

TSAC REPORT

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PHYSICAL FITNESS INITIATIVES IN THE FIRE SERVICE—BARRIERS AND BENEFITS

INTRODUCTION

Firefighters across the United States may be not meeting the recommended fitness levels based on the cardiovascular and metabolic demands of the occupation (7,21,33). Recent statistics indicate that firefighters are at an increased risk of cardiovascular incidents or injury (10,17), which may stem from the strenuous nature of the profession combined with a high prevalence of firefighters being overweight or obese (33). Although recruits are required to undergo extensive training programs, many departments fail to uphold fitness standards among incumbent firefighters. As individuals settle into firehouse culture, unhealthy behaviors (e.g., lack of physical activity, poor sleep habits, and unhealthy diet) may arise and leave firefighters physically unprepared for duty (16). While many of the governing bodies of the United States Fire Service (e.g., National Fire Protection Association (NFPA), International Association of Fire Chiefs (IACF), and International Association of Firefighters (IAFF)) encourage mandatory annual health screenings and on-duty exercise, only an estimated 27% of United States departments actually provide such resources (12). Therefore, the purpose of this article is to identify and discuss some barriers and benefits of training initiatives among professional firefighters.

BARRIERS

INTRAPERSONAL

Barriers to physical training may occur at the individual or departmental level. A qualitative study analyzing the perception of training initiatives identified that firefighters may avoid working out while on shift for fear that it could interfere with response to an emergency call (22). For instance, it was reported that training on-duty was avoided so as to not arrive at a scene fatigued. While this is a major concern for firefighters, a study by Dennison et al. sought to examine the effects of exercise on occupational performance (9). To represent a worst-case scenario, participants engaged in simulated fireground tasks (i.e., stair-climb, hose drag, equipment carry, ladder raise, forcible entry, and search and rescue) 10 min following a fatiguing circuit training exercise protocol. Results indicated that while exhaustive exercise hindered fireground performance, physically trained firefighters outperformed their untrained and non-fatigued counterparts, even in a fatigued state. Even so, it has been recommended to avoid exhaustive exercise (e.g., near-max efforts, rating of perceived exertion 9 – 10) while on-duty or to exercise during low call volume times to ensure peak performance (1).

Another potential barrier may be that many firefighters are unaware of their current health status. Baur et al. reported that, of 768 professional firefighters, approximately 68% underestimated their respective BMI classification (4). Moreover, firefighters

self-perceived fitness levels did not align with actual fitness measured by aerobic capacity (31). Due to this lack of personal awareness, the perceived need to improve health may be diminished (36). Through the provision of mandatory, non-punitive health screenings and appropriate consultations, firefighters can potentially identify these weaknesses and begin improving upon poorer components of health (36).

INTERPERSONAL

Similar to the general population, lack of self-motivation and ambivalence can be highly influenced by social groups (e.g., firehouse culture), and are frequently reported deterrents to exercise among firefighters (6). One recent study noted the negative impact food cultural (i.e., snacking, grazing, and eating out) can have on exercise routines in the firehouse (24).

Interpersonal relationships can, however, have a positive influence on firefighter fitness. Competition and camaraderie appear to be particularly strong motivators among this profession (22,23). It is possible that the initiation of group-based exercise sessions may improve exercise adherence, shift cohesion, and create a sense of accountability. Additionally, firefighters can become qualified to lead such sessions with certifications such as the Tactical Strength and Conditioning Facilitator® (TSAC-F®) through the National Strength and Conditioning Association (NSCA) or Peer Fitness Trainer certification through the American Council on Exercise (ACE).

INSTITUTIONAL

One prominent barrier from the departmental level is a lack of funding, especially among many smaller communities (12). However, a lack of space or equipment should not be considered an impediment to exercise. Although supplying each station with fitness equipment may be unfeasible, recommended alternatives include incorporating one centralized location, involving a contracted fitness center, or utilizing available outdoor space (18). Moreover, body weight exercises and plyometrics can sufficiently improve strength and force production (8), with the addition of firehouse equipment (e.g., stairs, hoses, chains) to be used as external weight when appropriate (30). Grants, such as the Assistance to Firefighters Grant programs, are also available for the promotion of health initiatives.

BENEFITS

PHYSICAL HEALTH

Firefighters have been shown to demonstrate multiple impaired health metrics, including increased levels of adiposity, hypertension, and dyslipidemia (7,13). This is of concern, as each is considered a risk factor for cardiovascular disease. Of

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particular importance, high blood pressure has been shown as a strong predictor of fatal cardiovascular incidents (13). Fortunately, lifestyle changes, such as increased physical activity and improved diet, can help promote favorable body composition and blood panels. Additionally, more fit firefighters have shown fewer cardiac abnormalities during stress testing (5) and fewer injuries (32) than their less fit counterparts.

Many previous studies have evaluated the efficacy of training initiatives among the fire service. For example, a study by Poston and colleagues sought to determine the benefits of health promotion programs within the fire service (34). In this study, researchers compared 10 departments that complied with multiple crucial components of the IAFC and IAFFs' Wellness Fitness Initiative (WFI) to 10 departments that did not. Results indicated that the departments that provided employees with annual health screenings, a health and fitness coordinator, peer fitness trainers, and time to exercise while on-duty tended to demonstrate more desirable physical, behavioral, and mental health. More specifically, WFI compliant departments were 42% less likely to be obese and more likely to be cognizant of current weight status. Additionally, these firefighters reported more physical activity, greater estimated aerobic capacity ($\text{VO}_{2\text{max}}$), job satisfaction, and lower incidence of hypertension.

Likewise, a recently published meta-analysis by Andrews et al. calculated that exercise interventions among firefighters were capable of eliciting significant moderate-to-large improvements in body fat percentage (-7.73%), aerobic capacity (+8.7%), endurance (+17.61%), strength (+8.83%), and power (+5.28%) (3). Controls, in contrast, demonstrated a <1% mean change in the same metrics, with the exception of strength (+2.48%). Furthermore, the authors concluded that a program structured around resistance training may be the most efficacious among firefighters, as those studies in particular observed the greatest number of improvements. It may be worth noting that while exercise interventions elicited improvements in four of the five components of physical fitness, non-significant improvements were reported for flexibility. These results may suggest that emphasizing flexibility training may be necessary for improving flexibility or mobility.

JOB PERFORMANCE

Departments may also benefit from health promotion programs as it applies to improved job performance. Occupational tasks can require high amounts of aerobic fitness ($\geq 44 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) and muscular strength ($\geq 68 \text{ kg}$) for extended periods of time (14). Adding strain caused by the environment (e.g., heat, anxiety, dehydration), these tasks are performed in protective gear weighing at least 23 kg (28). If a firefighter is physically unable to execute these tasks in harsh conditions, the safety of the public, engine, and self are placed at risk.

Considering the physical demands associated with the job, it is apparent that more fit individuals are more likely to better execute physical job tasks. To further support this, an abundance of previous literature has reported associations between fitness and job performance (25,26,29,35). For instance, Michaelides et al. found that upper-body and abdominal strength, upper-body endurance, and anaerobic power all contributed to enhanced performance on time to completion of a simulated fireground test (i.e., stair climb, rolled hose lift and move, Keiser sled, hose pull and hydrant hookup, mannequin drag, charged hose advance) (25). Conversely, performance decreased with increased resting heart rate, body mass index, body fat percentage, age, and waist circumference. This is in agreement with the findings of Rhea and associates (35), which indicated that upper-body strength and endurance, lower-body endurance, and sprint time were associated with time to completion of a similar test (i.e., hose pull, victim drag, stair climb, equipment hoist). These results lend support to the notion that physical training is essential for peak physical job performance (36).

ECONOMIC

Training programs may also appeal to departments from an economic standpoint. Seven years post implementation, the WFI reports indicate that despite a 5% increase in total injury claims, the average cost per claim decreased by 23% (18). In comparison, non-WFI compliant departments observed a 22% increase in claims and a 35% increase in average cost per claim (18). Moreover, engaged departments demonstrated fewer missed days and less of an increase in total incurred costs than those not. While a study by Poston and colleagues surprisingly found that departments complying with multiple components of the WFI reported higher workers compensation claims than non-compliant departments, the authors note that these claims may be a result of more physical activity or that these firefighters were more comfortable reporting injuries (34). In addition, Jahnke and associates found that although the risk of exercise-induced injury was greater in those that habitually exercised while on-duty, the incidence rate of non-exercise injury was significantly lower (20).

In agreement with these findings, another study by Poston et al. identified that the number of missed workdays due to injury was proportional to increasing weight status/body mass index (33). Subsequent costs associated with these absences ranged from ~\$5,076 for healthy weight firefighters to ~\$25,271 for those that were class I or II obese. There were, however, no differences in the prevalence or type of injury between healthy and overweight or obese firefighters. Additionally, poor physical fitness has been reported as one of the leading causes of on-duty injury (27).

CONSIDERATIONS

While implementing fitness programs for the fire service is essential to increasing health and wellness measures, several considerations are warranted prior to their adoption. For instance,

a needs assessment should be performed to determine available resources. Additionally, fitness assessments should be performed to identify weaknesses in physical capabilities (e.g., cardiovascular health, muscular strength). Though, based on recommendations through the NFPA, results should not be used for punitive purposes. Laboratory and occupational assessments, along with annual physician health screenings, may also educate firefighters who are at high risk for disease, and clear employees for physical activity before beginning a program. As normative values for firefighters continue to be established regarding physical health and occupational performance, data collected from individual departments can further provide information regarding strengths and weaknesses, and available funds may be allocated where deemed most necessary. While simply adopting an assessment program has the potential for behavioral change, multiple variables (e.g., consultation with local government or an audit) may be needed prior to a warranted increase in departmental procedures and funding.

Other considerations should be made in terms of optimal training styles. As previously discussed, resistance training should account for a large proportion of regimens among this population (3). Tactical personnel, though, may find functional or circuit training modalities appealing, as they stress both the aerobic and anaerobic systems and transfer well to job specific requirements (2,15). Furthermore, they also require less time commitment, less costs, and can be modified for varying skill levels (15). To evaluate the physiological responses to circuit training compared to actual fireground tasks, Abel et al. monitored blood lactate and heart rate before and following an extensive training circuit (2). Participants completed two rotations of the following exercises interspersed with 30 s of rest: cable pulldown, seated row, leg press, shoulder press, deadlift, step-up, wood chop, single-arm cable pull, step-up, push-up, and abdominal crunch. While heart rate was comparable to performing smoke-diving tasks, it did not elicit a heart rate response similar to fire suppression tasks. Therefore, these results imply that circuit training may be an appropriate training stimulus for some firefighter tasks but not all. As such, and based on the metabolic demands of the occupation, this form of exercise should be periodized with an additional emphasis on higher-intensity cardiovascular exercise (14).

While exercise has been shown to be beneficial, it is important that individuals also learn fundamental movement patterns. Strain, sprain, and muscular pains caused by overexertion are consistently among the leading causes of injury within the service (17). These musculoskeletal injuries are often accompanied by poor mobility or flexibility (19). Frost et al. emphasized the role of corrective exercise techniques in a study comparing the movement patterns of firefighters while completing typical movements associated with the occupation (i.e., lifting from floor to waist height, squat, lunge, push, pull) (11). Participants were categorized into either a standard exercise group, with emphasis on promoting

performance and peak fitness; a movement-guided training group, with emphasis on execution of key movement patterns (e.g., spinal control); or a control group. Following 12 weeks of training, both exercise groups demonstrated improvements in body composition, aerobic capacity, grip strength, upper-body endurance, lower-body power, and flexibility. The movement-guided group, though, exhibited less spine and frontal plane knee motion during occupational-related tasks. It is within reason to speculate that these adaptations could result in fewer injuries. Given this information, training initiatives should strive to teach proper form and the avoidance of potentially harmful movement patterns.

PRACTICAL APPLICATIONS

Noting the aforementioned benefits of physical training programs, it is apparent that fire departments should implement, and actively support, exercise initiatives. Barriers of physical health initiatives can often be overcome, and the benefits can occur in health, performance, and economic domains. Baseline health screenings are encouraged to identify weaknesses and contraindications to exercise, although results should not be used for punitive purposes. Furthermore, functional or circuit style training modalities may be particularly efficacious among this population, given the reduced cost and time commitment, as well as the transfer to job-specific tasks. Finally, programs should ideally be under supervision of experienced personnel who emphasize the importance of correct movement patterns. Therefore, departments interested in implementing wellness programs may find success in partnering with strength and conditioning facilities or local universities.

REFERENCES

1. Abel, MG. Concerns and benefits of on-duty exercise training for firefighters. *TSAC Report* 23(1): 1-4, 2012.
2. Abel, MG, Mortara, AJ, and Pettitt, RW. Evaluation of circuit-training intensity for firefighters. *Journal of Strength and Conditioning Research* 25(10): 2895-901, 2011.
3. Andrews, KL, Gallagher, S, and Herring, MP. The effects of exercise interventions on health and fitness of firefighters: A meta-analysis. Published ahead of print. *The Scandinavian Journal of Medicine and Science in Sports*, 2019.
4. Baur, DM, Christophi, CA, Tsismenakis, AJ, Jahnke, SA, and Kales, SN. Weight-perception in male career firefighters and its association with cardiovascular risk factors. *BMC Public Health* 12(480): 1-8, 2012.
5. Baur, DM, Leiba, A, Christophi, CA, and Kales, SN. Low fitness is associated with exercise abnormalities among asymptomatic firefighters. *Occupational Medicine* 62(7): 566-590, 2012.
6. Bonnell, E, Huggins, M, and Bonham, MP. Factors influencing rotating shift workers eating habits: A cross-sectional study of Melbourne Metropolitan fire fighters. *Journal of Nutritional and Intermediary Metabolism* 4(12): 24-38, 2016.

PHYSICAL FITNESS INITIATIVES IN THE FIRE SERVICE— BARRIERS AND BENEFITS

7. Clark, S, Rene, A, Theurer, WM, and Marshall, M. Association of body mass index and health status in firefighters. *Journal of Occupational and Environmental Medicine* 44(10): 940-946, 2002.
8. Davies, G, Riemann, BL, and Manske, R. Current concepts of plyometrics exercise. *International Journal of Sports Physical Therapy* 10(6): 760-786, 2015.
9. Dennison, K, Mullineaux, D, Yates, J, and Abel, M. The effect of fatigue and training status on firefighter performance. *Journal of Strength and Conditioning Research* 26(4): 1101-1109, 2012.
10. Fahy, RF, LeBlanc, PR, and Molis, JL. Firefighter fatalities in the United States-2017. Quincy, MA: NFPA Research, Data, and Analytics Division; 2018.
11. Frost, DM, Beach, TA, Callaghan, JP, and McGill, SM. Exercise-based performance enhancement and injury prevention for firefighters: Contrasting the fitness- and movement-related adaptations to two training methodologies. *Journal of Strength and Conditioning Research* 29(9): 2441-2459, 2015.
12. Fourth needs assessment of the U.S. fire service. Quincy, MA: National Fire Protection Association, 2016.
13. Geibe, JR, Holder, J, Peebles, L, Kinney, AM, Burress, JW, and Kales, SN. Predictors of on-duty coronary events in male firefighters in the United States. *American Journal of Cardiology* 101(5): 585-589, 2008.
14. Glenhill, N and Jamnik, VK. Characterization of the physical demands of firefighting. *Canadian Journal of Sport Science* 17(3): 207-213, 1992.
15. Haddock, CK, Poston, WSC, Heinrich, KM, Jahnke, SA, and Jitnarin, N. The benefits of high-intensity functional training programs from military personnel. *Military Medicine* 181(11): e1508-e1514, 2016.
16. Haddock, CK, Poston, WS, and Jahnke, SA. Addressing the epidemic of obesity in the United States fire service. Greenbelt, MD: National Volunteer Fire Council, 2011.
17. Haynes, HJG and Molis, JL. United States firefighters injuries-2016. Quincy, MA: NFPA Research, Data, and Analytics Division; 2017.
18. International Association of Fire Chiefs, International Association of Fire Fighters. *The Fire Service Joint Labor Management Wellness-Fitness Initiative*. Washington DC: International Association of Fire Chiefs and International Association of Fire Fighters; 2018.
19. Jafari, M, Zolaktaf, V, and Ghasemi, G. Functional movement screening (FMS) composite scores in firefighters: effects of corrective exercise training. *Journal of Sport Rehabilitation* 1-21, 2018.
20. Jahnke, SA, Poston, WSC, Haddock, CK, and Jitnarin, N. Injury among a population based sample of career firefighters in the central USA. *Injury Prevention* 19(6): 393-398, 2013.
21. Li, K, Lipsey, T, Leach, HJ, and Nelson, TL. Cardiac health and fitness of Colorado male and female firefighters. *Occupational Medicine* 67: 268-273, 2017.
22. Lovejoy, S, Gillespie, GL, and Christianson, J. Exploring physical health in a sample of firefighters. *Workplace Health and Safety* 63(6): 253-258, 2015.
23. Mabry, L, Elliot, DL, MacKinnon, DP, Thoemmes, F, and Kuehl, KS. Understanding the durability of a fire department wellness program. *American Journal of Health Behavior* 37(5): 693-702, 2013.
24. Melton, B, Ryan, GA, Bigham, L, and Pedigo, J. Qualitative assessment of barriers and ideal wellness programming among rural firefighters. Published ahead of print. *Journal of Occupational and Environmental Medicine*, 2019.
25. Michaelides, MA, Parpa, KM, Henry, LJ, Thompson, GB, and Brown, BS. Assessment of physical fitness aspects and their relationship to firefighters' job abilities. *Journal of Strength and Conditioning Research* 25(4): 956-965, 2011.
26. Michaelides, MA, Parpa, KM, Thompson, J, and Brown, BS. Predicting performance on firefighter's ability test from fitness parameters. *Physical Education, Recreation, and Dance* 79(4): 468-475, 2008.
27. Moore-Merrell, L, McDonald, S, Zhou, A, Fisher, E, and Moore, J. Contributing factors to firefighter line-of-duty death in the United States. *International Association of Firefighters* 1-56, 2006.
28. National Fire Protection Association 1582. Standard on comprehensive occupational medical program for fire departments. Quincy, MA: NFPA Fire Analysis and Research Division, 2018.
29. Nazari, G, MacDermid, JC, Sinden, KE, and Overend, TJ. The relationship between physical fitness and simulated firefighting task performance. *Rehabilitation Research and Practice* 1-7, 2018.
30. Pawlak, R, Clasey, JL, Symons, TB, and Abel, MG. The effect of a novel tactical training program on physical fitness and occupational performance in firefighters. *Journal of Strength and Conditioning Research* 29(3): 578-588, 2015.
31. Peate, WF, Lundergan, L, and Johnson, JJ. Fitness self-perception and VO2max in firefighters. *Journal of Occupational and Environmental Medicine* 44(6): 546-550, 2002.
32. Poplin, GS, Roe, DJ, Burgess, JL, and Peate, WF, and Harris RB. Fire fit: Assessing comprehensive fitness and injury risk in the fire service. *International Archives of Occupational and Environmental Health* 89(2): 251-259, 2015.
33. Poston, WS, Jitnarin, N, Haddock, CK, Jahnke, SA, and Tuley, BC. Obesity and injury-related absenteeism in a population-based firefighter cohort. *Obesity* 19(10): 2076-2081, 2011.
34. Poston, WS, Haddock, CK, Jahnke, SA, Jitnarin, N, and Day, RS. An examination of the benefits of health promotion programs for the national fire service. *BMC Public Health* 13: 805, 2013.
35. Rhea, MR, Alvar, BA, and Gray, R. Physical fitness and job performance of firefighters. *Journal of Strength and Conditioning Research* 18(2): 348-352, 2004.

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BRIDGET MELTON, EDD, CSCS, TSAC-F, AND GREG RYAN, PHD, CSCS, TSAC-F

36. Sell, K, Abel, M, and Domitrovich, J. Physiological issues related to fire and rescue personnel. In: Alvar BA, Sell K, Deuster PA (Eds.), *NSCA's Essentials of Tactical Strength and Conditioning*. Champaign, IL: Human Kinetics; 455-485, 2017.

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1. Murdoch RC, Hagen JA. Soldier safety and performance through wearable devices. Proceedings of SPIE. 2018;10639.

2. Eckart RE, Scoville SL, Campbell CL, et al. Sudden death in young adults: A 25-year review of autopsies in military recruits. *Ann Intern Med*. 2004;141(11):829-834.

3. Armed Forces Health Surveillance Branch. Update: Heat Illness, Active Component, US Armed Forces. <https://health.mil/News/Gallery/Infographics/2017/04/04/Update-Heat-Illness-Active-Component-US-Armed-Forces-2016>.

TSAC REPORT—APRIL 2019 RESEARCH COLUMN

RESPIRATORY RESPONSES DURING EXERCISE IN SELF-CONTAINED BREATHING APPARATUS AMONG FIREFIGHTERS AND NONFIREFIGHTERS. SAFETY AND HEALTH AT WORK 9(4): 468-472, 2018. HOSTLER, D, AND PENDERGAST, DR.

A recent study conducted at the Center of Research and Education in Special Environments examined the effect of using self-contained breathing apparatuses (SCBA) in firefighters. SCBAs are required pieces of equipment used by firefighters in their line of duty; however, the impairment of the respiratory mechanics caused by using a SCBA may affect firefighters during physical exertion.

Ten firefighters and ten nonfirefighters (eight males and two females in each group) completed all phases of the study. Firefighters had an average of 11.7 years of experience. Maximal aerobic capacity ($\text{VO}_{2\text{max}}$) was measured on day one using a cycle ergometer. Participants then returned on separate days to complete a submaximal test based on 25, 50, and 75% of their $\text{VO}_{2\text{max}}$ while wearing either control attire (shorts, t-shirt, athletic shoes, SCBA facemask only), or firefighter attire (heavy coat, fire resistant hood, helmet and full SCBA unit). The submaximal test consisted of a 2-min warmup at 25W pedaling at 60 revolutions per minute (RPM), followed by three 5-min stages at the appropriate resistance to achieve 25, 50, and 75% of their $\text{VO}_{2\text{max}}$.

In this study, the firefighters were statistically heavier (FF: 89.4 ± 10.4 kg, NON: 73.4 ± 10.1 kg) and older (FF: 32.9 ± 7.6 years, NON: 20.8 ± 1.7 years) than nonfirefighters. However, relative $\text{VO}_{2\text{max}}$ did not differ between the groups (FF: 34.4 ± 6.6 L/min, NON: 39.2 ± 7.9 L/min). Nonfirefighters had a significantly higher respiratory rate (FF: 25 ± 7 breaths per min, NON: 34 ± 10 breaths per min) when breathing with the SCBA, however, firefighters showed no difference between wearing the SCBA (25 ± 7 breaths per min) and the facemask alone (24 ± 5 breaths per min). Furthermore, firefighters breathing frequency during maximal testing was ~20% less than the nonfirefighter group.

Heart rate as a function of oxygen consumption increased more so in the nonfirefighters. This means firefighters were more efficient at utilizing the oxygen they consumed. Additionally, end-tidal CO_2 (the amount of CO_2 exhaled) was higher in firefighters at all work rates and increased more so than the nonfirefighters while wearing the SCBA. These results led the researchers to conclude that years of using SCBA have altered the breathing mechanics in firefighters, allowing them to physically perform while they hypoventilate to aide in conserving O_2 supply. Tactical facilitators working with firefighters should consider including SCBAs during exercise to aide in this adaptation, especially for new firefighters.

EFFECTS OF PERSONAL PROTECTIVE EQUIPMENT ON METABOLISM AND PERFORMANCE DURING AN OCCUPATIONAL PHYSICAL ABILITY TEST FOR FEDERAL HIGHWAY POLICE OFFICERS. PUBLISHED AHEAD OF PRINT. JOURNAL OF STRENGTH AND CONDITIONING RESEARCH, 2018.

MARINS, EF, CABISTANY, L, FARIAS, C, DAWES, J, AND DEL VECCHIO, FB.

Tactical personnel often perform their duties while wearing additional loads. These loads can be in the form of personal protective equipment (PPE) or other torso-borne loads. A recent article examined the metabolic and performance cost while wearing PPE in federal highway police officers. Thirteen male officers completed an Occupational Physical Ability Test (OPAT) with and without PPE.

Prior to testing, anthropometric data were collected using a digital scale and stadiometer. On both days, officers wore a heart rate monitor. In the condition without the PPE (NPPE), officers wore standard work out attire (t-shirt, pants, and boots) as well as a training long gun with a total weight of 5.2 kg. During the PPE condition, officers carried the same training long gun and wore their issued PPE as well as a tactical belt with the basic accessories an officer would carry on the job (e.g., handcuffs, pepper spray, pistol holster with training pistol, and flashlight). The total load in this condition was 12 kg.

The OPAT used was designed, based on previous literature, to simulate the performance of various actions and movements related to police work. Each task in the OPAT was performed consecutively without rest on a grass field. Officers started in a car seat with the training long gun in a sling across their chest. The OPAT tasks included: 1) exiting a vehicle and sprinting 30 m to a cone while carrying the long gun, 2) zig-zagging between four barriers set 10 m apart while also performing the firing position known as "tower" (one knee flexed touching the ground and the other flexed at the front with foot supporting), raising the weapon to a firing position, and moving to the next barricade, 3) jumping over two barriers (0.6 m tall) set 10 m apart with the training gun slung to the back, 4) running 10 m before having to jump over two 1.5-m long obstacles set 10 m apart, 5) dragging a dummy (53 kg) for 15 m 6) collecting four traffic cones over 15 m and placing them in the trunk of a car, 6) pushing a car for 10 m (this last task had a 30-s time limit).

The use of a PPE caused officers to complete the OPAT significantly slower than without (125.9 ± 13.8 s vs 118.3 ± 11.0 s). Tasks 1, 3, 4, and 6 were performed significantly slower with PPE compared to NPPE. Heart rate variability, maximum heart rate, and perceived exertion during the OPAT did not differ between the

conditions. Additionally, blood lactate was elevated immediately after the OPAT in the NPPE condition. The increase in blood lactate is possibly due to the officers being able to move faster without the PPE.

Overall, tactical facilitators who work with police officers should consider incorporating the use of PPE into agility drills and high-intensity intervals 2 – 3 times per week to allow officers to adapt to the additional weight and the mobility restriction. Emphasis should be placed on agility and power due to the importance of change of direction, acceleration, and deceleration in police work. This may allow officers to better perform job tasks while wearing PPE.

EPIDEMIOLOGY OF MUSCULOSKELETAL INJURIES AMONG US AIR FORCE SPECIAL TACTICS OPERATORS: AN ECONOMIC COST PERSPECTIVE. *BMJ OPEN SPORT AND EXERCISE MEDICINE* 4(1): 2018.

LOVALEKAR, M, JOHNSON, CD, EAGLE, S, WOHLEBER, MF, KEENAN, KA, BEALS, K, NINDL, BC, AND CONNABOY, C.

Knowing what musculoskeletal injuries (MSI) are common among tactical personnel is important information for the tactical facilitator and the human performance team, and may help to monitor and prevent these injuries from occurring. Researchers recently examined the medical records of 130 Air Force Special Tactics Operators over the course of one year to study the rates and cost of MSI.

An MSI was defined as an injury to the musculoskeletal system (bones, ligaments, tendons, muscles, etc.) for which medical care was sought and recorded. Certain MSI were labeled as “preventable” if they could have been prevented through an injury prevention training program. Previous literature was used to categorize these MSI. Additionally, the cost associated with the MSI was determined using the Cost of Injury Reports from the National Center for Injury Prevention and Control Web-based Injury Statistics Query and Reporting System.

Over the course of one year, 110 MSI were recorded, with 46 labeled as preventable. Out of the 130 Special Tactics Operators, 34 had one, 16 had two, 12 had three, two had four, and 66 had zero recorded MSI. These results worked out to 35.4 preventable MSI per 100 participants per year. The lower extremity was the most common location for MSI, followed closely by the spine, then the upper extremities (a very small percentage occurred in the torso). The most common cause of preventable MSI was lifting (47.8%) followed by ruck marching (13%). Pain/spasm/ache was the most common type of MSI, followed by tendon-related issues. Based on the preventable MSI reported in the 130 Special Tactics Operators, the authors estimated the total lifetime cost was around US\$440,000.

Based on the reported MSI and associated costs, tactical facilitators who work with the military should monitor lifting (47.8% preventable MSI), walking, and running, especially with a rucksack (13.0% preventable MSI), for injury risk in training. Emphasizing good technique during physical training may help lower MSI rates, since a large portion of the injuries (38%) occurred during PT. The authors of the study did not identify if the PT was supervised, as those data may not have been available.

ABOUT THE AUTHORS

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SURVIVAL SWIMMING PERFORMANCE ENHANCEMENT WORKSHOP—MENTAL SKILLS AND VIRTUAL REALITY TO MANAGE ACROPHOBIA

INTRODUCTION

It is believed that wariness of heights progresses across the lifespan and is driven by developments in visual proprioception (5). For some, wariness of heights is significant, and in extreme cases, individuals can develop a debilitating fear known as acrophobia. This clinical disorder is frequently cited as affecting approximately 5 – 6.8% of the general population and can significantly affect quality of life and health outcomes (8). Individuals suffering from acrophobia experience mental, emotional, and physiological strain in a variety of situations when they perceive themselves to be far from the ground. Symptoms range in severity and may include a sense of panic, feelings of anxiety, shakiness and instability, increased cardiovascular activation, and difficulty rationalizing the situation. Like other phobias, acrophobia often contributes to avoidance behaviors. For example, individuals with severe acrophobia may structure their lives in a way to avoid heights, such as living on the first floor, avoiding driving over bridges, and abstaining from air travel. Consequences to individuals suffering from acrophobia include limiting life activities and spending excessive amounts of time and money to avoid instances where heights could be problematic.

For cadets at the United States Military Academy (USMA) at West Point, this issue can be a significant deterrent to successful performance in the survival swimming course, a requirement to graduate and commission as an officer in the US Army. A heights-based test, in which cadets step off of a 6.5-m tower into water in full combat uniform, is part of this course and is a requirement for graduation. Cadets who struggle in this course experience acrophobia, fear of water (i.e., hydrophobia), performance anxiety, or some combination of the three (9). Based on general population figures, approximately 55 per class year (5%) of otherwise generally exemplary cadets, will struggle specifically with acrophobia. Inability to execute this task results in failing the entire course, regardless of swim performance on other tests, and after three class failures cadets are separated (expelled), preventing graduation and commissioning. For many cadets struggling over the course of several semesters, the challenge has far-reaching consequences, often causing significant psychological distress and performance decrements in all areas of life. Additionally, USMA spends roughly \$62,500 annually per cadet. This indicates a financial incentive for USMA to develop resources to assist these cadets in managing their acrophobia.

There is an immediate need to provide support and resources to assist these cadets throughout this process from both humanistic and financial perspectives. The Performance Psychology Program (PPP) in the Center for Enhanced Performance is one such entity at the academy uniquely positioned to do this. PPP staff are individuals trained in the academic discipline of sport and performance psychology along with graduate student interns operating under trainer supervision. This article will highlight an intervention involving mental skills training and virtual reality (VR) to address acrophobia with this population.

HOW PERFORMANCE PSYCHOLOGY CAN ASSIST CADETS

Currently, the PPP's educational model teaches five core mental skills considered to be essential to high-level performance: confidence, energy management, attention control, imagery, and goal setting. These skills are taught through several courses, cadet-initiated one-on-one training sessions, team meetings (e.g., Division I teams, club teams, Sandhurst teams), and group workshops (e.g., captains, military school prep, position players). PPP staff regularly seek to better understand cadet needs and offer opportunities for the development of mental skills relevant to their performances, including those related to the survival swimming course.

There are several interventions that have been demonstrated to alleviate the symptoms of acrophobia that fall under the purview of the PPP. For example, cadets who struggle with performance anxiety may be taught affirmations to increase confidence, relaxation strategies to decrease arousal, and/or focusing techniques to control attention prior to engaging in graded events. Specific to acrophobia, research has demonstrated that even a single 15-min imaginal intervention can significantly reduce scores on the Heights Interpretation Questionnaire (1). *In vivo* experiences and traditional exposure therapy (systematic desensitization to heights in the real world) alongside a trained therapist have also been demonstrated to be effective, with recent research suggesting that VR may be just as effective as more traditional therapies (4). One study even indicated that VR treatment may be superior to traditional techniques, especially at a long-term follow-up (2). Other studies and several reviews have duplicated these findings, indicating that VR may lessen the symptoms of acrophobia, decrease self-reported outcomes on various acrophobia-related scales, and provide sustainable improvements in acrophobia symptoms and avoidance behavior (6).

SURVIVAL SWIMMING PERFORMANCE ENHANCEMENT WORKSHOP— MENTAL SKILLS AND VIRTUAL REALITY TO MANAGE ACROPHOBIA

A BLENDED MENTAL SKILLS AND VIRTUAL REALITY PROGRAM FOR PERFORMANCE ENHANCEMENT

The Survival Swimming Workshop Program includes a mental skills training and VR workshop series spanning the eight-week duration of the Survival Swimming course. The goal of this intervention is to increase the success rate of cadets with acrophobia in the survival swimming course heights-based test through mental skills and VR training. Fifty-minute workshops are held twice each week, and include classroom group discussions of mental skills that compliment physical training in the course (e.g., arousal regulation strategies, imagery, affirmations, cognitive restructuring, pre-performance routines, etc.) and applied training at the aquatics facility to integrate mental skills in a context-specific environment. The workshops are taught utilizing a combination of exposure therapy and cognitive behavioral strategies that have been demonstrated to be effective for individuals suffering from acrophobia (2,4). For example, after learning diaphragmatic breathing, cadets are taken to the aquatics facility where they utilize breathing in their pre-performance routine to reduce arousal and step off of a one-meter tower; upon successful completion of a low-arousal one-meter tower entry, they progress to the three-meter height, and so forth. Workshops are offered at common “off” hours twice each week, and cadets attend as often as their schedule allows. Cadets who cannot attend workshop topics they are interested in schedule individual training sessions with PPP staff.

VR training is incorporated into this workshop series to improve program effectiveness as well as provide additional training opportunities outside of the pool. Cadets engage in adapted VR exposure therapy (VRET) in order to desensitize symptoms of acrophobia and enhance performance in the survival swimming course. An Oculus Rift is used to play 360-videos of the tower entry test at varying heights both with and without instructor commands. Similarly, cadets engage in arousal reduction strategies prior to increasingly challenging virtual scenarios until they have mastered a low-arousal 6.5-m VR tower entry. Heart rate variability is measured through biofeedback monitors (e.g., EmWave2 by HeartMath) in order to provide visual, objective feedback to the cadet. In addition to VR and VRET access through the workshops, cadets can walk in during normal business hours for brief VR and VRET training interventions. Training is overseen by a member of the PPP, who will be able to provide additional mental skills training and debrief the experience. Between the exceptionally busy schedules of cadets and the extremely limited pool and tower access on post, these brief walk-in interventions vastly improve training opportunities and enhance cadet performance.

Cadets who regularly engage in this program master several mental skills that facilitate performance in the survival swimming course as well as performance in other areas at USMA. Cadets generally report increased confidence, improved self-regulation

abilities, and decreased sensitivity to heights following regular use of VR and VRET. Although this program is in its early stages, initial evidence of effectiveness and cadet reporting indicates a blended mental skills and VR program is a promising strategy to address acrophobia amongst tactical populations.

PRACTICAL IMPLICATIONS

Trainers and coaches working with individuals who suffer from acrophobia in similar tactical populations can apply several of these performance enhancing strategies to their populations.

Although VR technologies have become increasingly cost-effective (3), they may not be affordable for all. Regardless, incorporating cognitive restructuring, normalization of the fear response (7), and diaphragmatic breathing into training can assist individuals struggling with acrophobia in tactical training and thus enhance performance. Additionally, teaching coping strategies alongside exposure to progressively graded levels of fear-inducing heights scenarios may improve performance for individuals experiencing acrophobia (6).

Disclaimer: The views expressed herein are those of the author and do not reflect the position of the United States Military Academy, the Department of the Army, or the Department of Defense.

REFERENCES

1. Arroll, B, Henwood, SM, Sundram, FI, Kingsford, DW, Mount, V, Humm, SP, et al. A brief treatment for fear of heights: A randomized controlled trial of a novel imaginal intervention. *The International Journal of Psychiatry in Medicine* 52(1): 21-33, 2017.
2. Arroll, B, Wallace, HB, Mount, V, Humm, SP, and Kingsford, DW. A systematic review and meta-analysis of treatments for acrophobia. *The Medical Journal of Australia* 206(6): 263-267, 2017.
3. Bun, P, Gorski, F, Grajewski, D, Wichniarek, R, and Zawadzki, P. Low-cost devices used in virtual reality exposure therapy. *Procedia Computer Science* 104: 445-451, 2017.
4. Coelho, CM, Silva, CF, Santos, JA, Tichon, J, and Wallis, W. Contrasting the effectiveness and efficiency of virtual reality and real environments in the treatment of acrophobia. *PsychNology* 6(2): 203-216, 2008.
5. Dahl, A, Campos, JJ, Anderson, DI, Uchiyama, I, Witherington, DC, Ueno, M, et al. The epigenesis of wariness of heights. *Psychological Science* 24(7): 1361-1367, 2013.
6. Emmelkamp, PMG, Krijn, M, Hulsbosch, AM, De Vries, S, Schuemie, MJ, and Van der Mast, CAPG. Virtual reality treatment versus exposure in vivo: A comparative evaluation in acrophobia. *Behaviour Research and Therapy* 40(5): 509-516, 2002.
7. Freeman, D, Haselton, P, Freeman, J, Spanlang, B, Kishore, S, Albery, E, et al. Automated psychological therapy using immersive virtual reality for treatment of fear of heights: A single-blind, parallel-group, randomised control trial. *Lancet Psychiatry* 5: 625-632, 2018.

8. Kapfhammer, HP, Huppert, D, Grill, E, Fitz, W, and Brandt, T. Visual height intolerance and acrophobia: Clinical characteristics and comorbidity patterns. *European Archives of Psychiatry and Clinical Neuroscience* 265(5): 375-385, 2015.

9. Westgate, EM. *Overcoming the 6.5 meter tower: Psychological approaches for West Point survival swimming* (Unpublished doctoral dissertation). United States Military Academy, West Point, NY, 2016.



FIGURE 1. AQUATICS DIRECTOR INSTRUCTING PROPER TECHNIQUE FOR FILMING



FIGURE 3. UTILIZING BIOFEEDBACK MONITOR TO MEASURE HEART RATE VARIABILITY ON TOP OF THE 6-M PLATFORM



FIGURE 2. INSTRUCTOR PROVIDING COMMANDS TO WORKSHOP PARTICIPANT

SURVIVAL SWIMMING PERFORMANCE ENHANCEMENT WORKSHOP— MENTAL SKILLS AND VIRTUAL REALITY TO MANAGE ACROPHOBIA

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TSAC—REDUCING THE RISK OF INJURY—USING A HIERARCHY OF CONTROLS

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

USING A HIERARCHY OF CONTROLS TO REDUCE INJURY RISKS

The development of tactical strength and conditioning demands attention to factors that are not significant concerns in most workplaces or sporting contexts. These include the need to prepare personnel to perform in harsh environments and circumstances, where their lives and the lives of people they seek to protect may be under threat from uncontrolled hazards or adversaries, and in which they are required to operate and often wear or carry cumbersome equipment. Such factors also include the need to prepare personnel to operate effectively even when fatigued, under high levels of stress, or nutritionally-deprived. For these reasons, tactical strength and conditioning is often developed through activities that are specific to tactical contexts and simulate some of the hazards, adversaries, stresses, time pressures, loads, equipment and other conditions under which tactical personnel may need to operate. Such approaches are associated with risks of injury and, as is common in wide-ranging workplaces, a hierarchy of controls can be used to identify the best ways to reduce such risks (1,2,3). The goal of this article is to consider how a hierarchy of controls can be used to manage injury risks in the pursuit of tactical strength and conditioning, given the range of factors unique to training and operational contexts of tactical populations.

Hierarchies of controls (1,3) (Figure 1) and ordered lists of injury countermeasure strategies (2,3) (Table 1), which are similar in concept, each start at the top with controls or countermeasures that are the most reliable and effective in reducing injury risks—for example, avoiding creation of hazards or eliminating them when they are identified. They each end at the bottom with controls that may in some circumstances be the only options available to protect or minimize injury consequences for personnel, but are the least reliable and effective for reducing injury risks. The latter types of controls are the least reliable and effective because their routine use or effectiveness can be impaired by neglect (e.g., warning signage fallen down or ignored, safety training inadequate or poorly attended), workplace culture (e.g., a culture of thinking that use of hearing protection is not necessary), damage (e.g., damaged fasteners in protective apparel) or other factors like fatigue—or their use might simply be too late to prevent the injury occurring in the first place (e.g., intervening through early detection and rehabilitation of injuries to minimize injury consequences). Essentially, the use and effectiveness of controls listed at the bottom of the hierarchy of controls or list of countermeasures depends on active engagement with the controls by those at risk and others managing the risks day-to-day. In contrast, controls at the top of the hierarchy or list require little or no engagement by those at risk and so will be effective whether personnel consider them or not. For example, if a particular hazard is eliminated, it can no longer create risk and personnel do not need to consider it when working in order to remain safe from it.

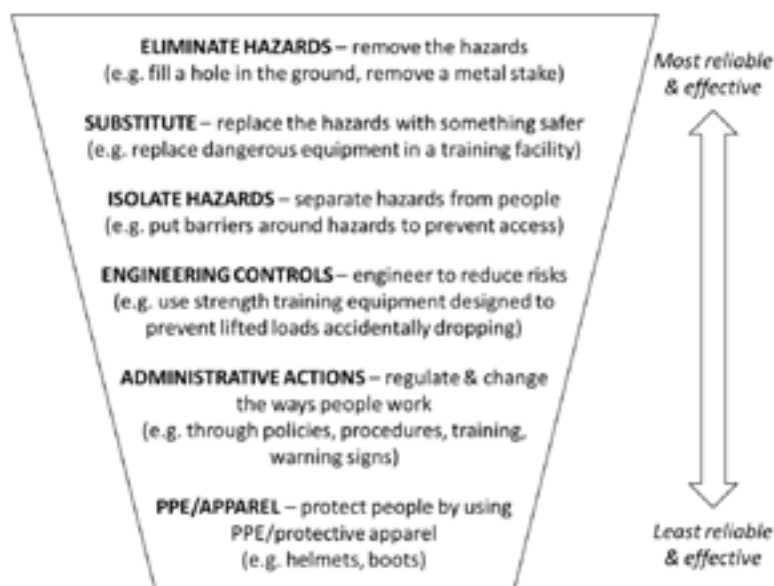


FIGURE 1. HIERARCHY OF CONTROLS (ADAPTED FROM RUSCHENA, 2012 AND NIOSH) (1,3)

TABLE 1. HADDON'S LIST OF 10 COUNTERMEASURE STRATEGIES (ADAPTED FROM RUNYAN, 2003) (2)

COUNTERMEASURE STRATEGIES, IN DESCENDING ORDER OF RELIABILITY AND EFFECTIVENESS
Countermeasure 1: Prevent the creation of the hazard
Countermeasure 2: Reduce the amount of hazard created
Countermeasure 3: Prevent the release of the hazard
Countermeasure 4: Modify the rate of release of the hazard from its source
Countermeasure 5: Separate the hazard from the people to be protected by time and space
Countermeasure 6: Separate the hazard from the people to be protected by a physical barrier
Countermeasure 7: Modify relevant basic qualities of the hazard to make it less potent
Countermeasure 8: Make affected people more resistant to harm from the hazard
Countermeasure 9: Begin to counter harm done by the hazard
Countermeasure 10: Stabilize, repair, and rehabilitate the people who have been injured

In a statement that is highly relevant to tactical populations, Ruschena wrote, “It may seem obvious that if a risk is identified, it should be eliminated. However, a risk-free environment is neither possible nor desirable,” (3). This statement expresses the dilemma faced by tactical strength and conditioning facilitators on a daily basis—they know that personnel cannot be adequately prepared to operate in tactical contexts if all risks are eliminated from the training context, but at the same time they want to keep personnel as safe as practically possible during training and ensure that any real risks are acceptable. Illustrating this point, at the most basic level, strength and conditioning cannot be developed without overload, and overload gives rise to risk. At more advanced levels, training may need to induce fatigue so that personnel can learn how to function despite fatigue. Similarly, the principle of specificity in training may mean that equipment and environments that characterize job tasks need to be simulated during training, potentially introducing risks at that time but reducing risks during subsequent operational task performance by ensuring personnel are optimally prepared.

Considering all this and the advice of Ruschena (3) and Runyan (2), the following points can be considered when planning controls or countermeasures that will reduce injury risks during activities designed to develop tactical strength and conditioning. All of these points assume that a proper risk assessment has already been conducted, with relevant hazards and risk factors identified through this process.

If hazards (e.g., simulated urban building structures, uneven terrain) or operating factors (e.g., fatigue, sense of urgency, perception of threat, speed) are to be deliberately employed during training to ensure personnel are adequately familiarized and prepared for job tasks and conditions, then the degree of risk associated with these should be carefully controlled and the numbers and types of such hazards and factors should be

managed to ensure they do not interact and accumulate to create levels of risk that exceed accepted levels. In this process, relevant occupational health and safety law and regulations applicable to the respective jurisdiction should be carefully considered to ensure compliance. For example, close monitoring of exercise technique may be critical when personnel are fatigued and combining speed or fatigue with hazards that personnel have not previously learned to negotiate may well push risk levels beyond those that are acceptable. Adequate progression will be essential in this context, and complexity of training tasks should only increase as conditioning, skill and knowledge levels grow sufficiently to control associated risks. Some types of activities or ways of conducting them may be prohibited or restricted under relevant law or regulations.

In seeking to control injury risks related to specific hazards and risk factors, start at the top of the hierarchy of controls (Figure 1) or list of countermeasures (Table 1) and consider each option carefully before descending further down the hierarchy or list. Select control options or injury countermeasures that are as close to the top of the list as possible, while considering and balancing the risks of injury occurring during training against risks arising from inadequately preparing personnel for operational duties and conditions.

Consider whether it may be appropriate to implement multiple controls or countermeasures, possibly at different levels of the hierarchy, which are complementary and provide multiple “layers of defense” and/or address multiple and cumulative sources of injury risk. In this way, if one control fails or is insufficient on its own, other controls can ensure risk remains well managed and all contributors are addressed. Injury causation is complex and multifactorial and so rarely will a single solution suffice on its own, to control injury risk.

When selecting controls or countermeasures, consider the time sequence of injuries, which extends from the pre-injury phase, to the time of injury, and then to the immediate post-injury phase and later post-injury phase. It may be possible to implement controls or countermeasures that reduce injury risks across these different phases to more effectively manage injury risks. For example, before training on an obstacle course commences, effort can be directed to good course design so that specific types of hazards (e.g., star pickets) are not created or are eliminated. In addition, steps can be taken to ensure the training only occurs if trainees are adequately skilled, conditioned, rested, hydrated, and protected with protective equipment. At the time training occurs and injuries may happen, raking of gravel or sand surfaces to ensure they are level (and thus reduce risk of rolling ankles, for example) and sound instruction and demonstration of correct technique and adequate monitoring and technique correction (as well as a range of other possible injury controls or countermeasures) could be implemented to counter injury risks. In the immediate post-injury phase (i.e., at the time training is being conducted), immediately stopping the training and providing first aid (e.g., stabilizing any possible spinal fractures) would be examples of further injury countermeasures in this phase. This clearly requires prior design of protocols and planning for immediate first aid availability. Finally, seamless and timely transition to paramedic and hospital/surgical care and/or injury rehabilitation might be appropriate injury countermeasures in the later post-injury phase, and this again may require prior planning and protocol development.

Think beyond the immediate hazards and risk factors—for example, you may need to ask how the hazards and risk factors came into being in the first place, and if you eliminate or control them, will the same processes lead to them being re-created? If so, what controls can be put into place to prevent the redevelopment of hazards and risk factors? For example, if you fill a hole on a training area, will rain and poor drainage systems cause it to redevelop again, and could you avoid this by thinking this through and implementing additional strategies?

It is important to remember, when seeking to control hazards and other factors that contribute to injury risk, that there are many potential sources of expertise that can assist in this process. Often others will have addressed similar concerns in other locations or organizations, and you may be able to draw on their experience and expertise. Operators may have unique understanding of the training context and requirements, which enables them to suggest specific controls or countermeasures. Published guidelines or research may have considered the types of hazards and risks you are seeking to control. And specific experts, including safety managers, engineers and health professionals, may all be able to contribute in various ways.

REFERENCES

1. National Institute for Occupational Safety and Health. Hierarchy of controls. Retrieved April 8, 2019 from www.cdc.gov/niosh/topics/hierarchy.
2. Runyan, C. Introduction: Back to the future—Revisiting Haddon's conceptualization of injury epidemiology and prevention. *Epidemiologic Reviews* 25(1): 60-64, 2003.
3. Ruschena, L. Control: Prevention and intervention. In: HaSPA (Health and Safety Professionals Alliance). *The Core Body of Knowledge for Generalist OHS Professionals*. Tullamarine, VIC. Safety Institute of Australia, 2012.

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PRACTICAL EXERCISE PROGRAMMING FOR WILDLAND FIRE SUPPRESSION AIDS

INTRODUCTION

Wildland firefighters, also called fire suppression aids (FSAs), are highly trained in suppression and prevention of fires that occur in non-urban areas (3,13). The typical job tasks of this population include sawing, clearing debris, digging line, laying hose, and scouting, most of which are performed in extreme terrain and under strenuous conditions (11,17). Accordingly, the primary physiological attributes recommended of an FSA include aerobic endurance, muscular strength, muscular endurance, and flexibility (2,17,18). Annual Work Capacity Tests are administered to all wildland firefighters in the United States of America to ensure that all individuals maintain a minimum level of fitness as required by the job tasks (10,12). A wildland firefighter must remain fit to complete their typical job tasks, as well as function under extreme weather and temperature conditions. High aerobic endurance in both structural and wildland firefighters has been shown to aid in thermoregulation (3,6,16), and increased muscular strength, endurance, and flexibility can decrease the risk of injury (4,9,11).

One of the challenges in creating a training program for this population is the variability and inconsistency of work hours. Typical shifts for FSAs are 12 – 14 hours, and shifts may be extended to 21 days without a day off during the active fire season (7,18). Currently, training sessions are not mandatory across many agencies; however, time to train is provided to individuals based on their activity levels and the operational demands of the day (14). Due to the wide variety of physiological capacities required to perform wildland firefighting tasks, it is difficult to create a standardized training program (20). It has been noted, however, that undulated training programs (i.e., training for muscular strength, endurance, hypertrophy, and power concurrently) can be effective in enhancing task-specific performance in firefighters (2). This type of training program, which is flexible in nature and can be adapted to the individual and their life demands, would be optimal for the FSA.

During fire season, wildland FSAs remain on-call with local and government agencies in the instance that they are needed on an active fire site. While on an active fire site, these individuals are performing low-intensity tasks (i.e., walking, driving to and from the site) for approximately 21% of their shift (3,16). The rest of their time is spent performing various moderate- to high-intensity tasks including, but not limited to, traversing uneven terrain while carrying equipment, hose handling, sawing or cutting debris, and digging line (7,10,18). A flexible training program during this time of year is necessary to ensure this population is both physically fit as well as properly rested to decrease the risk of a work-induced/occupational injury. This paper will provide sample training parameters for individuals in the FSA population, with

the parameters assuming the firefighters have experience with resistance training; however, example exercises are provided that can be adapted to individuals with all levels of experience. Due to the variability of the job itself, the program will include options for strength, muscular endurance, trunk/stability, and flexibility. The program will rely on the Borg rating of perceived exertion (RPE) scale to determine the intensity of the training based on the shift worked, which is shown in Table 1 (5). The Borg scale has been used and validated with this population previously (21). A 10 point category-ratio (CR) scale has also been used with FSAs during circuit training (Table 2) (1,21). It should be noted that in this previous research, the scales for RPE have been used during- or post-exercise rather than before, as suggested by this manuscript. Due to the use prior to exercise, it will be addressed as pre-training rating of perceived exertion (P-RPE) in this manuscript. Fatigue index scales have been used in fitness programs for the general population, as a self-assessment prior to exercise (15). The CR and fatigue scales have been consolidated into one table (Table 2), and will be referred to as CR-F. Utilizing an RPE scale for this population allows the firefighters and training staff to tailor the session to their individual needs based on the tasks they completed, or are planning on completing that day.

These scales could be used to determine the individual occupational load of each individual through a given day on the job. To measure this load, the training staff or the firefighter themselves (if they are completing their training session on their own) can multiply their reported P-RPE or CR-F by the amount of time they are on-duty/on-site. This is an approach commonly used for athletic populations (5,9,12). For example, if the individual is on-site for an active fire for six hours, they would multiply that by the P-RPE/CR-F that they have selected (i.e., $11\text{RPE} \times [6\text{ hr} \times 60\text{ min}/1\text{ hr}] = \text{occupational load of } 3,960\text{ units}$). This formula could be utilized by training staff to learn about the occupational loads as a guide to future programming of training sessions. It is outside the scope of this manuscript to provide occupational loads without knowing the shift length of the firefighters. The following guidelines outline each individual's P-RPE/CR-F levels, and can then be used to determine set and repetition ranges for each training session (8).

An exercise index has been provided for the program. The exercises will fall under the categorical movement patterns of lower body, push/pull movements, trunk and stability training, and flexibility/recovery strategies. It should be noted that these are not the only exercises that could be completed within this program, and firefighters can add or subtract exercises depending on their personal preference. Nonetheless, the index provides a context for appropriate exercises that could be utilized by the firefighter.

TABLE 1. THE BORG RATING OF PERCEIVED EXERTION SCALE (5)

RATING	PERCEIVED EXERTION
6	No Exertion
7	Extremely Light
8	
9	Very Light
10	
11	Light
12	
13	Somewhat Hard
14	
15	Hard
16	
17	Very Hard
18	
19	Extremely Hard
20	Maximal Exertion

THE TRAINING PROGRAM

This program relies primarily on self-regulation. The P-RPE and CR-F scales should be referenced after each shift, prior to when a training session is going to take place. The firefighter should evaluate their physical exhaustion as well as mental fatigue to accurately report exertion levels. If a training session will take place prior to or during a shift, the potential physical job tasks that may take place during the shift should be taken into consideration. It is better for the individual to be more conservative with training in these instances, so the training sessions do not interfere with their daily assignments. In order to obtain accurate reporting of P-RPE/CR-F numbers from the firefighters, the training staff must build a rapport with the individuals under their supervision (13). As a coach for this population, they should be observant of the body language as well as the effort that each individual is putting into the session. If there is a concern during training, the staff should adjust the load/volume of the session in order to ensure that the individual does not get injured or “burnt-out.” The exercise index should be utilized when an individual lacks experience in resistance training, as well as to provide variability within each training session.

The training session information is summarized in Table 3. A strength session would typically include 4 – 5 different exercises depending on the individual’s determined P-RPE/CR-F for that

TABLE 2. THE MODIFIED CATEGORY-RATIO RATING OF PERCEIVED EXERTION AND FATIGUE SCALE (1,15,21)

RATING	DESCRIPTOR
0	Rest Not Fatigued at All
1	Very, Very Easy
2	Easy
3	Moderate A Little Fatigued
4	Somewhat Hard
5	Hard Moderately Fatigued
6	
7	Very Hard Very Fatigued
8	
9	
10	Maximal Total Exhaustion

day. If the occupational tasks were primarily upper-body, the training session should focus on lower-body exercises, and vice-versa. For a P-RPE of less than 11 or CR-F of less than three, each exercise should consist of 3 – 4 sets of 6 – 8 repetitions at a heavier load, determined by the individual. If the P-RPE is between 12 – 15 or the CR-F is between 4 – 6, each exercise should be performed for 2 – 3 sets of 5 – 6 repetitions of a moderate load. If the individual determines their P-RPE to be higher than 16 or their CR-F to be greater than seven, the exercises should be performed for 1 – 2 sets of 5 – 6 repetitions of a light to moderate load, depending on the overall fatigue of the firefighter.

A muscular endurance training session would typically consist of 3 – 4 exercises, ideally encompassing a total-body workout by incorporating multiple modes of training (i.e., resistance training, bodyweight calisthenics, etc.). For a P-RPE of less than 11 or CR-F of less than three, each exercise should be performed for five sets of 10 – 12 repetitions at approximately 35% of the individual’s estimated maximum effort. If the P-RPE is between 12 – 15 and the CR-F is between 4 – 6, each exercise should be performed for three sets of 8 – 10 repetitions at approximately 30% of the individual’s maximum effort. If the individual determines their P-RPE to be higher than 16 and the CR-F higher than seven, the chosen exercises should be performed for three sets of 6 – 8 repetitions at approximately 30% maximal effort.

TABLE 3. SUMMARIZED TRAINING PARAMETERS FOR EXERCISE SESSIONS BASED ON EXERCISE GOAL AND RPE/CR-F

	RPE ≤ 11 / CR-F ≤ 3	RPE 12 – 15 / CR-F 4-6	RPE ≥ 16 / CR-F ≥ 7
STRENGTH	3 – 4 sets x 6 – 8 repetitions at 75 – 85% maximum effort	2 – 3 sets x 5 – 6 repetitions at 65 – 75% maximum effort	1 – 2 sets x 5 – 6 repetitions at 65 – 75% maximum effort
ENDURANCE	5 sets x 10 – 12 repetitions at 35 – 65% maximum effort	3 sets x 8 – 10 repetitions at 35 – 65% maximum effort	3 sets x 6 – 8 repetitions at 35 – 50% maximum effort
TRUNK/ STABILITY	3 – 4 sets x 45 – 60 s at bodyweight	2 – 3 sets x 45 – 60 s at bodyweight	2 – 3 sets x 30 – 45 s at bodyweight
FLEXIBILITY	3 sets x 4 – 5 min at bodyweight	3 sets x 4 – 5 min at bodyweight	2 sets x 5 min at bodyweight

Trunk and stability sessions should consist entirely of exercises that are designed to increase strength and endurance in the trunk muscles. Each repetition for this type of session will be timed due to the stabilizing nature of the target muscles. Loading for these sessions will be minimal (i.e., bodyweight), and most exercises will consist of isometric holds. For a P-RPE of less than 11 or CR-F of less than three, each exercise should consist of 3 – 4 sets of 45 – 60-s holds. For a determined P-RPE of 12 – 15 or a CR-F between 4 – 6, each exercise should be performed for 2 – 3 sets of 45 – 60-s holds. If the individual determines their P-RPE to be higher than 16 or their CR-F to be greater than seven, the exercises should be performed for 2 – 3 sets of 30 – 45 s holds.

Flexibility sessions should be comprised of stretching, foam rolling, yoga, or a combination of the three. Ideally, these will be used in conjunction to other training sessions as a cool-down; however, if the individual indicates a high P-RPE (16 or above) or CR-F (7 or above), these can be stand-alone sessions. Similar to the trunk and stability sessions, each repetition will be timed rather than numbered in order to achieve a sufficient stretch of the target muscles. For an RPE of less than 15 or CR-F of less than seven, each exercise should be performed for three sets of 4 – 5 min per exercise. If the RPE is determined to be 16 or above or CR-F is seven or above, each exercise should be performed for two sets at five minutes per exercise.

EXERCISE INDEX

LOWER-BODY

Squat Movement

The squat movement develops muscles of the lower-body which are essential to wildland firefighter job tasks such as moving equipment on uneven terrain and hose handling (19). Additional loading can be added on-site by using equipment (e.g., Olympic bar for the back squat, dumbbells held in the hands, water cans, backpacks) if it is safe to do so. The squat movement has many variations that can be performed by this population including, but not limited to, the sumo squat, goblet squat, and front squat. Instructions for the back squat variation of the exercise are as follows:

- **Starting:** Begin with a bar resting across the shoulders (Figure 1A).
- **Downward:** With feet slightly wider than hip-width, flex the (dorsi) ankles, knees, and hips together until thighs are close to parallel with the ground (Figure 1B).
- **Upward:** Keeping the chest elevated, extend the legs until straight. The hips, knees, and shoulders should return to upright at the same pace (i.e., hips do not rise faster than the shoulders).
- Throughout the movement, track the knees over the toes.



FIGURES 1A AND 1B. SQUAT

(A) Starting position for the movement.

(B) Bottom position of the squat movement.

Deadlift

The deadlift targets posterior leg musculature and aims to develop the glutes, hamstrings, and trunk (22). Wildland firefighters would benefit from this increased strength during job tasks such as clearing debris and picking equipment or loaded stretchers up from the ground. This exercise can be modified based on ability by changing the equipment used (e.g., changing the barbell to water cans, dumbbells, or just using bodyweight to perform the action). Instructions for the barbell deadlift exercise are as follows:

- **Starting:** Grip the bar with either an overhand or alternating grip. Knees and hips should be flexed while the spine remains neutral. Shoulders should be over the bar (Figure 2A).
- **Upward:** While keeping the spine straight and knees tracking over the toes, engage the posterior chain of muscles (glutes, hamstrings, etc.) to lift the bar off the ground until the knees are fully extended (Figure 2B).
- **Downward:** While flexing at the knees and hips at the same time, track the bar down the front of the legs until it reaches mid-shin or the plates touch the floor.



FIGURES 2A AND 2B. DEADLIFT

(A) Starting position for the deadlift.

(B) Lockout position for the deadlift.

Box Drop

Box drops can be utilized by wildland firefighters to educate individuals in proper landing techniques. Wildland firefighters often climb over debris while wearing assigned personal protective equipment (PPE) (19). The added weight from their equipment creates a stress on the joints in the lower body, which can be injured if the individual is not knowledgeable in appropriate landing techniques. The recommended guidelines for box jumps is the ability to squat 1.5 x body mass prior to performing this exercise. Nonetheless, for firefighters that do not have this requisite strength, they can complete other variations for this exercise such as completing box drops from a lower height, or simply jumping rope. Instructions for the box drop are as follows:

- **Starting:** Begin by standing on a box or surface that is slightly elevated from the ground (Figure 3A).
- Step off the box without jumping or hopping (Figure 3B).
- **Finish:** Land with both feet at the same time, back neutral, and knees tracking over the toes when bending to absorb the shock (Figure 3C).



FIGURES 3A, 3B, AND 3C. BOX DROP

(A) Starting position on top of the box.

(B) Step out with one leg prior to drop.

(C) Landing position with knees bent and back neutral.

PUSHING MOVEMENTS

Military Press

The military press conditions the shoulders and arms, which carry out the majority of tasks required by wildland firefighters (17). This movement pattern is present when digging line, as well as lifting assigned PPE overhead. The military press can be performed with various items including, but not limited to, a barbell, water cans, sandbags, and packs. Instructions for this exercise using a barbell are as follows:

- **Starting:** Begin with the bar resting across the front of the shoulders and clavicle (Figure 4A).
- **Upward:** Using arm and shoulder muscles, drive the bar upwards and overhead until elbows are straight (Figure 4B).
- **Downward:** To return to the starting position, control the bar back down onto the shoulders and flex the knees to absorb the weight.



FIGURES 4A AND 4B. MILITARY PRESS

(A) Starting position with bar across shoulders.

(B) Lockout position at the top of the lift with elbows straight.

Unilateral Overhead Press

The unilateral overhead press develops muscles in the shoulders and arms. These muscles are primarily activated when moving and handling the hose, digging line, and lifting assigned PPE (3, 16). This exercise can be adjusted based on ability level of the individual by lowering the weight or using a tool (i.e., filled water bottle, helmet, etc.) found on an active-fire site. Instructions for the dumbbell variation of this exercise are as follows:

- **Starting:** With the back neutral and the trunk stabilized, grip a dumbbell in one hand next to the corresponding shoulder (Figure 5A).
- **Upward:** While bracing the trunk, engage the shoulder and arm muscles to press the weight straight overhead (Figure 5B).
- **Downward:** Control the weight as you return to the starting position.



FIGURES 5A AND 5B. UNILATERAL OVERHEAD PRESS

(A) Preparatory position for the lift.

(B) Lockout position with shoulders pressed down and elbows straight.

Half-Kneel Rotational Press

The half-kneel rotational press conditions the muscles of the arms, shoulders and back while also working on developing trunk stability. These traits are required when handling a live hose and passing supplies (3). Traditionally, this exercise uses a dumbbell or kettlebell, however other items found on-site (i.e., water can, pack, etc.) can be used. Instructions for this exercise utilizing a dumbbell are as follows:

- **Starting:** Kneel with one knee on the ground, and the other knee at a 90° angle over the ankle. With one arm out to the side for stability, begin with the weight held across the body (Figure 6A).
- **Transition phase:** Twist back to center, keeping the weighted arm close to your trunk (Figure 6B).
- **Upward:** Lift the weight to shoulder height (Figure 6C), then press overhead using arm and shoulder muscles (Figure 6D). Be sure to keep the activated shoulder pressed down during the lift and away from the ears.
- **Downward:** Control the weight back down to the shoulder, and then twist back to the starting position.



FIGURES 6A AND 6B. HALF-KNEEL ROTATIONAL PRESS

(A) First phase of the rotation with weight across the body.

(B) Return to center.



FIGURES 6C AND 6D. HALF-KNEEL ROTATIONAL PRESS

(C) Raise weight to shoulder.

(D) Final phase before reversing the movement.

PULLING MOVEMENTS

Bent-Over Row

Rowing develops the muscles in the arms and back, which are utilized in job tasks such as sawing, digging line, and hose handling (10). Depending on equipment availability, this exercise can be modified to use tools found on-site such as packs, sandbags, or water cans. Instructions for this exercise utilizing a barbell are as follows:

- **Starting:** Holding the bar in a similar manner as the deadlift, hinge the hips back with a slight bend in the knees (Figure 7A).
- **Upward:** Keep your elbows close to the body while lifting the bar to your chest or abdomen (Figure 7B). Squeeze the shoulder blades together at the top of the lift.
- **Downward:** While slowly lowering the weight downward, continue to keep the elbows close to the body. Control the weight down until the elbows are straightened.



FIGURES 7A AND 7B. BENT-OVER ROW

(A) Starting phase of the movement with back neutral and arms straight.

(B) Upward pull of the bar to the torso.

Bridge Pull-Through

The bridge pull-through develops muscles in the posterior arm muscles and back, as well as trunk stability. These muscles are primary movers in hose handling, sawing, and clearing debris (2,13). This exercise can be performed using a sandbag, filled water bottle, pack, or other equipment found on an active-fire site. Instructions for this exercise using a dumbbell are as follows:

- **Starting:** Begin in a high plank position with palms flat on the ground and elbows straight. Place a dumbbell behind one of the hands. Throughout the exercise, keep shoulders pulled back and out of the neck. Shift weight into the hand where the dumbbell is and lift the opposite hand off of the ground (Figure 8A).
- **Movement phase:** Grab the weight and pull it through to the lifting arm's shoulder (Figure 8B). Set the weight down and return to a high plank position (Figure 8C).
- Repeat the process with the opposite arm. For the duration of the exercise, the goal is to keep the shoulders and hips parallel to the ground, and to engage all trunk muscles to prevent twisting.



FIGURES 8A, 8B, AND 8C. BRIDGE PULL-THROUGH

(A) Grabbing weight while keeping shoulders and hips stable.

(B) First phase of the pull with the weight to the shoulder.

(C) Controlling the weight to the ground, completing the movement.

Alternating Hose Pull

Alternating hose pulls develop the anterior arm muscles, back, and stabilizing trunk muscles. Along with handling live hoses, these muscles aid in movements including the Pulaski to dig line, as well as any unilateral movements that require stabilization of the trunk (2,3,13). Instructions for this exercise using a battle rope are as follows:

- **Starting:** Begin in a power stance with knees and hips slightly bent and back neutral (Figure 9A).
- **Movement phase:** Using a rope or hose, grasp hand over hand and pull the rope towards the torso (Figure 9B). Be sure to stay in the power position throughout the movement and try to avoid turning the body to pull the hose.
- **Note:** The primary movement should be from the arm and back muscles.



FIGURES 9A AND 9B. ALTERNATING HOSE PULL

(A) Power stance to begin the movement.

(B) Pull to one side.

TRUNK/STABILITY

Farmer's Walk

The farmer's walk involves both the use of grip strength as well as trunk and lower-body musculature to carry a load for a predetermined distance or time (22,23). Wildland firefighters would benefit from this exercise not only by increasing grip strength, but by increasing trunk stability. These characteristics are present in tasks such as hose handling, sawing, and traversing uneven terrain. This exercise can be modified to train unilateral musculature by only loading one hand at a time. On-site, the farmer's walk can be performed with sandbags, water cans, or any available equipment that can be carried. Instructions for this exercise using dumbbells are as follows:

- **Starting:** Grip a weight in each hand and stand with the back neutral and the chest up.
- **Movement phase:** Using controlled steps and without bending to either side, walk forward for either a set distance or set amount of time (Figure 10).
- **Note:** This exercise could be done unilaterally to target each side individually for anti-flexion.



FIGURE 10. FARMER'S WALK

Carry equal weights in both hands and remain "tall" during walk.

Plank

The plank is designed to isometrically stress the abdominal muscles (4). Wildland firefighters require trained trunk muscles in order to stabilize themselves when carrying equipment over uneven terrain, or doing primarily unilateral work such as hose handling or sawing. Instructions for this exercise are as follows:

- This exercise is isometric, so there should be little or no movement during the duration of the hold.
- Ears, shoulders, hips, and ankles should be in alignment, with the shoulder blades flat and spine long (Figure 11). Keep forearms and palms flat on the ground throughout the repetition.



FIGURE 11. PLANK

Maintain contact with the ground at the toes and elbows while keeping the body in a straight line off the ground.

Side Plank with Arm Rotation

The side plank with an arm rotation works on stabilization of the abdominal muscles during dynamic movement, as well as increasing shoulder flexibility. Similar to the standard plank, this exercise would benefit wildland firefighters when carrying equipment unilaterally, walking over uneven terrain, and hose-handling (2,11,16). Instructions for this exercise are as follows:

- **Starting:** Begin by lying on your side with your elbow directly underneath your shoulder. Legs should be straight and feet can be stacked on top of each other or with the top foot behind the bottom one. With knees, hips, shoulders, and spine in alignment, reach the top arm toward the ceiling and lift the hips off the ground (Figure 12A).
- **Movement phase:** Rotate through your shoulders and thoracic spine to reach the top arm underneath and behind the body (Figure 12B). Be sure to keep hips raised off the ground at all times and return to starting position.



FIGURE 12A. SIDE PLANK WITH ARM ROTATION

(A) Reach toward the ceiling with the top arm.



FIGURE 12B. SIDE PLANK WITH ARM ROTATION

(B) Twist under the body by reaching with the same arm while stabilizing the body.

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Turkish Get-Ups

Turkish get-ups require a complex movement pattern that engages many of the body's major muscle groups. This is an advanced exercise, and only firefighters with a strength training history and appropriate mobility should attempt the loaded version of this exercise. Indeed, anecdotally many firefighters report having limited shoulder mobility, so this exercise in its entirety could prove too difficult. It is recommended that this exercise and its components be introduced without any loading to increase mobility. Once mastered, external loading should be introduced gradually, as to not injure the individual. This exercise (and its regressions) would prepare the firefighter for a majority of the demands of the job including tool use, live hose handling, and equipment carrying. Instructions for this exercise are as follows:

- **Starting:** Using a dumbbell, begin by laying in a curled position on one side (Figure 13A). Roll onto the back and

straighten out the leg opposite of the weighted arm (Figure 13B). Press the weight towards the ceiling (Figure 13C).

- **Phase one:** While holding the weight, roll up onto the opposite elbow (Figures 13D-E). Continue the motion and lift up onto the hand until sitting on the hips (Figure 13F).
- **Phase two:** Shift up so the hips are off the ground and the weight is distributed between the hand, the bent knee, and the extended leg (Figure 13G). Take the extended leg and thread it back between the hand and other leg on the ground until it is in a kneeling position (Figure 13H).
- **Phase three:** Continuing to control the weight overhead, shift all of the bodyweight into a half kneel position (Figure 13I). While engaging trunk and leg muscles, push into a full standing position with the weight held overhead (Figure 13J).
- **Downward:** Reverse the movements back down to laying, then switch sides.



FIGURES 13A, 13B, AND 13C. TURKISH GET-UP

- (A) Starting position on side.
- (B) Roll to back while lifting one knee.
- (C) Pressing weight toward ceiling.



FIGURES 13D, 13E, AND 13F. TURKISH GET-UP

- (D) Rolling onto one shoulder.
- (E) Rolling up onto an elbow.
- (F) Sitting up onto hand and hips.



FIGURES 13G AND 13H. TURKISH GET-UP

- (G) Shifting weight off of the ground.
- (H) Threading leg under body.



FIGURES 13I AND 13J. TURKISH GET-UP

- (I) Shifting weight into a kneeling position.
- (J) Pressing up to a standing position with weight overhead.

Dead Bug

The dead bug exercise primarily builds isometric strength in the trunk muscles but can be adjusted into a dynamic exercise to engage different muscle groups (2). Wildland firefighters utilize this cross-body stabilization when working with chainsaws and axes. Instructions for this exercise are as follows:

- **Starting:** Laying on the back, reach the arms toward the ceiling and bend the knees and hips to 90° angles with toes pointing toward the ceiling (Figure 14A).
- **Movement phase:** Straighten out an arm and the opposite leg until just above the ground. Be sure to keep shoulders and hips off the ground and the non-targeted limbs stationary (Figure 14B).
- Return the straightened arm and leg to the starting position and then repeat on the opposite side.



FIGURE 14A. DEAD BUG

(A) Trunk engaged with arms and knees towards the ceiling.



FIGURE 14B. DEAD BUG

(B) Reaching contralateral limbs straight out.

FLEXIBILITY/RECOVERY STRATEGIES

Stretching

There are many different exercises for flexibility and types of stretching that would benefit the wildland firefighter population. Stretching preferences and various recovery strategies will vary between individuals, however a few different sources include *NSCA's Essentials of Tactical Strength and Conditioning* and *NSCA's Essentials of Personal Training* books (7,16).

REFERENCES

1. Abel, MG, Mortara, AJ, and Pettitt, RW. Evaluation of circuit-training intensity for firefighters. *The Journal of Strength and Conditioning Research* 25(10): 2895-2901, 2011.
2. Abel, MG, Sell, K, and Dennison, K. Design and implementation of fitness programs for firefighters. *Strength and Conditioning Journal* 33(4): 31-42, 2011.
3. Aisbett, B, and Nichols, D. Fighting fatigue whilst fighting bushfire: An overview of factors contributing to firefighter fatigue during bushfire suppression. *The Australian Journal of Emergency Management* 22(3): 31, 2007.
4. Akuthota, V, Ferreiro, A, Moore, T, and Fredericson, M. Core stability exercise principles. *Current Sports Medicine Reports* 7(1): 39-44, 2008.
5. Banister, EW, Good, P, Holman, G, and Hamilton, CL. Modeling the training response in athletes. *Sport and Elite Performers* 3: 7-23, 1986.
6. Barr, D, Gregson, W, and Reilly, T. The thermal ergonomics of firefighting reviewed. *Journal of Applied Ergonomics* 41(1): 161-172, 2010.
7. Choi, B, Schnall, P, and Dobson, M. Twenty-four-hour work shifts, increased job demands, and elevated blood pressure in professional firefighters. *International Archives of Occupational and Environmental Health* 89(7): 1111-1125, 2016.
8. Clayton, ND, Larkin, S, Linkul, R, Martino, M, Nutting, M, and Tumminello, N. Foundations of fitness programming. National Strength and Conditioning Association, 2015.
9. Coutts, A, Reaburn, P, Murphy, A, Pine, M, and Impellizzeri, F. Validity of the session-rpe method for determining training load in team sport athletes. *Journal of Science and Medicine in Sport* 6(4): 52, 2003.
10. Cuddy, JS, and Ruby, BC. High work output combined with high ambient temperatures caused heat exhaustion in a wildland firefighter despite high fluid intake. *Wilderness and Environmental Medicine* 22(2): 122-125, 2011.
11. Cuddy, JS, Slivka, DR, Tucker, TJ, Hailes, WS, and Ruby, BC. Glycogen levels in wildland firefighters during wildfire suppression. *Wilderness and Environmental Medicine* 22(1): 23-27, 2009.
12. Foster, C, Hector, LL, Welsh, R, Schrager, M, Green, MA, and Snyder, AC. Effects of specific versus cross-training on running performance. *European Journal of Applied Physiology and Occupational Physiology* 70(4): 367-372, 1995.

13. Hofman, JI. Tactical facilitators in firefighting. *Tactical Strength and Conditioning Report* (36): 2015.
14. Interior, DOT. Interagency standards for fire and fire aviation operations. 2016.
15. Micklewright, D, St Clair Gibson, A, Gladwell, V, and Al Salman, A. Development and validity of the rating-of-fatigue scale. *Journal of Sports Medicine* 47(11): 2375-2393, 2017.
16. Phillips, M, Payne, W, Lord, C, Netto, K, Nichols, D, and Aisbett, B. Identification of physically demanding tasks performed during bushfire suppression by Australian rural firefighters. *Journal of Applied Ergonomics* 43(2): 435-441, 2012.
17. Rhea, MR, Alvar, BA, and Gray, R. Physical fitness and job performance of firefighters. *Journal of Strength Conditioning Research* 18(2): 348-352, 2004.
18. Ruby, BC, Shriver, TC, Zderic, TW, Sharkey, BJ, Burks, C, and Tysk, S. Total energy expenditure during arduous wildfire suppression. *Medicine and Science in Sports and Exercise* 34(6): 1048-1054, 2002.
19. Ruby, BC, Iii, GWL, Armstrong, DW, and Gaskill, SE. Wildland firefighter load carriage: Effects on transit time and physiological responses during simulated escape to safety zone. *International Journal of Wildland Fire* 12(1): 2003.
20. Sell, KL, and Livingston, B. Training considerations for wildland firefighters. *TSAC Report* 39: 8-15, 2015.
21. Smith, DL, Manning, TS, and Petruzzello, SJ. Effect of strenuous live-fire drills on cardiovascular and psychological responses of recruit firefighters. *Ergonomics* 44(3): 244-254, 2001.
22. Winwood, PW, Keogh, JW, and Harris, NK. The strength and conditioning practices of strongman competitors. *Journal of Strength and Conditioning Research* 25(11): 3118-3128, 2011.
23. Winwood, PW, Cronin, JB, Brown, SR, and Keogh, JW. A biomechanical analysis of the farmers walk, and comparison with the deadlift and unloaded walk. *International Journal of Sports Science and Coaching* 9(5): 1127-1143, 2014.

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