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LOAD CARRIAGE—PROGRAMMING FOR SPECIAL OPERATIONS FORCES

INTRODUCTION

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

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

AEROBIC CONSIDERATIONS

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

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

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

ANAEROBIC CONSIDERATIONS

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

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

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

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

STRESS INOCULATION TRAINING

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

PROGRAM RECOMMENDATIONS

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

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

CONCLUSION

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

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TABLE 1. LOAD CARRIAGE PERFORMANCE PROTOCOL

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

**See Figures*

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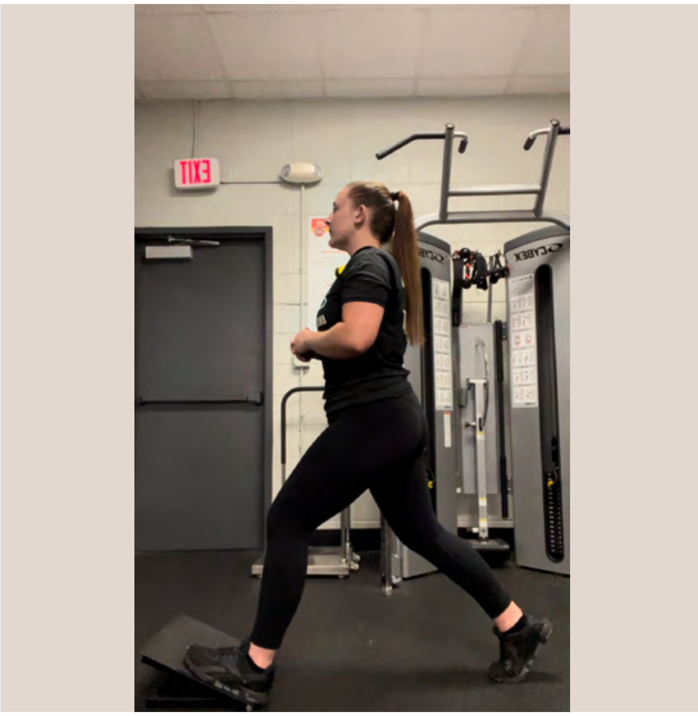

FIGURE 1A. FRONT FOOT TOE ELEVATED LUNGE

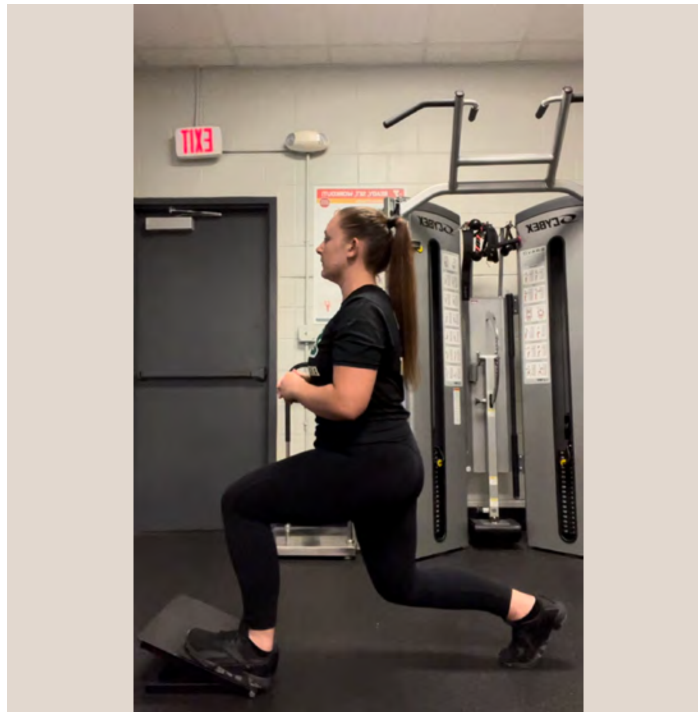

FIGURE 1B. FRONT FOOT TOE ELEVATED LUNGE

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

FIGURE 2A. FRONT FOOT HEEL ELEVATED LUNGE

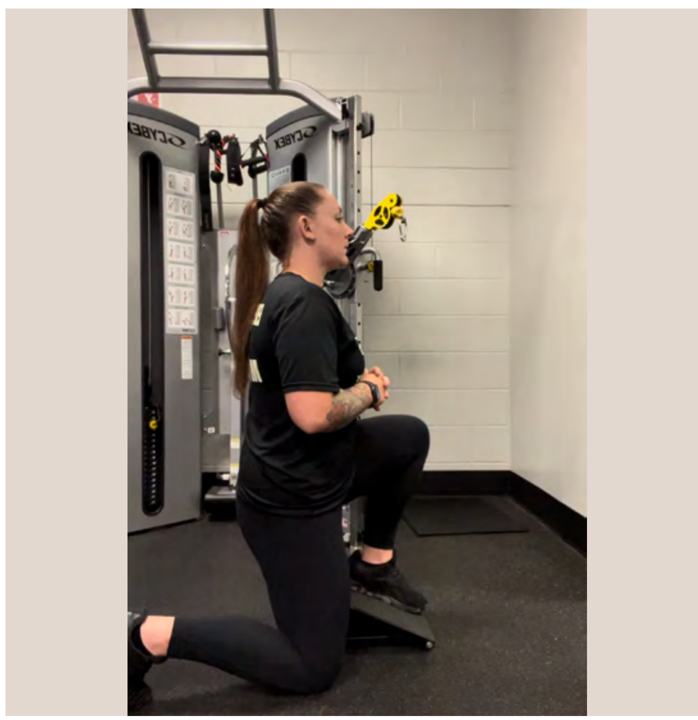

FIGURE 2B. FRONT FOOT HEEL ELEVATED LUNGE

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

FIGURE 3A. SINGLE-LEG CHOP WITH LATERAL LUNGE

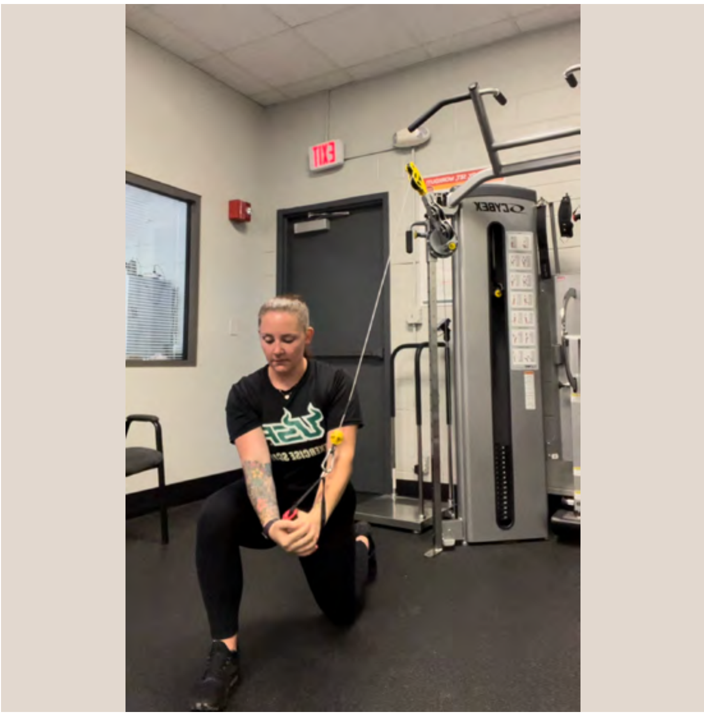

FIGURE 3B. SINGLE-LEG CHOP WITH LATERAL LUNGE

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

FIGURE 4A. SINGLE-ARM SPLIT STANCE LANDMINE PRESS

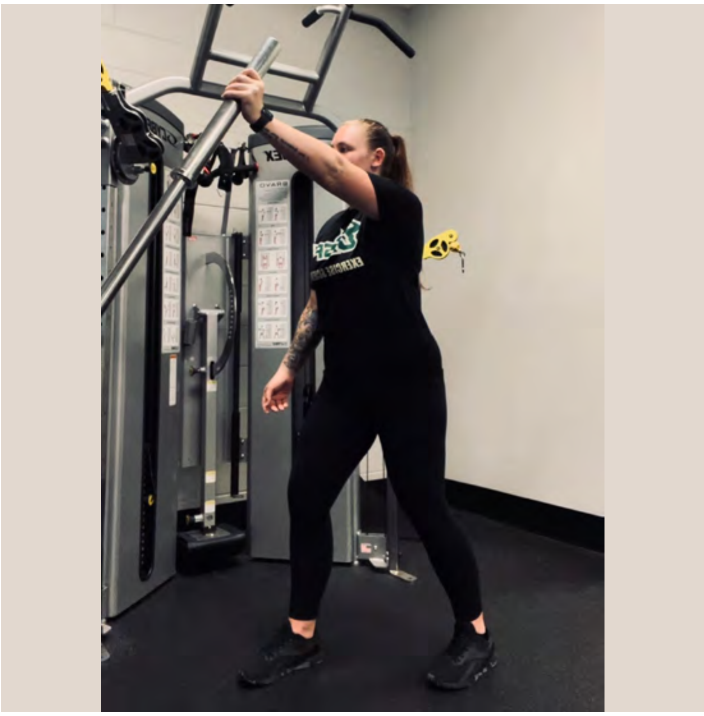

FIGURE 4B SINGLE-ARM SPLIT STANCE LANDMINE PRESS

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