touch their wrists to the floor, or have to struggle through discomfort or even pain, they should consult with a medical provider or physical therapist to rule out any underlying conditions before proceeding with these exercises.

THORACIC ROTATION STRETCH

- Lie on the floor on one side with both arms extended at shoulder level with palms touching together.
- The top knee should be bent, and an implement can be used to support the top knee (Figure 1).
- Slowly move the top arm back and toward the floor on the opposite side of the body, while tracking that arm with the eyes.
- Attempt to get the shoulder as close to the floor as possible. Should feel a stretch through the front of the chest (Figure 2).
- Hold the stretch for 10 – 30 s and repeat as necessary.

SCAPULAR WALL SLIDES

- Stand tall with the back flat against a wall.
- Flex the elbows to 90 degrees and press the arms into the wall (Figure 3).
- Maintain contact with the wall as the arms slide vertically overhead while maintaining elbow flexion (Figure 4).
- Pause and then slide the arms back down the wall until the elbows return to the starting position.
- Caution should be applied with this movement, especially if any tightness, "catching," or pain is felt on the outer tips of the shoulder (subacromial space), as this could indicate an impingement.

THORACIC EXTENSION OVER FOAM ROLLER

- Lie on a foam roller on the floor with the roller near mid-back (avoid using foam roller on the low back).
- With the roller near the mid-back, cross the hands over the chest (Figure 5).

- Keeping the glutes and feet on the floor, extend the back over the roller.
- While extending the back over the roller, reach the arms overhead and relax the head and neck as the upper body approaches the floor (Figure 6).
- Try to touch the backs of the hands to the floor behind the roller without lifting the glutes or feet off the floor (do not simply arch the lower back to extend over the roller).

THORACIC MOBILIZATION ON A CHAIR

- Sit down (on a bench, a chair, or the floor) and put both hands behind the head (Figure 7).
- Spread the elbows as far apart as comfortable.
- Be sure to sit upright with good posture. Rotate the thoracic spine one way as far as possible without the hips and lumbar spine rotating (Figure 8).
- After rotating, bend at the thoracic spine (Figure 9). Come back up and rotate even further.
- Bend again, come back up, and try to rotate further. Continue to do this as long as possible while still making range of motion progress with the rotations (normally 3 – 4 times).
- Switch to the other side.

QUADRUPED T-SPINE ROTATION

- In a quadruped position with the knees under the hips, the hands under the shoulders, and the spine in a neutral position, place one hand on the back of the neck (Figure 10).
- Begin to rotate the flexed elbow and thoracic spine towards the ceiling as far as possible (Figure 11).
- Maintain the position of opposite arm with the elbow extended to keep the lumbar, thoracic, and cervical spine aligned during rotation.
- Return to the starting position in the full quadruped position before switching sides.

CONCLUSION

Tactical operators face many challenges in relation to their job and need to be able to move optimally in order to avoid injuries. The tools provided in this article may assist in helping to develop the ability to improve thoracic mobility in tactical operators.

REFERENCES

1. Ambulatory visits among members of the active component, U.S. Armed forces, 2010. *Medical Surveillance Monthly Report* 18(4): 16-21, 2011.

2. Crawford, HJ, and Jull GA. The influence of thoracic posture and movement on range of arm elevation. *Physiotherapy Theory and Practice* 9: 143-148, 1993.

3. Greenfield, B, Catlin, PA, Coats, PW, Green, E, McDonald, JJ, and North, C. Posture in patients with shoulder overuse injuries and healthy individuals. *Journal of Orthopedic Sports Physical Therapy* 5: 287-295, 1995.

4. Hauret, K, Jones, BH, Bullock, SH, Canham-Chervak, M, and Canada, S. Musculoskeletal injuries: Description of an under-recognized injury problem among military personnel. *American Journal of Preventive Medicine* 1: 61-70, 2010.

5. Kibler, BW. The role of the scapula in athletic shoulder function. *The American Journal of Sports Medicine* 26: 325-337, 1998.

6. Moore, J, Goffar, S, Teyhen, DS, Pendergrass, TL, Childs, JD, and Ficke, JR. The role of U.S. military physical therapists during recent combat campaigns. *Physical Therapy* 93(9): 1268-1275, 2013.

7. Spatz, G, and Shaw, N. Thoracic mobility. *NSCA Coach* 3(3): 4-7, 2013.

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FIGURE 1. THORACIC ROTATION STRETCH – START

FIGURE 2. THORACIC ROTATION STRETCH – END

FIGURE 3. SCAPULAR WALL SLIDES – START

FIGURE 4. SCAPULAR WALL SLIDES – END

FIGURE 5. THORACIC EXTENSION OVER FOAM ROLLER – START

FIGURE 6. THORACIC EXTENSION OVER FOAM ROLLER – END

FIGURE 7. THORACIC MOBILIZATION ON A CHAIR – START

FIGURE 8. THORACIC MOBILIZATION ON A CHAIR – ROTATION

FIGURE 9. THORACIC MOBILIZATION ON A CHAIR – THORACIC BEND

FIGURE 10. QUADRUPED T-SPINE ROTATION – START

FIGURE 11. QUADRUPED T-SPINE ROTATION – END

SHANE IRVING

THE TECHNOLOGY PIECE – INDUSTRY, ACADEMIA, AND SUBJECT MATTER EXPERTS ALL WORKING TOGETHER FOR THE BEST OUTCOME FOR THE END USER

BACKGROUND

Today's modern law enforcement agency (LEA) and first responders seem to face more challenges than any generation before them. The obvious challenges are high-threat environments as a result of geopolitical and religious extremism/terrorism, high operational tempos with extreme training loads put onto agencies, and fiscal constraints. It is common for LEAs around the world to face diminishing or unchanging budgets, having to do more with less, and operate within aging facilities and outdated training and education processes. Considering this, there is growing momentum in the modernization of law enforcement (and other tactical populations) to integrate industry and academic institutions into modernization plans. LEAs are realizing that they cannot continue to be one dimensional in their approach to modernization and rely solely on their own internal resources, so they are reaching out to specialist niche consulting companies for everything from construction and management of training facilities to specialist training provision. One example is the recent collaboration between a LEA, a company in the industry, and an academic institution, which saw the design of a prototype ballistic vest for law enforcement. As a caveat before further discussion, it should be noted that in both the industry and academic institutions involved in this collaboration, a qualified Tactical Strength and Conditioning Facilitator® (TSAC-F®) was involved. As such, this article aims to highlight other areas that the TSAC-F may have the scope to provide useful insights.

ACADEMIA AND INDUSTRY

Research has shown that load bearing on the skeletal frame can affect performance and repeated load every day, on every shift, and can cause long-lasting side effects (1,3). Load carriage can increase postural sway, reduce mobility, increase thermal burden, and cause a plethora of injury types, especially if fitted poorly (4,6). Considering this, industries that support LEAs (and other tactical organizations) have an intrinsic desire to appropriately fit tactical personnel with products that perform highly favorably as ultimately, from a business view point, this would equate to more product sales. As such, when designing a new product like a ballistic vest that may add load to the tactical operator, previous academic research is often considered. However, once considered, it is rarely reconsidered and contextualized to the product under development.

THE LEA

Looking at the actual physical modalities of the modern law enforcement officer encountering high-risk policing tasks, the very nature of their daily operational activities will require them to be able to move from static to dynamic multi-plane movements over varied terrain and in potentially hostile and life-threatening environments, all while wearing and carrying external loads (which would include their ballistic vests) (2,6). The significance of these requirements on ballistic vest design, fit, and form on performance is notable, given that the vest would directly impact the daily capabilities of the officer.

However, the design of a ballistic vest is complex for many reasons. Firstly, the garment is personal protective equipment (PPE); as such, the design has to meet the mandatory international standards of ballistic protection. For example, there are many technology textiles that offer extreme light weight solutions; however, if they cannot perform to the level of a heavier more robust product during ballistic trials, then the end user has to endure the heavier product. Further, the design in the modern policing world means the vest has to able to sustain the load carriage and placement of various equipment for the officer to perform his or her duties. The garment also needs to be appropriately "fitted" for the human form so as not to restrict movement, while appreciating that every human body is different and comes in many different shapes and sizes. There is also the essential requirement for the garment to actually cover the majority of the torso region anteriorly and posteriorly, as well

FIGURE 1. INDUSTRY EXPERTS, SUBJECT MATTER EXPERTS, AND ACADEMICS DISCUSSING THE POTENTIAL VEST TYPES

as allowing for a full “wrapping” around the sides and under the arms. With all these considerations, the actual human under the garment still needs to be able to perform their duty effectively.

COLLABORATION IN ACTION

Considering all of these above factors, the following example demonstrates how the design process can follow a collaborative path where industry, academia, and experienced end users all contribute to the final product. An industry textile company that specializes in ballistic vests commenced the process by developing different samples of the product that had been prepared to satisfy the mandatory configuration and ballistic standards. Subject matter experts (consisting of both current and previous end users) were then engaged to work hand-in-hand with the company design team and start developing the actual functional substance to the garment (e.g., modular lightweight load-carrying equipment [MOLLE] configurations, pouches, cummerbund fit, grab handles, etc). This process continued with adjustments until a final cut was produced. Once the basic designs were produced, a collaboration with academia commenced. Then a plan to functionally assess the new designs were established (Figure 1). It was at this stage that the TSAC-F was successfully integrated into the process (Figure 2).

FIGURE 2. DEMONSTRATING THE PROPOSED VICTIM DRAG

Once protocols had been established, the physical performance was undertaken by a sample population group of law enforcement officers wearing the vest. The officers were randomly selected to wear two garments on opposing days: the first, a standard issue military plate carrier and the second, the new prototype vest. They were asked to undertake a series of repeatable physical tests while wearing both vests.

The testing protocol was designed to be reliable, valid, and comparable to previous studies in order to contextualize the findings. The tests selected also replicated movement patterns identified as fundamental to the occupational requirements of the officers. All test members were required to wear standard issue uniform pants and footwear. The protocol included:

1. Body postural sway measures
2. A vertical jump test
3. An Illinois agility test
4. A rapid vehicle egress from a seated static position with a five-meter sprint to cover
5. A replicated victim drag which involved a 20-m sprint from cover to a dead weight, a lift of the weight to a drag position, and a reverse drag back the entire 20 m to cover
6. A Functional Movement Screen (FMS) while wearing the garment
7. A subjective written assessment and self-selection of performance rated perceived exertion (RPE) during each activity

The majority of the testing (1 – 6) was conducted by a TSAC-F (Figure 3).

FIGURE 3. AN OFFICER PERFORMING A FMS ON AN OFFICER WEARING THE VEST

CONCLUSION

The process of designing essential protective equipment for the law enforcement officer through a collaborative approach was very successful. The prototype garment performed well during the trials: outperforming the military version in some events (the agility task, FMS, and subjective ratings of performance and comfort—especially during the occupational task performance) while being comparable with the military version for the remainder of the tests (5).

Considering that the law enforcement product was designed for “all day, every day” wear, the general mobility (measured via FMS) and the subjective rating were considered of high importance. The subjective responses about the new garment (regarding fit, form, function, moveability, weight, thermal effects, etc.) were very positive from the officers (5). In conclusion, with the right consultative processes and investment from multiple stakeholders and skill sets, the goal of developing an effective technology-based product was achieved.

REFERENCES

1. Burton AK, Tillotson KM, Symonds TL, Burke C, and Mathewson T. Occupational risk factors for the first- onset and subsequent course of low back trouble: A study of serving police officers. *Spine* 21: 2612-2620, 1996.

2. Crawley, AA, Sherman, RA, Crawley, WR, and Cosio-Lima, LM. Physical fitness of police academy cadets: Baseline characteristics and changes during a 16-week academy. *Journal of Strength and Conditioning Research* 30: 1416-1424, 2016.

3. Dempsey, PC, Handcock, PJ, and Rehrer, NJ. Impact of police body armour and equipment on mobility. *Applied Ergonomics* 44: 957-961, 2013.

4. Knapik, JJ, Reynolds, KL, and Harman, E. Soldier load carriage: Historical, physiological, biomechanical, and medical aspects. *Military Medicine* 169: 45-56, 2004.

5. Orr, R, Schram, B, and Pope, R. A comparison of military and law enforcement body armour. *International Journal of Environmental Research and Public Health* 15: 339, 2018.

6. Orr, RM, Pope, R, Schram, B, Lyons, K, Correa, D, Tomes, C, and Hing, W. Individual light armour vest (ILAV) report. Gold Coast, Australia. Tactical Research Unit, Bond University, 2017.

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CONFLICT OF INTEREST STATEMENT

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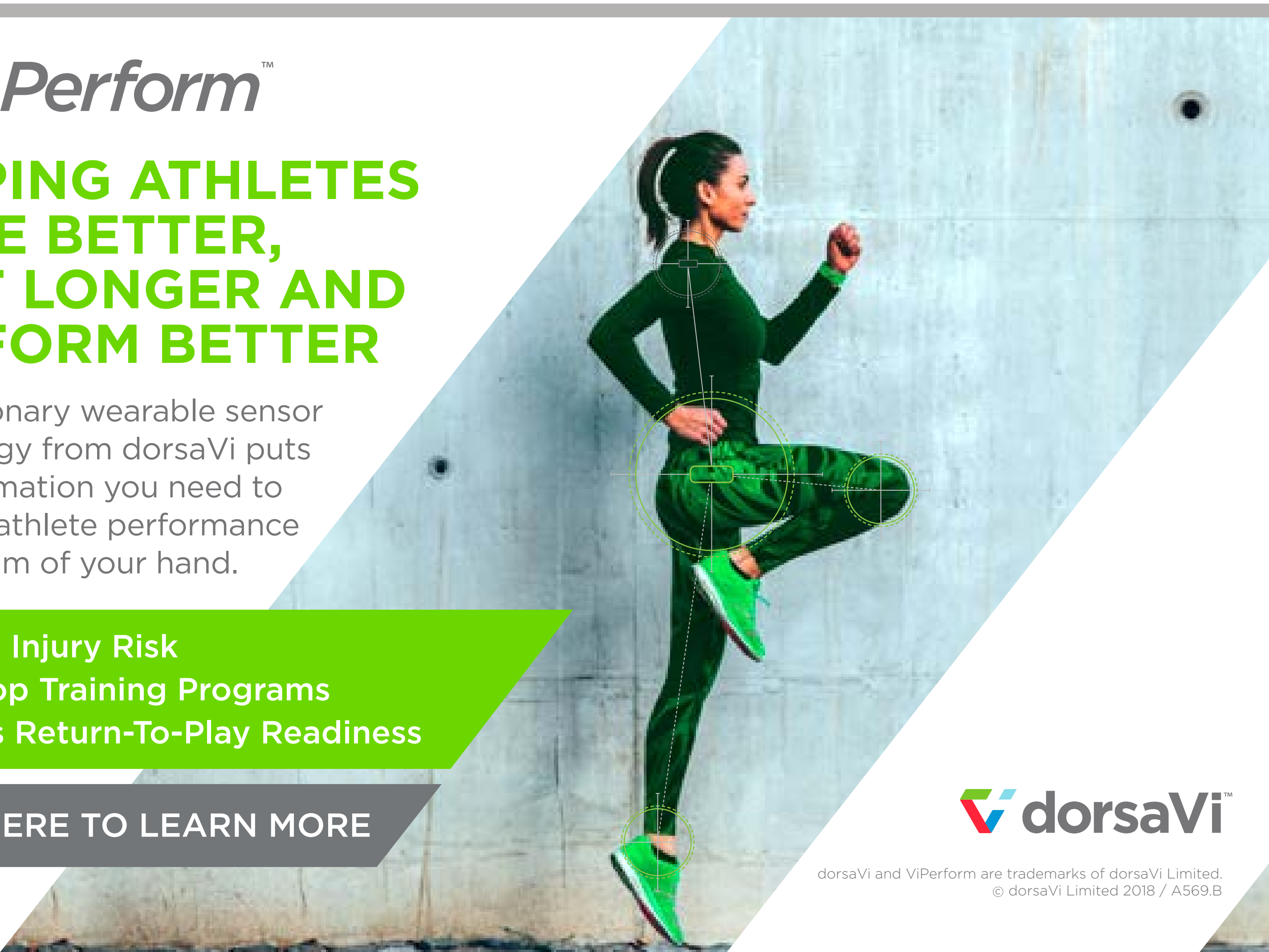

ROD POPE, PHD

TSAC RESEARCH REVIEW

This article is the 12th in 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.

IN ELITE SOLDIERS, POORER ANAEROBIC POWER AND STATIC BALANCE ABILITY PREDICT AN INCREASED INJURY RISK

Nagai and colleagues recently reported a study of elite, specialized soldiers from an operational division—the 101st Airborne (Air Assault) Division of the United States Army—to examine physiological, balance, and biomechanical predictors of injury risk (4). Such studies are relatively uncommon, with reports of studies conducted in training contexts being far more common in the literature.

Nagai and colleagues started with a group of 491 volunteers from the division, who were subjected to a battery of tests including: anthropometrics, aerobic and anaerobic fitness, strength, flexibility, static balance ability with eyes closed or eyes open, and jump landing biomechanics (4). All soldiers (n = 183) who had a documented injury or other medical condition that had occurred in the two years prior to testing were excluded from data analysis, so that prior injuries and health conditions would not influence the study results (4). Female soldiers were also excluded based on small sample size, as well as the notion of gender differences in biomechanics (4). The final analysis was therefore based on 275 male soldiers who did not have any documented injury or medical condition in the two-year period prior to testing (4). The injuries considered in the analysis were termed "preventable musculoskeletal injuries" and operationally defined by the authors as "injury to the musculoskeletal system (bones, ligaments, muscles, tendons, etc.)… that can be reduced through injury prevention programs that are developed to improve neuromuscular and physiological characteristics related to musculoskeletal injury risk," (4). Injuries that the authors considered non-preventable, "musculoskeletal injuries such as motor vehicle accidents, direct trauma, and falls, or other medical conditions," were excluded from the analysis (4).

Among these 275 male soldiers, 162 had no documented injury in the 12-month period that followed testing and 113 had one or more documented injuries (4). The analysis revealed that both peak anaerobic power and static balance performance with eyes closed were significant independent predictors of future musculoskeletal injury risk (4). Injury risk in the following 12-month period increased by 6% for every one Newton increase in the standard deviation (SD; indicating magnitude of variability) of the vertical ground reaction forces during static balance testing with eyes closed, where each Newton increase reflected a reduction in static balance ability (4). The variability in vertical ground reaction forces was large in injured soldiers (SD of 17 Newtons) and much larger than in the uninjured soldiers (SD of 7 Newtons), and the overall injury risk for the full cohort of male soldiers was quite high (113 of 275, or 41%, injured in a 12-month period) (4). On this basis, a 6% increase in injury risk for every Newton increase in the SD of the vertical ground reaction force represents a potentially very large increase in injury risk. For example, in a soldier with a 17 Newton greater SD in the vertical ground reaction force during static balance testing (i.e., poorer balance) than another soldier, this balance deficit would increase injury risk by 102%, effectively doubling their injury risk relative to the other soldier. Injury risk also decreased by 20% for every watt/kg increase in peak anaerobic power, so that a soldier whose peak anaerobic power was 2.5 watts/kg higher than that of another soldier would be half as likely as their less fit peer to be injured in a 12-month period (4). On all other tests (anthropometrics, aerobic fitness, strength, flexibility, and biomechanical performance during a jumping activity), injured and uninjured soldiers in this elite cohort performed or scored very similarly; thus, these tests were not significant predictors of injury risk in the overall cohort of male soldiers (4).

These findings are valuable, as often elite tactical personnel are very similar on a range of fitness characteristics and it can be difficult to find performance measures on which they differ from each other substantially, which may then affect injury risk and be amenable to training to enhance performance and reduce injury risk. This study has identified two such fitness characteristics: static balance ability with eyes closed and anaerobic power (4). While the study results should be validated through further research in similar elite army populations, for the tactical strength and conditioning facilitator, the study provides some valuable direction when seeking to achieve additional performance and injury reduction gains in similar elite tactical populations (4). It may be valuable to conduct some simple testing of anaerobic power and static balance ability with eyes closed and provide specific training in these areas to personnel at this elite level. Nagai and colleagues provide some useful practical suggestions in the discussion section of their article on how to approach this (4). However, a caution is also warranted at this point: previous research has indicated that adding additional balance and agility training into an already intensive training program may increase, rather than decrease, injury rates (2). If the training program undertaken by soldiers is already intensive and fatiguing, any remedial training to address balance or anaerobic power should be offset by reducing workload in other areas of training. Careful program design will be essential.

PHYSICAL DEMANDS FOR PERSONNEL IN A SPECIALIST POLICING UNIT

Silk and colleagues introduced their recent comprehensive study of the physical demands for an Australian specialist policing unit (SPU) by noting that there has been little previous research on this topic for SPU, specifically (7). They also noted that information about the physical demands for SPU is important to underpin and inform strategies for physical training, personnel selection, injury management, and management of return to work in SPU (7). The same could clearly be said for other types of tactical populations. Their research report provides a valuable overview of approaches that are frequently used in tactical contexts to assess key tasks and associated physical demands, in order to arrive at appropriate training scenarios and job-related performance or selection tests (7). The approaches they outline are relatively straightforward and can be applied in most tactical contexts by those responsible for understanding the physical demands of the tactical occupation and on that basis designing strategies for physical training, personnel selection, injury management, and management of return to work (7). With this in mind, a copy of the full report would be worth obtaining by those with such interests (7).

The study was conducted with the SPU of the Victorian Police, in Australia, and involved four key stages (7):

- Review of relevant literature and organizational documents to identify a list of job tasks undertaken by the SPU
- Review of that task list with a panel of seven SPU personnel to identify the most common and physically demanding tasks
- An online survey of all SPU personnel, asking them to rate each of the shortlisted tasks on frequency of performance, physical demand, operational importance, and dominant fitness domain
- Further work with the panel of SPU personnel to identify key (or "criterion") tasks, informed by the task ratings from the survey, and to then develop realistic operational scenarios that incorporated the criterion tasks and could be used in assessment and training of personnel

Eleven criterion tasks were identified from the study, and these included: cell clearance; forced entry searches utilizing specialist equipment; carrying additional equipment during deployment; firing a shotgun; wrestling, restraining, and handcuffing someone resisting arrest while wearing full SPU kit; loading and unloading equipment; firing a taser; firing a semi-automatic weapon; running long distances in full SPU kit in support of dog squad operations; standing or sitting in full SPU kit for extended periods in varied climatic conditions; and negotiating obstacles during cordon and contain activities in full SPU kit (7). Dominant fitness components required for these tasks included muscular strength (four tasks), muscular endurance (two tasks), muscular power (one task), aerobic power (one task), and agility (one task) (7). Three operational scenarios were designed with the seven SPU panel members and between them included all 11 criterion tasks. These scenarios were: extrication of a non-compliant offender from a police cell, supporting a dog squad operation during the tracking and arrest of an alleged offender, and cordoning and containing a suspected offender stronghold.

The relevance and transferability of these specific findings and operational scenarios will clearly vary by context and tactical population. Therefore, anyone planning to use the findings of this study to inform physical training, physical performance testing, injury prevention, and return to work strategies should first consider carefully how similar the population for which they are responsible is to the SPU involved in the study (7). If similar, the findings may be relevant and transferable, at least in part. If not, further local investigations using similar approaches to those reported in this study may be appropriate. For the tactical facilitator, the findings of this study provide useful insights to the physical demands faced by personnel in a SPU and ways in which operational scenarios can be constructed based on detailed knowledge of job tasks to aid training and ongoing assessment of tactical personnel (7). These insights may guide refinement of approaches to training and assessment in a range of contexts.

AN EIGHT-WEEK INDIVIDUALIZED EXERCISE PROGRAM CAN IMPROVE FUNCTIONAL MOVEMENT SCREEN SCORES IN FIREFIGHTERS

Stanek and colleagues recently published a study that examined whether completion of an eight-week, individualized exercise program, generated by subscription FMS Pro 360 software and based on individual Functional Movement Screen (FMS) scores could successfully address functional movement deficits in firefighters (8). They noted that the FMS has been shown in previous research to be a useful predictor of injury risk in active populations and that firefighters depend heavily on their functional movement capabilities to underpin their occupational performance and reduce their injury risk (8). The authors note the FMS is a screening tool that assesses proficiency in seven different movement patterns, each scored on a scale of 0 – 3, giving a maximum total score of 21 (8).

The study involved 56 male, active duty firefighters who completed FMS testing at baseline (8). Each firefighter's itemized baseline scores were then input to FMS Pro 360 software, and the software generated two four-week progressive and sequential exercise programs for each firefighter based on their baseline FMS scores (8). The purpose of having two four-week programs was, according to the researchers, to enable progression, from unloaded to loaded exercises, and from exercises addressing mobility deficits to exercises addressing static motor control, dynamic motor control, and strength (8).

These individualized exercise programs were emailed to the firefighters, who were asked to perform them at least three days per week (8). After the programs were emailed, participants met with the researchers for an initial visit to gain further instruction on how to use the program and ask questions they might have about the exercises (8). Participants then performed the exercise programs independently, with self-monitoring; however, there is no mention that records were kept by participants of their compliance with the program (8). Following the eight-week period, the firefighters were screened again using the FMS (8).

While the researchers acknowledged the limitations of the pre-post research design they employed, which did not involve a control group, it is nevertheless instructive to note that total average FMS scores increased significantly from 12.1 at baseline to 13.7 following the eight-week program (a 13% improvement), indicating substantial improvements in functional movement capabilities and a potentially reduced injury risk (8). Breaking down these improvements in total FMS scores, stability scores improved significantly (12% for trunk stability push-up and 7% for rotary stability scores) on average, along with advanced movements scores (38% for deep squats, 16% for hurdle step, and 11% for inline lunge scores) (8). However, mobility scores (shoulder mobility and active straight-leg raise scores) did not change significantly across the cohort, on average, though together they did improve by 7% for the majority (55%) of firefighters involved in the study (8). The authors noted that, while the study participants did not, on average, achieve total scores that exceeded 14 (the score that is recommended to reduce injury risk) they did achieve substantial improvements (8). They also noted that the participants were older and started from a lower initial FMS score when compared to participants in other studies, and thus, may have required more time to reach a total average score of 14 through continued similar exercise programs (8).

The authors acknowledged that several previous studies have shown that FMS scores can be improved through exercise interventions (8). However, they also noted that key features of this study were the use of the individualized exercise programs produced in automated fashion by the subscription FMS Pro 360 software and the fact that firefighters performed their prescribed exercises with minimal support and supervision (8). These approaches have potential as efficient ways for tactical facilitators to support firefighters with individualized exercise programs that can improve their functional movement capabilities, particularly if the tactical facilitator has limited time or many personnel or sites to serve (8). Tactical facilitators who are subscribed to the FMS network may benefit from this knowledge if they prescribe exercise using the FMS Pro 360 software, on the basis of FMS scores for each participant. It should be noted, however, that the researchers did visit each participant following initial exercise prescription to provide further instruction on how to use the exercise program and answer questions participants might have had about the exercises (8). Therefore, tactical facilitators who use a similar approach should also consider this additional education component.

RECRUIT PUSH-UP PERFORMANCE AND 1.5-MILE RUN TIME PREDICT RISK OF FAILING TO GRADUATE FROM POLICE ACADEMY

In a recent retrospective cohort study involving records of 2,993 police recruits (287 female, 2,681 male) who undertook 20 weeks of initial training at 10 United States police academies, Shusko and colleagues examined the relationships between entry scores on several fitness measures and subsequent failure to graduate from the respective police academies (6). The entry fitness measures included body composition (body mass index [BMI] and skinfold measurements), push-ups, sit-ups, sit-and-reach, and 1.5-mile run time (6). Failure to graduate could be for any reason, and the authors noted that one key reason was recruits failing to attend a mandated minimum of at least 30% of all scheduled fitness training sessions (6).

The overall rate of failure to graduate from the police academies was 10% (6). Both push-up scores and 1.5-mile run times were strong predictors of failure to graduate (6). Odds of failing to graduate were five times higher for recruits achieving push-up scores of 20 or less, when compared to those achieving push-up scores between 41 and 60 (6). Odds of failing to graduate were similarly four times higher for recruits achieving 1.5-mile run times of 15:20 min or more, when compared to those achieving 1.5-mile run times of 10:37 – 12:33 min (6).

This study was affected by missing data in the retrospective data set and the authors recommended further prospective research to address this. Nevertheless, for the tactical facilitator, the findings serve as a useful reminder of the importance of physical conditioning in determining success or failure of tactical personnel undertaking initial training (6). These results are supported by similar findings in military personnel and flag the important roles that well-designed physical training both prior to and during initial training and the tactical facilitator play in ensuring trainees successfully complete entry-level training programs (5).

FIREFIGHTER PROTECTIVE ENSEMBLES IMPAIR JOINT RANGES OF MOTION AND REACH DISTANCE BUT NOT TIMES TO PERFORM SELECTED OCCUPATIONALLY-RELEVANT TASKS

Coca and colleagues have reported a study in which they examined the impacts of wearing a standard firefighter ensemble (SE) when compared to wearing jogging shorts, a T-shirt, and athletic shoes (baseline attire [BL]) on range of motion of various joints of the body and times to complete selected occupationally-relevant tasks (1). The SE consisted of turnout coat, pants, boots, gloves, hood, helmet, and self-contained breathing apparatus, and was individually fitted to each of the eight study participants (three female, five male; three firefighters and five other physically-active volunteers; age range 20 – 40 years) (1). Participants were randomly assigned to don either the SE or the

BL on one day, and donned the other type of attire on another day, with the same tests then conducted on each day (1).

The researchers measured each participant's range of motion (ROM) in each of the following joints: elbow, shoulder, wrist, knee, ankle, neck, and back (1). They also measured reach distance for sit and reach, stand and reach, and overhead reach actions (1). In addition, the researchers measured the times participants took when wearing each type of attire to complete a series of occupationally-relevant tasks, including single-leg kneel and rise, double-leg kneel and rise (both knees), seated squat, alternating step-up, one-arm search, ladder pick-up, crawl over/under objects, mannequin drag, and object lift (1).

The researchers found that ROM was reduced when wearing the SE in all joints and in the reach tasks, with several of these reductions in ROM being substantial and reaching statistical significance, and the researchers attributed these reductions in ROM to the physical constraints imposed on ROM by the SE (1). Rotation and forward bending of the neck were most affected when wearing the SE, with ROM reducing in these movements by 34% and 42%, respectively (1). The researchers noted that this level of restriction in rotation ROM at the neck is likely to affect peripheral vision, but clearly a substantial restriction to neck bending ROM may also interfere with visibility of the ground, floor hazards, etc. (1). Back extension ROM was also reduced by 30% and ankle ROM was reduced by around 25%; with regard to the latter, the researchers noted that this may affect mobility on the job (1). Distances that the participants could sit and reach and stand and reach when wearing the SE were also reduced by 33% and 32%, respectively (1).

However, participants could complete nearly all of the occupationally-relevant tasks faster when wearing the SE than when wearing the BL, with the only exceptions being the alternating step-up task and the mannequin drag task (1). Those latter tasks were performed only slightly (3% and 12%, respectively) slower when participants were wearing the SE (1). The researchers attributed the increases in speed when completing tasks while wearing the SE to the protection provided by the SE; for example, padding over the knees which protected the participants from the hard surface when crawling, meaning they could crawl faster without fear of injury to their knees (1). However, the researchers also noted that energy expenditure would be greater when wearing the SE, and clearly this increase in energy requirements due simply to the additional loads imposed by the SE would be exacerbated by also performing the tasks faster in the SE, thus requiring a greater power output (i.e., the same amount of work performed in less time) (1).

For the tactical facilitator, the findings of this study indicate that, for the firefighter, the strength of the muscles around the joints and the firefighter's work capacity (aerobic and anaerobic fitness) will be important in determining their occupational performance when wearing personal protective equipment (PPE) (1). Greater strength will enable the firefighter to better cope with the added loads and restrictions imposed by the PPE, so as to maximize their ROM within the limitations of the PPE. Greater work capacity will enable them to more readily sustain the greater power requirements associated with the combination of the added weight of the PPE and the faster times in which they may be able to complete many occupational tasks when wearing PPE, the latter due to the protection afforded to their body by the PPE.

INCREASING AGE IN LAW ENFORCEMENT OFFICERS IS ASSOCIATED WITH DECLINES IN AEROBIC FITNESS, MUSCULAR ENDURANCE, AND LEG POWER

Lockie and colleagues note that given the range of ages of law enforcement officers and the consistency of job tasks (regardless of age), it is important to understand how physical capacity changes with age, so that physical training can be designed to address any identified shortfalls that might adversely affect job performance (3). To address this need, they conducted a retrospective study of records of 383 United States law enforcement officers (average age 38 years; ages ranging between 20 – 59; 362 males, 21 females) to examine the associations between age and physical performance on a range of physical performance tests, with separate analyses conducted for male and female officers (3).

In both male and female officers, average flexibility assessed by a sit-and-reach test was maintained across the range of ages (3). In male officers, average push-up performance was maintained across the range of ages, but in female officers, average push-up performance reduced by half in those aged 30 – 39 and 40 – 49 years when compared to those aged 20 – 29 years (3). Conversely, in male officers, average sit-up performance declined steadily with age, by a cumulative total of 16%; whereas in female officers, average sit-up performance did not decline with age (3). In both male and female officers, average vertical jump height declined steadily with age by a cumulative total of 16% and 17%, respectively; though only the change for males reached statistical significance, potentially due to the small number of female officers in the study sample (3). Time to complete a 2.4-km run also increased with age in both male and female officers by a cumulative total of 15% and 24%, respectively; though again, only the change for males reached statistical significance (3).

The findings relating to sit-up and push-up performance are interesting due to the fact that performance on each of these tests declined in officers of one sex but not the other, while each sex maintained performance on one test, which suggests that the declines in muscular endurance represented in these findings for officers of each sex are likely to be preventable and reversible through appropriate physical training. The authors recommend carefully-designed training programs to address all of these declines in physical performance that were found to be associated with increasing age, noting that such programs must be formulated to fit within the context of the occupational demands and schedules of law enforcement officers, where officers may not have the time to follow a traditional periodization model (3). For the tactical facilitator, the need for regular assessment to underpin program development is also apparent. Such assessment will enable the tactical facilitator to address the specific training needs of subgroups that may be defined by gender, age, fitness, or other factors, in order to ensure that all personnel achieve the levels of conditioning required to perform their occupational tasks safely and effectively.

REFERENCES

1. Coca, A, Williams, W, Roberge, R, and Powell, J. Effects of fire fighter protective ensembles on mobility and performance. *Applied Ergonomics* 41: 636-641, 2010.

2. Goodall, R, Pope, R, Coyle, J, and Neumayer, R. Balance and agility training does not always decrease lower limb injury risks: a cluster-randomised controlled trial. *International Journal of Injury Control and Safety Promotion* 20(3): 271-281, 2012.

3. Lockie, R, Dawes, J, Kornhauser, C, and Holmes, R. A cross-sectional and retrospective cohort analysis of the effects of age on flexibility, strength endurance, lower-body power, and aerobic fitness in law enforcement officers. Publish ahead of print. *Journal of Strength and Conditioning Research*, April 18, 2017.

4. Nagai, T, Lovalekar, M, Wohleber, M, Perlsweig, K, Wirt, M, and Beals, K. Poor anaerobic power/capability and static balance predicted prospective musculoskeletal injuries among Soldiers of the 101st Airborne (Air Assault) Division. *Journal of Science and Medicine in Sport* 20: S11-S16, 2017.

5. Pope, R, Herbert, R, Kirwan, J, and Graham, B. Prediction of attrition in basic military training. *Military Medicine* 164(10): 710-714, 1999.

6. Shusko, M, Benedetti, L, Korre, M, Eshleman, E, Farioli, A, Christophi, C, and Kales, S. Recruit fitness as a predictor of police academy graduation. *Occupational Medicine* 67: 555-561, 2017.

7. Silk, A, Savage, R, Larsen, B, and Aisbett, B. Identifying and characterising the physical demands for an Australian specialist policing unit. *Applied Ergonomics* 68: 197-203, 2018.

8. Stanek, J, Dodd, D, Kelly, A, Wolfe, A, and Swenson, R. Active duty firefighters can improve Functional Movement Screen (FMS) scores following an 8-week individualized client workout program. *Work* 56: 213-220, 2017.

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