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14. ABSTRACT

The U.S. Army Research Institute of Environmental Medicine (USARIEM) was tasked by the U.S. Army Training and Doctrine Command (TRADOC) to develop criterion-based physical requirements for entry into the seven physically demanding combat MOSs, including the 11 Series Infantry. Researchers from USARIEM completed three studies to develop a valid, safe, and legally defensible physical performance battery to predict a Soldier's ability to serve in the MOS. Study 1 involved measuring and identifying the physiological requirements of each of the tasks of the MOS in order to identify a set of criterion tasks encompassing the physical demands of all of the tasks of the MOS. Study 2 involved developing task simulations of the most physically demanding tasks: casualty evacuation, casualty drag, foot march, move under fire, and sandbag carry. In the final study, screening batteries using basic predictor tests for each MOS were developed to fit a range of needs of the Army.

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DEVELOPMENT OF A PHYSICAL EMPLOYMENT TESTING BATTERY FOR INFANTRY SOLDIERS: 11B INFANTRYMAN AND 11C INFANTRYMAN- INDIRECT FIRE

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FOREWORD

This Technical Report is one of several in a series documenting the development of a physical employment screening test for seven Combat Arms Military Occupational Specialties (MOSs) as part of the Soldier 2020 initiative. The models presented herein are developed specifically using information from the 11 Series studies. Additional reports were written for the studies on the Combat Engineers (12B), Field Artillery (13B, 13F), and Armor (19D, 19K) MOSs. Portions of the data presented herein were previously reported in the technical reports for those MOSs. A final report will be written to develop one overarching test battery of five to seven tests to cover all seven MOSs. While this final model may not be optimized for any one MOS, it will provide a testing battery with acceptable predictive capability to identify candidates for each of the seven MOSs.

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LIST OF ACRONYMS

ACH	Advanced Combat Helmet
ACU	Army Combat Uniform
AIT	Advanced Individual Training
APFT	Army Physical Fitness Test
ASVAB	Armed Services Vocational Aptitude Battery
BCT	Basic Combat Training
BFV	Bradley Fighting Vehicle
ESAPI	Enhanced Small Arms Protective Insert
ESBI	Enhanced Side Ballistics Insert
HEI-T	High Explosive Incendiary Tracer
HR	Heart Rate
IOTV	Improved Outer Tactical Vest
MEPS	Military Processing Station
MOS	Military Occupational Specialty
O_2	Oxygen Consumption
OSUT	One Station Unit Training
PPE	Personal Protective Equipment
RPE	Rate of Perceived Exertion
SME	Subject Matter Experts
TOW	Tube-Launched, Optically-Tracked, Wire-Guided
TRADOC	Training and Doctrine Command
USARIEM	U.S. Army Research Institute of Environmental Medicine
VO_2	Oxygen Uptake
VTC	Video Teleconference

BACKGROUND

Performing physically demanding tasks is an integral part of being a Soldier (34). In general, these tasks include combinations of lifting/lowering, lifting and carrying, pushing/pulling, climbing, digging, and walking/marching/running. Such tasks require a great deal of muscular strength, muscular endurance, and cardiovascular fitness. While recruits in the U.S. Army are required to complete a mental aptitude test (Armed Services Vocational Aptitude Battery (ASVAB)) in order to enlist in certain Military Occupational Specialties (MOSs), Soldiers are not currently selected for their MOS based on their ability to do the physical tasks necessary for that MOS. The safety and efficiency of Soldiers is based upon the ability of everyone in the team being capable of completing these physically demanding tasks. Thus, when assigning a Soldier to a MOS, it is important to match the physical capabilities of the Soldier with physical requirements of the critical tasks of that MOS. Otherwise, Soldiers who are physically unsuited to the MOS are at risk for injuring themselves and those around them, and have the potential to diminish larger group performance. In addition, training time and resources are misused on individuals who are not physically capable of being trained to perform these demanding tasks.

Presently, the only way that the Army assesses a Soldier's physical readiness for occupational and combat-related duties is through the Army Physical Fitness Test (APFT). This test creates a score based on the number of push-ups performed in two minutes, the number of sit-ups performed in two minutes, and time to complete a 2 mile-run. A number of studies have shown, however, that this score is not highly correlated with the performance of the physically demanding tasks performed by Soldiers (17, 23). Furthermore, the APFT score includes adjustments for age and sex, not only biasing for/against certain groups, but making it potentially legally indefensible if used as a screening tool for entrance into certain MOSs (13). Using physically demanding tasks corresponding to an MOS as a screening assessment is not practical and may violate the EEOC Uniform Guidelines on Employment Selection Procedures (9178). However, criterion-based physical performance tests (i.e., tests that are predictive of Soldiering task performance) can be used to predict whether Soldiers possess the physical capabilities needed for effective MOS performance.

The U.S. Army Research Institute of Environmental Medicine (USARIEM) has been tasked by the Training and Doctrine Command (TRADOC) to develop a new criterion-based physical testing procedure for entry into seven physically demanding combat MOSs. The seven Combat Arms MOSs are: 11B Infantryman, 11C Infantryman- Indirect Fire, 12B Combat Engineer, 13B Cannon Crewmember, 13F Fire Support, 19D Cavalry Scout, and 19K Armor Crewman. Understanding the physiological demands placed on these MOSs will allow for the development of valid, safe, and legally defensible physical performance tests to predict a Soldier's ability to serve in these MOSs. This is particularly important as the Army direct ground combat exclusion was lifted by the former Secretary of Defense (Leon Panetta), which will require the services to either open these MOSs to females or justify the decision to keep them closed.

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DISCLAIMERS

The opinions or assertions contained herein are the private views of the author(s) and are not to be construed as official or as reflecting the views of the Army or the Department of Defense.

The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, and the research was conducted in adherence with the provisions of 32 CFR Part 219. Protocol # 9300.

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Portions of the data presented in this report have been previously reported.

EXECUTIVE SUMMARY

Currently, Soldiers in the U.S. Army are not selected for their Military Occupational Specialty(MOS) based on their ability to do the physical tasks necessary for that MOS. The US Army Research Institute of Environmental Medicine (USARIEM) has been tasked by the Training and Doctrine Command (TRADOC) to develop criterion-based physical requirements for entry into seven physically demanding combat MOSs, including the 11B Infantryman and 11C Infantryman- Indirect Fire.

Researchers from USARIEM completed three studies to develop a valid, safe, and legally defensible physical performance test battery to predict a Soldier's ability to serve as an 11B Infantryman or 11C Infantryman-Indirect Fire. Study 1 involved identifying and measuring the physiological requirements of the 11B and 11C tasks. This was done in order to develop a set of criterion tasks encompassing the physical requirements of all the jobs performed in the MOS. From these data, as well as incorporating data from focus groups, the casualty evacuation, casualty drag, sandbag carry and foot march were identified as representative of all heavy lift, heavy drag, lift and carry, and load carriage tasks. These tests were vetted by SMEs, who also requested an additional test be added: move under direct fire.

Once these tests were identified, it was important to determine if the task simulations that were developed were reliable to use as criterion tasks for development of a predictive model. Study 2 involved developing simulations of these tasks. All of the criterion tasks were determined to have sufficient reliability to use in development of a final predictive model.

Finally, once reliable criterion tasks were developed, predictive models of criterion task performance were developed. Four models for each MOS were proposed to fit a range of needs of the Army (i.e., cost and space requirements). Potential predictor tests included medicine ball put, squat lift, beep test, arm ergometer, standing long jump, resistance pull, 1-minute push-ups, 1-minute sit-ups, and Illinois agility test.

With the models developed, future work will require TRADOC to select a testing battery and identify acceptable performance on the criterion tasks in order to identify appropriate cut scores.

Note: Additional technical reports were written for the Combat Engineers, Field Artillery, and Armor MOSs. A final report will be written to develop one overarching test battery of five to seven tests to cover all seven MOSs. The overarching model may be slightly different than those presented here, as the model will be optimized for all seven MOSs collectively.

Study 1: Physiological Observation

STUDY 1: INTRODUCTION

According to Payne & Harvey (25), the first steps in developing a physical testing battery are to identify the most physically demanding tasks and then quantify the physiological demands of the individual tasks. TRADOC began by reviewing field manuals, training videos and physical task descriptions related to each of the MOSs of interest (11B Infantryman, 11C Infantryman- Indirect Fire, 12B Combat Engineer, 13B Cannon Crewmember, 13F Fire Support, 19D Cavalry Scout, and 19K Armor Crewman). A group of subject matter experts (SMEs) from each of the proponent schools then developed a task list and associated minimum standards based on this review. The result was a list of 32 physically demanding tasks relevant to these MOSs (Table 1.1). Of these tasks, nine were common to multiple MOSs, and 23 were specific to less than three of the MOSs. TRADOC then observed Soldiers from each MOS performing the tasks. If 90% of the Soldiers observed could not perform the tasks to standard, the task statements were revised until the 90% threshold was reached. As part of this TRADOC exercise, USARIEM researchers also observed the Soldiers. Quantifiable task details were recorded, including quantity and weights of loads being moved or lifted, distances traveled, Soldier gear, and equipment required.

USARIEM researchers also conducted focus groups with enlisted Soldiers from each MOS. Both junior enlisted (Corporal/Specialist and below) and senior enlisted (Sergeant through Sergeant First Class) Soldiers completed surveys about each of the tasks identified as relevant to their MOS. Soldiers were asked how often they completed the tasks both in training and while deployed in order to better understand the frequency of performing the task. This was followed with a face-to-face focus group session where Soldiers were asked about the details collected during phase one, such as if the weights and distances were correct, and if there were any additional tasks which warranted consideration (20).

With the first two steps (task validation and focus groups) complete, the next phase of the project required the direct measurement of the identified physically demanding tasks. Quantifiable metrics of task performance and physiological responses were collected from members of each of the MOSs. These measurements included heart rate (HR), rate of perceived exertion (RPE), and metabolic cost. In addition to male Infantry (11B and 11C) Soldiers, female Soldiers from other MOSs also performed the tasks in order to include physiological responses from both sexes. These data were used to select the most physically demanding tasks for each MOS and to develop criterion task simulations.

The Infantry MOS is the main land combat force of the Army. Both the 11B Infantryman and 11C Infantryman- Indirect Fire MOSs are included in the highest level of physical demands. Infantrymen operate weapons and equipment in ground combat operations. Infantrymen- Indirect Fire supervise and lead to employ crew and individual weapons in offensive, defensive, and retrograde ground combat tactical operations.

While a number of their tasks have been identified as having high physical demands, the exact physiological requirements of these tasks have not been quantified.

STUDY 1: METHODS

Data were collected at Ft. Stewart, GA during March 2014 from Soldiers of the 2nd Armored Brigade Combat Team, 3rd Infantry Division. Two cohorts of males and females were recruited to complete the tasks of the either the 11B or 11C MOS. Physiological measurements were collected on 24 males with MOS 11B and 15 females from other MOS/AOCs (12Y, 25B, 25U, 27D, 42A, 53A, 68Q, 68W, 92F, 92G, 92W) while performing the Infantryman tasks. Measurements were collected from 19 males with MOS 11B and a separate set of 13 females (25B, 68W, 88M, 91A, 91C, 91P, 92A, 92G, 92Y, 95G) for the Infantryman- Indirect Fire tasks. Prior to testing, all Soldiers were briefed, signed a consent form, and completed questionnaires about their demographics and most recent Army Physical Fitness Test (APFT). Height and weight in their Army Combat Uniform (ACU) were also collected prior to the start of testing.

All participants completed a training and deployment history questionnaire (Appendix H). Participants were asked the duration of their Army service, time in the MOS, and time deployed. Then, for each of the tasks, Soldiers were asked if they had performed the task in training or while deployed (if applicable), and how many times they had performed each task in either setting.

Prior to testing, Soldiers completed a four-week train-up to familiarize themselves with the technical aspects of all of the tasks. Details of the training schedule can be found in Appendix D.

TASK SIMULATIONS

Fifteen tasks were identified by TRADOC as relevant to these two MOSs and were tested: seven relevant to 11B, three relevant to 11C, and five to both (Table 1.2). One task identified by TRADOC (employing hand grenades) was not tested because it has been demonstrated that this task is more skill-based rather than physiologically demanding, and the task performance is not always repeatable (35). Of the 15 tasks, two of the tasks (prepare a fighting position and casualty evacuation) were divided into multiple parts for the purpose of understanding the physical demands of performing different aspects of the task. For prepare the fighting position (Task 3), the two tasks were divided into filling sandbags and carrying sandbags. For the Bradley Fighting Vehicle (BFV) casualty evacuation (Task 4b), Soldiers were tested both individually and as a team.

During each task, Soldiers wore the designated uniform as defined by the SMEs from the Infantry School. The full breakdown of each load is illustrated in Appendix B. Briefly, the approximate weight of the basic ACU was 12.4 lb. The fighting load includes the uniform plus the weight of the personal protective equipment (PPE) and weapon (70.4 lb) for a total of 83 lb. The loads varied based on the size of the Soldier, particularly the weight of the body armor. The weight of the standard PPE can vary from 63.1-77.5 lb. The loads worn for each task are listed in the task descriptions. The

sustainment load consisted of everything included in the fighting load, plus 19 lb of additional supplies and equipment carried in an assault pack, for a total load of 102 lb. The approach march load varies from 94 to 110 lb based on size. The task specific uniform can vary between 42.5-57.1 lb, which includes the ACU, Improved Outer Tactical Vest (IOTV) with Enhanced Small Arms Protective Insert (ESAPI) and Enhanced Side Ballistics Insert (ESBI), and Advanced Combat Helmet (ACH). The loads stated herein refer to size large body armor, so the loads represent the middle of the actual range of weight worn.

Descriptions of the testing condition for each task, as well as the acceptable standard of completion provided by TRADOC (when applicable) are listed below. All testing instructions and data sheets for Study 1 can be found in Appendix G and H, respectively.

1. Foot March (11B & 11C; Figure 1.1)

Conduct a Tactical Movement

Soldiers completed a 12-mile foot movement, wearing the approach march load (approximately 102 lb of equipment). Three mandatory rest stations were placed on the course at miles 3, 6, and 9. Soldiers were required to rest for approximately 10 minutes at the first and third station and for 30 minutes at the midpoint station (mile 6). The midpoint station represented a simulation of a mission execution. Soldiers were allowed to take additional breaks as needed, and were permitted to stay at each official rest stop longer if needed. Soldiers were instrumented with a heart rate monitor and a timing chip (SPORTident Model SIAC1, Arnstadt, Germany). Heart rate, RPE, and timing splits were collected at each rest stop as well as at the start and finish line. For simplicity, only the finish line data are presented in this document.

Army Standard: Successful completion of the task

2. Employ Hand Grenades (11B & 11C; NOT TESTED)

While wearing a fighting load without a weapon (approximately 71 lb) throw a 1-lb hand grenade at least 30 m.

3. Fighting Position (11B, 11C; Figure 1.2)

Prepare a Fighting Position

Part A: Fill

While wearing a fighting load (approximately 83 lb), Soldiers shoveled sand from a large pile of loose sand into a bucket (to simulate a sandbag) using an entrenchment tool. A bucket was used to standardize the filling sandbag phase of the task. Had the Soldiers been required to fill a sandbag held by another Soldier, the stability of the bag opening would have varied with the individual holding the bag. Upon auditory signal, Soldiers filled buckets 26 times at 55% to 60% full (30-40 lb of sand).

Army Standard: Fill 26 sandbags in 52 minutes

Part B: Carry
The Soldier lifted and carried 26 pre-filled sandbags, weighing 40 lb each, a horizontal distance of 10 m where they built a fighting position within 26 minutes. The fighting position consisted of three rows in a rectangular formation. Each row consisted of three sandbags in length and three sandbags in height. One of the three rows only had two sandbags on the third level.

Army Standard: Carry 26 sandbags in 26 minutes

4a. Casualty Drag (11B & 11C; Figure 1.3)
Drag a Casualty to Immediate Safety
Upon auditory signal, Soldiers dragged a simulated casualty (approximately 271 lb) a distance of 15 m as quickly as possible while wearing a fighting load (approximately 83 lb). For the simulated casualty, a Survivor dummy (Dummies Unlimited, Pomona, CA) was modified to obtain the necessary weight. The dummy was outfitted with a modified Fighting Load Carrier to serve as a pulling handle.

Army Standard: Casualty dragged 15 m in 1 minute

4b. BFV Casualty Evacuation (11B; Figure 1.4)
Remove a Casualty from a Vehicle (Mounted)
As part of a two-Soldier team and while wearing a fighting load minus the weapon (approximately 71 lb), Soldiers removed a simulated casualty (approximately 207 lb, prorated at 103.5 lb/Soldier) from the commander's seat of a BFV. In order to standardize conditions, which would be impossible using a standard dummy with limbs that may catch in an irregular manner, the simulated casualty for this task was a haul bag (Black Diamond Zion, Salt Lake City, UT) modified to include straps that simulate the shoulder straps of a Combat Vehicle Crewman protective vest. Soldiers performed this task twice from the outside of the hatch as a member of a two person team with the bag weighted at 207 lb. Learning from the testing during the development of the 12B test battery (11), Soldiers also performed the task once solo, with the bag weighted at 103.5 lb.

Army Standard: Casualty removed from vehicle in 2 minutes

5. 25mm Barrel Install (11B; Figure 1.5)
Lift, Carry, and Install the Barrel of a 25mm gun on the BFV
As part of a two-Soldier team and wearing a fighting load (approximately 83 lb), Soldiers lifted, carried (25 m) and emplaced the barrel of the M242 25mm gun (107 lb, prorated at 53.5 lb/Soldier) onto the BFV. This involved placing the barrel onto the hood of the BFV, and climbing up onto the hood/deck. The Soldiers took turns supporting the barrel, while the other Soldier climbed onto the BFV. Once on the hood, the barrel was lifted as a team, and rotated into place.

Army Standard: Successful completion of the task

6. Feeder Assembly (11B; Figure 1.6)

Remove the Feeder Assembly of a 25mm gun on the BFV

While wearing approximately 39 lb of task specific PPE, a Soldier removed the M242 feeder assembly (59 lb) from the gun on the BFV and placed it on the floor in the rear of the vehicle. This involved lifting, pulling and lowering the assembly out of the slot, holding it while moving across the vehicle seat, and placing it on the floor behind the seat.

Army Standard: Successful completion of the task

7. Ammo Can Carry (11B; Figure 1.7)

Load 25mm High Explosive Incendiary Tracer (HEI-T) Ammunition Cans onto the Bradley Fighting Vehicle

While wearing a fighting load minus the weapon (approximately 71 lb), Soldiers lifted 30 HEI-T cans of 25 mm ammunition (45 lb), carried them 15 m, and placed them onto the tailgate of a BFV or a platform of similar height and dimensions. The can dimensions were 36 x 33 x 13 cm. Soldiers carried one or two cans at a time.

Army Standard: Successful completion of the task

8. Load TOW Missile (11B; Figure 1.8)

Load Tube-Launched, Optically-Tracked, Wire-Guided (TOW) Missile Launcher on BFV

While wearing a fighting load minus the weapon (approximately 71 lb), Soldiers loaded and unloaded two TOW-2B Aero Missiles (65 lb) into the BFV Mounted TOW Weapon System.

Army Standard: Successful completion of the task

9. Obstacles (11B & 11C)

Move Over, Through, or Around Obstacles

While wearing or carrying a fighting load, Soldiers scaled/climbed a 2-m vertical obstacle with assistance. During the task, Soldiers were allowed to remove their equipment and throw it over the obstacle before attempting to climb over.

Army Standard: Successful completion of the task

10. Move Under Fire (11B & 11C; Figure 1.9)

Move Under Direct Fire

During this task, Soldiers wore a fighting load (approximately 83 lb) and carried a weapon at the ready. Soldiers started the task in the prone position. Upon command, they sprinted to a marker and assumed the predetermined position for

that marker (either the kneeling, crouched or prone positions). Soldiers remained in the position for about 5 seconds. Upon signal, Soldiers stood up and sprinted to the next marker and assumed the predetermined position for that marker. This was repeated until the Soldier sprinted a total of 100 m.

Army Standard: Successful completion of the task

11. Prepare Dismounted TOW (11B)

Prepare Dismounted TOW Firing Position

While wearing a fighting load minus the weapon (approximately 71 lb), Soldiers lifted, carried a distance of 15 m, and loaded a TOW-2B Aero Missile (65 lb) onto a Ground Mounted TOW Weapon System.

Army Standard: Successful completion of the task

12. Engage Targets (11B; Figure 1.10)

Engage Targets with a .50 Caliber M2 Machine Gun

While wearing a fighting load (approximately 83 lb) and working as a member of a two-person team, Soldiers lifted and carried the M2 HB Machine Gun with tripod (153 lb) a distance of 10 m.

Army Standard: Successful completion of the task

13. Emplace Base Plate (11C; Figure 1.11)

Lay a 120mm Mortar- Emplace Base Plate

While wearing a fighting load (approximately 83 lb) and working as a member of a two-person team. Soldiers lifted and carried a distance of 25 m and emplaced the 120mm mortar base plate (136 lb, prorated 68 lb/Soldier).

Army Standard: Successful completion of the task

14. Emplace Cannon (11C; Figure 1.12)

Lay a 120mm Mortar- Emplace Cannon

While wearing a fighting load (approximately 83 lb), Soldiers lifted, carried a distance of 25 m, and emplaced the 120mm mortar cannon tube (110 lb, prorated 55 lb/Soldier).

Army Standard: Successful completion of the task

15. Traverse a Mortar (11C; NOT TESTED)

Lay a 120mm Mortar for Deflection and Elevation (Traverse)

As part of a two-Soldier team and wearing a task specific uniform (approximately 49 lb), Soldiers lifted and carried the 120mm mortar cannon with the site and bipod (183 lb; prorated 91.5 lb/Soldier) in order to change deflection.

Army Standard: Successful completion of the task

16. Fire a Mortar (11C; Figure 1.13)

Fire a Mortar (Lift and Hold Round, Place in Tube)

While wearing a task specific uniform weighing approximately 49 lb, Soldiers lifted 120mm HE rounds (29 lb) to approximately 2 m in height a total of five times. Soldiers lifted the first round up (2 m) and the round in place at the end of the cannon for 10 seconds prior to releasing it. Rounds 2-5 did not have to be suspended prior to release.

Army Standard: Successful completion of the task

Soldiers were instructed to perform the tasks at the rate they would normally perform the task. All tests were graded "Go" or "No-Go" depending on whether they completed the task to standard.

PHYSIOLOGICAL MEASUREMENTS

Measurements varied by task (see Table 1.2). Time to completion was recorded for all tasks. Rate of perceived exertion (4) values were also recorded for all tasks, with those tasks deemed aerobically-intensive graded on the Borg 6-20 scale (Tasks 1, 3, 7, and 10), and tasks primarily requiring strength (Tasks 4a, 4b, 5, 6, 8, 9, 10, 11, 12, 13, 14, 16) graded on the Borg CR-10 (i.e. 1-10) scale. Tasks with an approximate duration of greater than 5 minutes were deemed aerobic tasks, while the remainder of the tasks were identified as strength tasks.

Metabolic data were also collected for the aerobic tasks using an Oxycon Mobile Metabolic Unit (CareFusion, San Diego, CA) for Tasks 3 and 7. Data were collected using 1 minute averaging, and then were averaged over the course of the task, leaving out the first minute. Metabolic variables of interest included average heart rate, average oxygen uptake (VO_2) in absolute units (L/min), average VO_2 relative to body mass (ml/kg/min), and percent of estimated VO_2 max. VO_2 max was estimated using the following equation (22):

Predicted VO_2max (ml·kg·min^{-1}) =110.9 – 2.79 (2-mile run time [min])-0.25 (weight [kg])

Absolute total O_2 consumption (L, product of average VO_2 and time) adjusted for body mass (ml/kg) was also calculated. For all aerobic tasks, HR at the end of the task was recorded using a Polar heart rate chest-strap monitor and watch (Polar Electro Model T31, Kempele, Finland).

STATISTICAL ANALYSES

All statistics were calculated using SPSS Version 20 (IBM Corporation, Armonk, New York). Significance was set at the $p<0.05$ level. Each MOS was analyzed independently.

For each task and outcome variable, mean and standard deviations were calculated separately for each sex. Sex differences in characteristics were assessed using unpaired t-tests. Sex differences in percentage of individuals who completed the task to standard were assessed using a Pearson's chi-square test. Two-factor (task, sex) ANOVAs were run for each physiological variable using data from those who successfully completed the task to ensure that the data corresponded to acceptable performance. The aerobic and strength tasks were tested separately. Significant main effects of task were separated using a post-hoc Scheffe's adjustment to determine differences in physiological demand across tasks. Marginal means were calculated by task for the interaction, and tested using post-hoc unpaired t-tests for differences across the physiological demands by sex for each task.

STUDY 1: RESULTS

SOLDIER VOLUNTEER CHARACTERISTICS

Characteristics of the subjects tested are summarized in Table 1.3. For the 11B testing, the males were taller and heavier than the females ($p<0.01$). Both sexes had similar total APFT scores ($p=0.42$), but the males had better push-up and 2-mile run raw scores ($p<0.01$).

For the 11C testing, the males were taller ($p<0.01$) but there was no significant difference in body mass by gender. Females were older and had spent more time in the military ($p<0.01$). Overall there were no differences in total APFT score by sex ($p=0.37$, but the males had better push-up, sit-up and 2-mile run raw scores ($p\leq0.05$).

The data from the training and deployment questionnaire for both MOSs are shown in Table 1.4. Training data indicates that the most commonly performed 11B aerobic task in training and while deployed was the foot march and the move under fire. The most common strength tasks in training and deployment were the casualty drag and move over, through or around obstacles, respectively. Of the 11C tasks, the foot march was the most commonly performed aerobic task in training. The most common aerobic task performed while deployed was move under fire. Of the strength tasks, fire a mortar was most commonly performed in training and deployment.

TASK COMPLETION

Table 1.5 indicates the number of participants tested for each of the 11B and 11C task, as well as the number of participants from each MOS who completed each task to the standard. Due to the time required to complete the tasks and collect the metabolic data, not all Soldiers performed the filling phase of fighting position task.

Four of the 11B tasks were not completed by all Soldiers to the required standard. While there was no formal time standard, three Soldiers in the 11B cohort were unable to complete the foot march. In addition, three Soldiers were unable to complete the casualty drag, two Soldiers were not capable of lifting the casualty from

the BFV, and one Soldier was unable to remove the feeder. The only task whereby completion percentage varied by sex was the casualty drag (p=0.02)

One of the tasks performed by the 11C cohort was not completed to standard. Two Soldiers were unable to complete the casualty drag.

PHYSICAL DEMANDS OF 11B TASKS

Physiological data were calculated only for individuals who completed the task to standard. 11B task completion times for the aerobic and strength tasks are shown in Figure 1.14. The foot march was the aerobic task that took the longest, followed by the filling phase of sandbags and then the ammo can carry (Figure 1.14, TOP LEFT). Of the aerobic tasks, the foot march followed by the sandbag carry (Figure 1.15, TOP LEFT) were perceived to require the greatest exertion, while the sandbag fill, ammo can carry, and move under fire were all equal. The greatest end-task heart rates (Figure 1.16, TOP LEFT) were observed during the carry phase of the fighting position, the ammo can carry, and move under fire. The carry phase of the fighting position and ammo can carry also had the highest average heart rate (Figure 1.16 BOTTOM LEFT), VO_2 in absolute terms (Figure 1.17, TOP LEFT), VO_2 when normalized to body mass (Figure 1.17, MIDDLE LEFT), and VO_2 when normalized to predicted VO_2max (Figure 1.17, BOTTOM LEFT). The fill phase of the fighting position and ammo can carry had the highest total oxygen consumption (Figure 1.18) in both absolute terms (Figure 1.18, TOP LEFT) and normalized to body mass (Figure 1.18 BOTTOM LEFT).

The heaviest load moved while performing the 11B tasks was the 271-lb load dragged for the casualty drag, while the heaviest load lifted was the prorated 103.5 lb from the casualty evacuation. The 25mm barrel install took the longest of the strength tasks followed by loading the TOW missile launcher (Figure 1.14, BOTTOM LEFT). The casualty drag was perceived to require the greatest exertion of the strength tasks (Figure 1.15, BOTTOM LEFT). Table 1.6 provides a summary of 11B tasks deemed most difficult, by nature of being in the top rank for each physiological measure.

Of the aerobic tasks, females took longer than the males to complete the foot march, fill phase and carry phase of the fighting position and the ammo can carry. Ratings of perceived exertion were higher for females during the foot march, both the fill and carry phase of the fighting position, the ammo can carry, and move under fire. There were no differences by gender in heart rate, but VO_2 (both absolute and relative) was less in females compared to males for both phases of the fighting position, ammo can carry and move under fire. In addition, absolute total oxygen (O_2) consumption was less for females compared to males during the fill phase of the fighting position, but equal to males for the carry phase of the fighting position and the ammo can carry. Relative O_2 for females was equal to males for the fill phase of the fighting position and the ammo can carry, but greater than males for the carry phase of a fighting position. Of the strength tasks, females took longer to complete the casualty drag, solo casualty evacuation, and loading the TOW. Females perceived the casualty drag, solo casualty evacuation, feeder assembly install, loading the TOW, and obstacle clearance to be

more difficulty than the males. A summary of differences in physiological demands by sex is provided in Table 1.7.

PHYSICAL DEMANDS OF 11C TASKS

Of the 11C tasks, the foot march was the aerobic tasks that took the longest (Figure 1.14, TOP RIGHT). Of the aerobic tasks, the foot march was perceived (Figure 1.15, TOP RIGHT) to have the greatest exertion, with move under fire and both phases of the fighting position all equal. The greatest end-task (Figure 1.16, TOP RIGHT) and average (Figure 1.16, BOTTOM RIGHT) heart rates were observed during carry phase of the fighting position. The sandbag carry had the highest values of VO_2 in absolute terms (Figure 1.17, TOP RIGHT), normalized to body mass (Figure 1.17, MIDDLE RIGHT), and normalized to predicted VO_2max (Figure 1.17, BOTTOM LEFT). Total oxygen consumption was highest in the filling phase of the fighting position in both absolute terms (Figure 1.18, TOP RIGHT) and normalized to body mass (Figure 1.18, BOTTOM RIGHT).

The heaviest load moved while performing the 11C tasks was the 271-lb dragged for the casualty drag, while the heaviest load lifted was the prorated 68 lb of the mortar baseplate. . The longest of the strength tasks (Figure 1.14, BOTTOM RIGHT) were the move over, through or around obstacles, casualty drag, fire a mortar, and moving the mortar cannon. Similar to the 11B, the casualty drag was perceived to require the greatest exertion of the strength tasks (Figure 1.15, BOTTOM RIGHT). A summary of 11C tasks deemed most difficult, by nature of being in the top rank, for each measure is provided in Table 1.8.

Of the aerobic tasks, females took longer than the males to complete the foot march, fill phase and carry phase of the fighting position, but had similar times to the males when completing move under fire. Ratings of perceived exertion were higher for females during the foot march and the carry phase of the fighting position, but were similar for the fill phase of the fighting position and move under fire. There were no differences by gender in heart rate, but absolute VO_2 was lower in females compared to males for both phases of the fighting position while relative VO2 was lower in females than males in the carry phase, but similar for the fill phase. Total O2 consumption was similar by sex for both phases of the fighting position. Of the strength tasks, females took longer to clear the obstacle and complete the casualty drag. Females perceived the casualty drag to be more difficult than the men. A summary of differences in physiological demands by sex is provided in Table 1.9.

STUDY 1: DISCUSSION

This descriptive study identified the physiological demands of the most physically demanding tasks performed by Infantry Soldiers. From these data, the foot march and the casualty drag were identified as the most commonly performed 11B aerobic and strength tasks, respectively, during training. The most commonly performed aerobic

and strength tasks while deployed were the foot march and move through obstacles, respectively. Of the aerobic tasks, the foot march required the longest time to complete. The highest RPE tasks were both the carry phase of the fighting position and foot march. The carry phase of the fighting position, the ammo can carry, and move under fire had the greatest end-task heart rate values. The carry phase of the fighting position and ammo can carry also had the highest average heart rate. For the metabolic measures, the carry phase of the fighting position and ammo can carry had the highest VO_2 in absolute terms, normalized to body mass, and normalized to predicted VO_2max. The fill phase of the fighting position and ammo can carry had the highest total oxygen consumption both absolute and normalized to body mass. The casualty drag was the heaviest load moved and had the highest RPE values of the strength tasks, while the 25mm barrel install took the longest in duration.

For the 11C, the foot march (aerobic) and fire a mortar (strength) were the most commonly performed tasks during training. While deployed, the most common tasks performed were move under fire (aerobic) and fire a mortar (strength). Of the aerobic tasks, the foot march was the task that took the longest. The foot march was perceived to have the greatest exertion. For both end-task and average heart rates, the highest values were seen during the carry phase of the fighting position. For metabolic measures, the carry phase of the fighting position had the greatest values of VO_2 in absolute terms, normalized to body mass, and normalized to predict VO_2max. The filling phase of the fighting position had the highest total oxygen consumption in both absolute terms and normalized to body mass.

PHYSICAL DEMANDS OF TASKS

The carry phase of the fighting position (11B and 11C) and the ammo can carry (11B) are the most demanding repetitive lift and carry tasks. For either MOSs, there is no statistical difference among the VO_2 measures for these two tasks when normalized to body weight. There are several possible rationales for this. One possibility is that the physical demands of performing each task to Army standards are very similar. Given that both tasks require similar movements with similar weights (carry 35-45 lb, 10-15 m, 26-30 times), this is not an unreasonable explanation. It is also possible that Soldiers are self-selecting a pace they know they can sustain. At least during long-duration load carriage, it has been shown that Soldiers will self-select a pace of ~45% of their VO_2max independent of load carried (10). While we observed Soldiers at closer to ~60% of VO_2max, this difference in pace selection may be due to the much shorter nature of the lift and carry tasks.

A number of the tasks required teamwork in groups of two or more participants. These include the strength tasks of casualty evacuations (Tasks 4b), 25mm barrel install (Task 5) and engage targets with an M2 machine gun (Task 12). During these tasks, the performance of one individual will affect the performance of others assisting to complete the task. For example, the weaker individual may be carrying less of the load, or a less aerobically fit individual may require the task to be performed at a slower rate. Likewise, the more the stronger or more fit Soldier is able to compensate for another Soldier, the less of a demand is placed on the weaker Soldier. In addition, if the

load is not evenly distributed, the task may not be the same for each member of the team. Thus, interpretation of the physical demands of these tasks should be performed with care, taking this influence into account. While the average data is still valid, given different combinations of individuals, it is likely that performance could be more variable. This is particularly true since tasks were completed at a work (i.e., submaximal) pace, and not necessarily at maximal effort. Simulations must be designed to reflect the demands of a single individual to assess an individual's capacity to perform the task.

Two tasks were divided into multiple parts for technical reasons. The casualty rescue was found to have similar physiological demands on both the casualty drag and casualty evacuation. Regardless of whether the Soldiers were performing the task solo or as part of a team, the RPE responses and time to completion were equivalent. This supports the concept that our modifications accurately reflected the physical demands of the original tasks. The remaining task, fighting position, was divided in order to better understand two distinct phases of the task. We observed similar RPE responses for both the fill and carry phases; however, the heart rate responses and metabolic measurements differed slightly. The carry phase produced higher values for both end-task and average heart rate, and all rates of oxygen consumption in comparison to the filling phase. Notably, the filling phase of the fighting position produced greater levels of total oxygen consumption. These differences between the two phases are not surprising due to the vast differences in the physical requirements of the two phases of this task.

SEX DIFFERENCES IN PHYSIOLOGICAL DEMANDS

Differences in task performance were observed between males and females. During performance of the aerobically demanding tasks (foot march, fill phase and carry phase of the fighting position, move under fire, and the ammo can carry for the 11B), females from the 11B and 11C often performed the tasks at a slower pace and perceived the tasks to be more difficult than their male counterparts. In addition, both absolute and relative VO2 were lower for females during these self-paced tasks. It is possible that when allowed to self-pace, females and males, once settled into performing the task, work at speeds which result in the same relative workload. Heart rates for females and males for both the 11B and 11C tasks were similar while performing these tasks. Despite the fact that females from both 11B and 11C took longer to complete the tasks, at least 80% of the females were able to complete each of the tasks to standard.

FUTURE TASK SIMULATIONS

For the purposes of identifying predictor tests, it is possible to break down the tasks further based on their constituent movements. The tasks tested consist of both aerobically demanding tasks and strength demanding tasks. The aerobic tasks can be subdivided into repeated lift and carry tasks (11B: both fighting positions and ammo can carry; 11C: both fighting positions), extended duration load carriage (11B and 11C: foot march), and quick movement/agility (11B and 11C: move through obstacles and move under fire). The strength tasks can be broken into heavy lift (11B: BFV casualty evacuation, 25mm barrel install, feeder assembly, load TOW, and engage targets with

an M2; 11C: mortar-base plate, mortar- cannon, and fire a mortar) and heavy drag (11B and 11C: casualty drag). All of the physical demands for the tasks identified should be represented in a set of tasks selected for simulations. Additionally, these tasks should:

- Test individuals, not teams
- Allow for a range of scores to show differences between people (cannot be go/no-go)
- Measure unique physical capabilities
- Be safe (not endanger Soldiers)
- Require minimal, available equipment
- Be reliable (same person gets same score on different days)
- Require minimal skill and practice
- Be time efficient

Both MOSs had only one task that could be considered a load carriage task: the foot march. This task took much longer than any other tasks (hours instead of minutes), and was rated as having the highest RPE. Thus, the foot march task should be included in future studies.

All of the repetitive lift and carry tasks for the 11B were in the most physically demanding group for at least one of the measures (completion time, heart rate, oxygen uptake, oxygen cost; Figures 1.15-1.19). The sandbag carry had high end-task and average heart rate values. The sandbag fill had the greatest metabolic demands in total oxygen cost in both absolute and normalized measures. In contrast, the ammo can carry rated higher on the oxygen uptake absolute and normalized metabolic measures with equivalent HR values and total oxygen cost to the sandbag carry and sandbag fill, respectively. Since both the fighting position and ammo can carry are not highly skilled, have among the highest physical demands, and require minimal equipment, these tasks are highly probable candidates for use in future studies.

The two phases of the fighting position have the highest physical demands of the 11C repetitive lift and carry tasks. The sandbag carry had the greatest heart rate and oxygen uptake values. The sandbag fill had the longest completion time and total oxygen cost. Similarly to the 11B, both phases of the fighting position are not highly skilled tasks. Further, they have the highest physical demands while requiring minimal equipment to administer, which makes these tasks acceptable for consideration to use in future simulations.

Among the strength tasks, the casualty evacuation (11B) and mortar base plate (11C) were the heaviest weight lifted of all the tasks. For the 11B, the BFV evacuation has a prorated weight of 103.5 lb. In this study, we were able to simulate the task as an individual task. For the 11C, the mortar base plate has a prorated weight of 68 lb. Both the casualty evacuation and mortar base plate are essential to the health and safety of the Soldiers as well as success in the respective MOSs. These tasks may be the best heavy lift tasks for future task simulations.

For both MOSs, the casualty drag should be simulated due to its unique motion, high physical demands (e.g. weight, RPE), and because it has life or death consequences.

LIMITATIONS

While this study was designed to simulate real world conditions, we were not able to account for all variables. Some tasks had to be modified to allow for testing (e.g., haul bag used for casualty evacuation). Tasks were completed on successive days, so any cumulative fatigue or discomfort may have affected performance on later days. While this may affect performance on individual tasks, it is not uncommon for Soldiers in the field to perform these physical tasks on consecutive days. In addition, several tasks were completed as teams of two or more people. This makes it difficult to fully understand the demands of the task on an individual, as the two Soldiers may not be evenly distributing the burden of the task.

Most notably, all tasks were tested in a controlled garrison environment. Soldiers were instructed exactly how to perform the task, based on recommendations provided by subject matter experts. It is possible that in a real situation, there may be variations to the task which may increase or decrease the individual demands, such as material on which the casualty is dragged, distance of carry (ammo cans, sandbags), or weight of the casualty. In addition, at no time were the Soldiers in immediate danger. In a deployed, high-stress situation, the physiological demands are likely increased, and tasks may be performed repeatedly or in an entirely different manner.

STUDY 1: CONCLUSIONS

The present study determined the physiological demand for the TRADOC identified physical demanding tasks of 11B Infantryman and 11C Infantryman- Indirect Fire. Among the most physically demanding tasks for the 11B are both phases of the fighting position, ammo can carry, foot march, casualty drag, and 25mm barrel install. For the 11C, the most demanding tasks were the both phases of the fighting position, foot march, mortar cannon, fire a mortar, and casualty drag.

STUDY 1: RECOMMENDATIONS

1. SMEs should be consulted to determine whether sandbags or ammo cans are the preferable task to use for simulations in the prediction model development.

2. SMEs should approve of the alteration of the casualty evacuations into solo tasks, and the use of simulations for the mortar base plate and casualty drag tasks.

3. Reliability of the tasks, particularly those using custom designed simulators, needs to be established.

Table 1.1. List of the 32 Physically Demanding Tasks of Combat Arms Soldiers

	TASK	IN 11B	IN 11C	EN 12B	FA 13B	FA 13F	AR 19D	AR 19K
1	Conduct Tactical Movement / Foot March	X	X	X		X	X	X
2	Employ Hand Grenades	X	X	X	X	X	X	X
3	Prepare a Fighting Position (Fill and Emplace Sandbags)	X	X	X	X	X	X	X
4a	Drag a Casualty to Immediate Safety	X	X	X	X	X	X	X
4b	Remove a Casualty from a Wheeled Vehicle	X		X		X	X	
5	Maintain 25mm Gun on BFV – Install the Barrel	X		X		X	X	
6	Maintain 25mm Gun on BFV – Remove Feeder Assembly	X		X		X	X	
7	Load 25mm H-EIT Tracer Ammunition Can on BFV	X		X		X	X	
8	Load TOW Missile Launcher on BFV	X					X	
9	Move Over, Through, or Around Obstacles	X	X					
10	Move Under Direct Fire	X	X	[1]		[1]	[1]	[1]
11	Prepare Dismounted TOW Firing Position	X						
12	Engage Targets with a Caliber .50 M2 Machine Gun	X						
13	Lay a 120mm Mortar – Emplace Base Plate		X					
14	Lay a 120mm Mortar – Emplace Cannon		X					
15	Lay a 120mm Mortar for Deflection and Elevation (Traverse)		X					
16	Fire a Mortar (Lift and Hold Round, Place in Tube)		X					
17	Mount M2 .50 Cal Machine Gun Receiver on an Abrams Tank							X
18	Stow Ammunition on an Abrams Tank (Load 120mm MPAT Round to the Ready Rack)							X
19	Load the 120mm Main Gun							X
20	Remove a Casualty from an Abrams Tank							X
21	Transfer Ammunition with an M992 Carrier (CAT)				X			
22	Emplace 155mm Howitzer / Lift Wheel Assembly				X			
23	Displace 155mm Howitzer / Recover Spade Trail Arm and Blade				X			
24	Set Up Gun Laying Positioning System (GLPS)				X			
25	Establish an Observation Point					X		
26	Prepare M1200 Armored Knight Vehicle for Operation					X		
27	Quickly Create a Footpath through Various Obstacles (Carry / Employ Antipersonnel Obstacle Breaching System (APOBS))			X				
28	Prepare Obstacle with the H6 40 lb Cratering Charge			X				
29	Operate a Modular-Pack Mine System (MOPMS)			X				
30	Assist in the Construction of a Bailey Bridge			X				
31	Load / Install a Volcano			X				

IN=Infantry, FA=Field Artillery, AR=Armor, EN=Engineers

[1] Following Study 1, move under direct fire was determined to be essential to 12B, 13F, 19D and 19K as well.

Table 1.2. Summary of Infantry Tasks and Measurements from Ft. Stewart

Task #	Performed by 11B	11C	Occupational Related Tasks	Measures
			Aerobic Tasks	
1	X	X	Conduct a 12 Mile Foot March	Time, RPE 6-20, HR
3	X	X	Prepare a Fighting Position (Fill and Emplace Sandbags)	Time, RPE 6-20, HR, VO_2
7	X		Load 25mm H-EIT Tracer Ammunition Cans onto the Bradley Fighting Vehicle	Time, RPE 6-20, HR, VO_2
10	X	X	Move Under Direct Fire	Time, RPE 6-20, HR
			Strength Tasks	
4a	X	X	Drag a Casualty to Immediate Safety (Dismounted)	Time, RPE CR10
4b	X		Remove a Casualty from a Vehicle (Mounted)	Time, RPE CR10
5	X		Lift, Carry, and Install the Barrel of a 25mm gun on the Bradley Fighting Vehicle	Time, RPE CR10
6	X		Remove the Feeder Assembly of a 25mm gun on the Bradley Fighting Vehicle	Time, RPE CR10
8	X		Load TOW Missile Launcher on Bradley Fighting Vehicle	Time, RPE CR10
9	X	X	Move Over, Through, or Around Obstacles	Time, RPE CR10
11	X		Prepare Dismounted TOW Firing Position	Time, RPE CR10
12	X		Engage Targets with a .50 Caliber M2 Machine Gun	Time, RPE CR10
13		X	Lay a 120mm Mortar- Emplace Base Plate	Time, RPE CR10
14		X	Lay a 120mm Mortar- Emplace Cannon	Time, RPE CR10
16		X	Fire a Mortar (Lift and Hold Round, Place in Tube)	Time, RPE CR10

Table 1.3. Soldier Characteristics: Study 1

11B: Infantryman			
	Males (n=24)	**Females (n=15)**	**p-value**
Age (years)	23.8 ± 3.2	27.0 ± 6.9	0.06
Height (cm)	179.6 ± 6.6	169.2 ± 5.8	<0.01
Mass (kg)	84.3 ± 11.7	67.0 ± 8.0	<0.01
Time in Military (years)	3.0 ± 2.6	6.2 ± 7.3	0.06
Time in MOS (years)	3.0 ± 2.6	5.3 ± 6.0	0.12
Number Deployed (%)	9 (36%)	9 (60%)	.
Time Deployed (years) *for only those who have deployed*	0.7 ± 1.1	0.9 ± 0.5	0.44
Army Physical Fitness Test Score (points)	253.9 ± 28.6	267.7 ± 29.4	0.42
Push-ups (# / 2 min)	70.2 ± 13.4	39.1 ± 9.5	<0.01
Sit-ups (# / 2 min)	70.8 ± 11.9	71.3 ± 8.3	0.89
Two-Mile Run Time (min)	14.3 ± 0.9	16.7 ± 1.6	<0.01
Predicted VO_2max (ml/kg/min)	51.3 ± 4.7	48.9 ± 5.0	0.13
11C: Infantryman- Indirect Fire			
	Males (n=20)	**Females (n=13)**	**p-value**
Age (years)	20.8 ± 3.1	27.4 ± 5.0	<0.01
Height (cm)	178.2 ± 6.8	166.9 ± 6.3	<0.01
Mass (kg)	80.5 ± 7.8	73.4 ± 7.7	0.86
Time in Military (years)	2.0 ± 1.3	3.6 ± 3.1	<0.01
Time in MOS (years)	2.1 ± 1.2	3.1 ± 3.2	0.41
Number Deployed (%)	3 (15%)	3 (23%)	.
Time Deployed (years) *for only those who have deployed*	0.6 ± 0.4	1.6 ± 0.6	0.08
Army Physical Fitness Test Score (points)	267.3 ± 23.2	259.7 ± 22.7	0.37
Push-ups (# / 2 min)	71.2 ± 11.2	43.9 ± 9.3	<0.01
Sit-ups (# / 2 min)	70.9 ± 9.0	64.3 ± 8.5	0.05
Two-Mile Run Time (min)	14.1 ± 1.2	17.1 ± 1.6	<0.01
Predicted VO_2max (ml/kg/min)	52.8 ± 4.0	46.0 ± 5.3	<0.01

Table 1.4. Frequency of Task Performance in Training and Deployment Environments

11B: Infantryman		Males		Females	
		In Training n=24	**Deployed n=14**	**In Training n=15**	**Deployed n=9**
Aerobic Tasks	**1: Foot March**	113.6 ± 103.2 (7-368)	179.3 ± 289.0 (10-1130)	12.2 ± 12.1 (2-36)	0.7 ± 1.3 (0-3)
	3: Fighting Position	29.4 ± 44.4 (1-180)	42.4 ± 64.4 (0-182)	3.7 ± 3.5 (1-12)	0.0 —
	7: Ammo Can Carry	22.8 ± 38.8 (0-150)	1.7 ± 5.8 (0-20)	0.0 —	0.0 —
	10: Move Under Fire	98.2 ± 120.0 (3-500)	115.1 ± 296.5 (0-1130)	12.4 ± 12.9 (1-36)	0.0 —
Strength Tasks	**4a: Casualty Drag**	61.3 ± 88.1 (3-300)	3.5 ± 4.4 (0-15)	41.0 ± 53.7 (1-144)	0.4 ± 0.7 (0-2)
	4b: BFV Casualty Evacuation	22.9 ± 46.6 (1-200)	3.2 ± 6.2 (0-20)	7.5 ± 7.0 (1-15)	0.0 —
	5: 25mm Barrel Install	37.0 ± 42.2 (4-150)	0.8 ± 2.9 (0-10)	0.0 —	0.0 —
	6: Feeder Assembly	30.0 ± 36.8 (3-150)	1.3 ± 4.3 (0-15)	0.0 —	0.0 —
	8: Load TOW	28.0 ± 39.3 (2-150)	2.5 ± 8.7 (0-30)	0.0 —	0.0 —
	9: Obstacles	44.7 ± 65.1 (2-300)	135.2 ± 279.9 (0-1130)	13.8 ± 13.6 (2-36)	0.0 —
	11: TOW Missile [a]	26.6 ± 37.8 (1-100)	0.4 ± 1.4 (0-5)	0.0 —	0.0 —
	12: Engage Targets [a]	35.6 ± 102.5 (1-500)	16.9 ± 46.3 (0-180)	0.0 —	0.0 —
11C: Infantryman- Indirect Fire		**Males**		**Females**	
		In Training n=20	**Deployed n=12**	**In Training n=13**	**Deployed n=3**
Aerobic Tasks	**1: Foot March**	43.8 ± 40.0 (10-150)	54.7 ± 42.2 (15-99)	9.8 ± 9.0 (2-31)	1.7 ± 2.1 (0-4)
	3: Fighting Position	12.7 ± 33.5 (1-150)	4.7 ± 4.5 (0-9)	4.3 ± 3.4 (1-10)	0.0 —
	7: Ammo Can Carry	31.6 ± 37.3 (3-150)	56.3 ± 89.9 (0-2)	6.9 ± 15.3 (2-20)	0.0 —
Strength Tasks	**4a: Casualty Drag**	17.7 ± 34.8 (1-150)	0.3 ± 0.6 (0-1)	12.1 ± 17.9 (1-50)	0.0 —
	9: Obstacles	18.4 ± 34.2 (2-150)	48.0 ± 45.1 (20-100)	9.4 ± 7.5 (2-21)	0.0 —
	13: Emplace Base Plate [a]	378.8 ± 1350.4 (10-5616)	25.7 ± 41.95 (0-74)	19.2 ± 4.9 (10-25)	0.0 —
	14. Emplace Cannon [a]	378.8 ± 1350.4 (10-5616)	26.3 ± 41.4 (0-74)	18.3 ± 4.1 (10-20)	0.0 —
	15. Traverse a Mortar [a]	387.1 ± 1348.5 (10-5610)	43.3 ± 34.5 (6-74)	17.0 ± 5.6 (6-20)	0.0 —
	16. Fire a Mortar [a]	419.8 ± 1359.6 (2-5616)	367.7 ± 548.9 (4-999)	16.7 ± 6.4 (4-20)	0.0 —

[a] Data for MOS-specific tasks while deployed shown only for male Soldiers who retained the MOS (11B, n=14; 11C, n=12)
Values Mean ± SD (Range);
In Training: Total # of times task*, not including train-up for study;*
Deployed: Average # of times per year deployed.

Table 1.5. Number Tested and Completion Rates of all Tasks

11B: Infantryman		Number Tested			Completion Rate			Gender Completion P-Value
		All	Male	Female	All	Male	Female	
Aerobic Tasks	**1: Foot March**	39	24	15	**92.3%**	**95.8%**	**86.7%**	**0.30**
	3: Fighting Position (FILL)	36	21	15	100%	100%	100%	—
	3: Fighting Position (CARRY)	39	24	15	100%	100%	100%	—
	7: Ammo Can Carry	39	24	15	100%	100%	100%	—
	10: Move Under Fire	39	24	15	100%	100%	100%	—
Strength Tasks	**4a: Casualty Drag**	39	24	15	**92.3%**	100%	**80.0%**	**0.02**
	4b: BFV Cas Evac	39	24	15	**94.9%**	100%	**86.7%**	**0.07**
	5: 25mm Barrel Install	39	24	15	100%	100%	100%	—
	6: Feeder Assembly	39	24	15	**97.4%**	100%	**93.3%**	**0.20**
	8: Load TOW	39	24	15	100%	100%	100%	—
	9: Obstacles	39	24	15	100%	100%	100%	—
	11: TOW Missile	39	24	15	100%	100%	100%	—
	12: M2 machine gun	39	24	15	100%	100%	100%	—
11C: Infantryman- Indirect Fire		**Number Tested**			**Completion Rate**			**Gender Completion P-Value**
		All	**Male**	**Female**	**All**	**Male**	**Female**	
Aerobic Tasks	**1: Foot March**	32	19	13	100%	100%	100%	—
	3: Fighting Position (FILL)	32	19	13	100%	100%	100%	—
	3: Fighting Position (CARRY)	32	19	13	100%	100%	100%	—
	10: Move Under Fire	32	19	13	100%	100%	100%	—
Strength Tasks	**4a: Casualty Drag**	32	19	13	**93.8%**	100%	**84.6%**	**0.08**
	9: Obstacles	32	19	13	100%	100%	100%	—
	13: Emplace Base Plate	32	19	13	100%	100%	100%	—
	14: Emplace Cannon	32	19	13	100%	100%	100%	—
	16: Fire a Mortar	32	19	13	100%	100%	100%	—

Bolding indicates <100% successful completion rate

Table 1.6. Summary of Physical Demands of Tasks of 11B

			Task in top rank of physical demand by:					
		Prorated Load Carried[a] (lb)	**Time**	**RPE**	**End HR**	**Mean HR**	**VO_2 (absolute or relative)**	**Total O_2 (absolute or relative)**
Aerobic Tasks	***1: Foot March*** *Load Carriage*	*19.5*	*†*	*†*				
	3: Fighting Position (FILL) *Repeated Lift & Carry*	*35*						
	3: Fighting Position (CARRY) *Repeated Lift & Carry*	*35*		*†*	*†*	*†*	*†*	*†*
	7: Ammo Cans *Repeated Lift & Carry*	*45*			*†*	*†*	*†*	*†*
	10: Move Under Fire *Quick Movement, Agility*	BW			†			
Strength Tasks	***4a: Casualty Drag*** *Heavy Drag*	*271*		*†*				
	4b: BFV Casualty Evacuation (TEAM) *Heavy Lift*	*103*						
	4b: BFV Casualty Evacuation (SOLO) *Heavy Lift*	*103*						
	5: 25mm Barrel Install *Heavy Lift*	*53.5*	*†*					
	6: Feeder Assembly *Heavy Lift*	*59*						
	8: Load TOW *Heavy Lift*	*65*						
	9: Obstacle *Quick Movement, Agility*	BW						
	11. TOW Missile *Heavy Lift*	65						
	12. Engage Targets *Heavy Lift*	76.5						

[a]: Load does not include uniform
†: In top rank for measure (significantly greater than all other tasks, $p<0.05$)
Italics: Task Common to Multiple Combat Arms MOSs
Gray: Not measured
BW: Body weight in uniform

Table 1.7. Tasks with Sex Differences (11B)

		Time	RPE	End HR	Mean HR	VO_2	Total O_2
Aerobic Tasks	**1: Foot March**	F>M	F>M	F=M			
	3: Fighting Position (FILL)	F>M	F>M	F=M	F=M	ABS: F<M REL: F<M %MAX: F<M	ABS: F<M REL: F=M
	3: Fighting Position (CARRY)	F>M	F>M	F=M	F=M	ABS: F<M REL: F<M %MAX: F<M	ABS: F=M REL: F>M
	7: Ammo Cans	F>M	F>M	F=M	F=M	ABS: F<M REL: F<M %MAX: F<M	ABS: F=M REL: F=M
	10: Move Under Fire	F=M	F>M	F=M			
Strength Tasks	**4a: Casualty Drag**	F>M	F>M				
	4b: BFV Casualty Evacuation (TEAM)	F=M	F=M				
	4b: BFV Casualty Evacuation (SOLO)	F>M	F>M				
	5: 25mm Barrel Install	F=M	F=M				
	6: Feeder Assembly	F=M	F>M				
	8: Load TOW	F>M	F>M				
	9: Obstacles	F=M	F>M				
	11: TOW Missile	F=M	F=M				
	12: Engage Targets	F=M	F=M				

$p<0.05$
M: Male, F: Female
For VO_2 and Total O_2, ABS: Absolute (L/min), REL: Relative to Body Mass (ml/kg/min), %MAX: Percent estimated VO_2max
Gray: Not measured

Table 1.8. Summary of Physical Demands of Tasks of 11C

			Task in top rank of physical demand by:					
		Prorated Load Carried[a] (lb)	**Time**	**RPE**	**End HR**	**Mean HR**	**VO_2 (absolute or relative)**	**Total O_2 (absolute or relative)**
Aerobic Tasks	***1: Foot March*** *Load Carriage*	*19.5*	*†*	*†*				
	3: Fighting Position (FILL) *Repeated Lift & Carry*	*35*						*†*
	3: Fighting Position (CARRY) *Repeated Lift & Carry*	*35*			*†*	*†*	*†*	
	10. Move Under Fire *Quick Movement, Agility*	BW						
Strength Tasks	***4a: Casualty Drag*** *Heavy Drag*	*271*	*†*	*†*				
	9: Obstacle *Quick Movement, Agility*	BW	†					
	13: Emplace Base Plate *Heavy Lift*	68						
	14: Emplace Cannon *Heavy Lift*	55	†					
	16: Fire a Mortar *Endurance Hold, Heavy Lift*	29	†					

[a]: Load does not include uniform
†: In top rank for measure (significantly greater than all other tasks, $p<0.05$)
Italics: Task Common to Multiple Combat Arms MOSs
Gray: Not measured
BW: Body weight in uniform

Table 1.9. Tasks with Sex Differences (11C)

		Time	RPE	End HR	Mean HR	VO_2	Total O_2
Aerobic Tasks	**1: Foot March**	F>M	F>M	F=M			
	3: Fighting Position (FILL)	F>M	F=M	F=M	F=M	ABS: F<M REL: F=M %MAX: F=M	ABS: F=M REL: F=M
	3: Fighting Position (CARRY)	F>M	F>M	F=M	F=M	ABS: F<M REL: F<M %MAX: F=M	ABS: F=M REL: F=M
	7: Ammo Cans						
	10: Move Under Fire	F=M	F=M	F=M			
Strength Tasks	**4a: Casualty Drag**	F>M	F>M				
	9: Obstacles	F>M	F=M				
	13: Emplace Base Plate	F=M	F=M				
	14. Emplace Cannon	F=M	F=M				
	16. Fire a Mortar	F=M	F=M				

$p<0.05$
M: Male, F: Female
For VO_2 and Total O_2, ABS: Absolute (L/min), REL: Relative to Body Mass (ml/kg/min), %MAX: Percent estimated VO_2max
Gray: Not measured

Figure 1.1. Image of Soldier Conducting a Foot March (Task 1)

Figure 1.2. Images of Soldier Building a Fighting Position (Task 3)

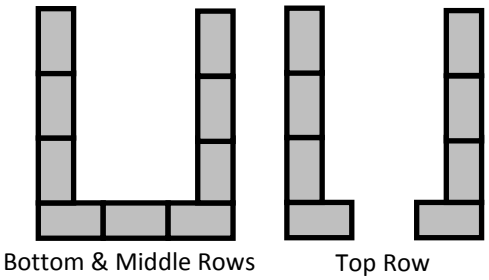


Figure 1.3. Image of Soldier Dragging the Simulated Casualty (Task 4a)

Figure 1.4. Images of Soldier Evacuating the Simulated Casualty from a BFV (Task 4b)

Figure 1.5. Image of Soldier Installing the Barrel of the 25mm Gun on a BFV (Task 5)

Figure 1.6. Image of Soldier Removing the Feeder Assembly from the 25mm Gun on a BFV (Task 6)

Figure 1.7. Images of Soldier Loading 25mm H-EIT Tracer Ammunition Cans (Task 7)

Figure 1.8. Image of Load a TOW Missile Launcher on BFV (Task 8)

Figure 1.9. Images of Move Under Direct Fire (Task 10)

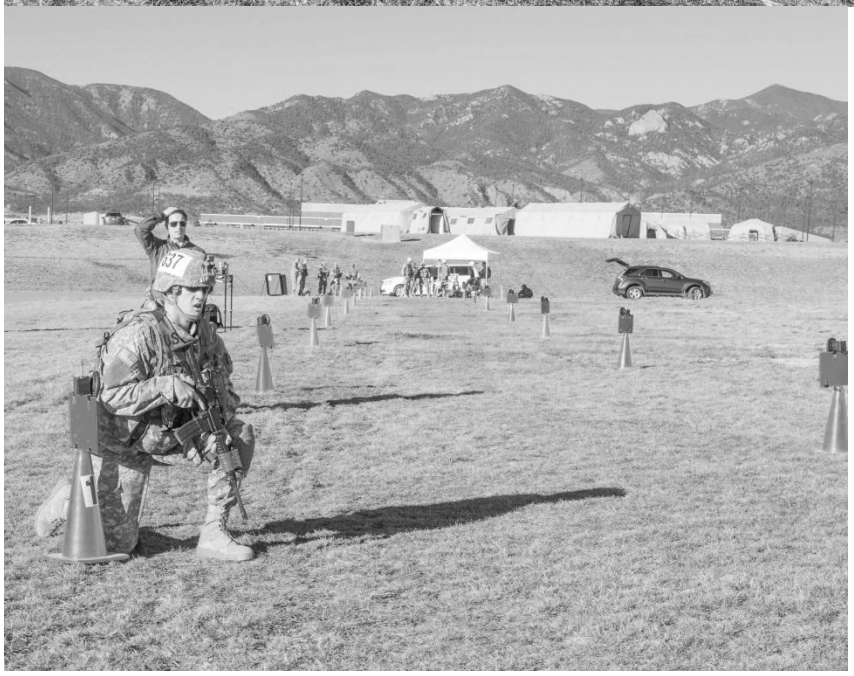


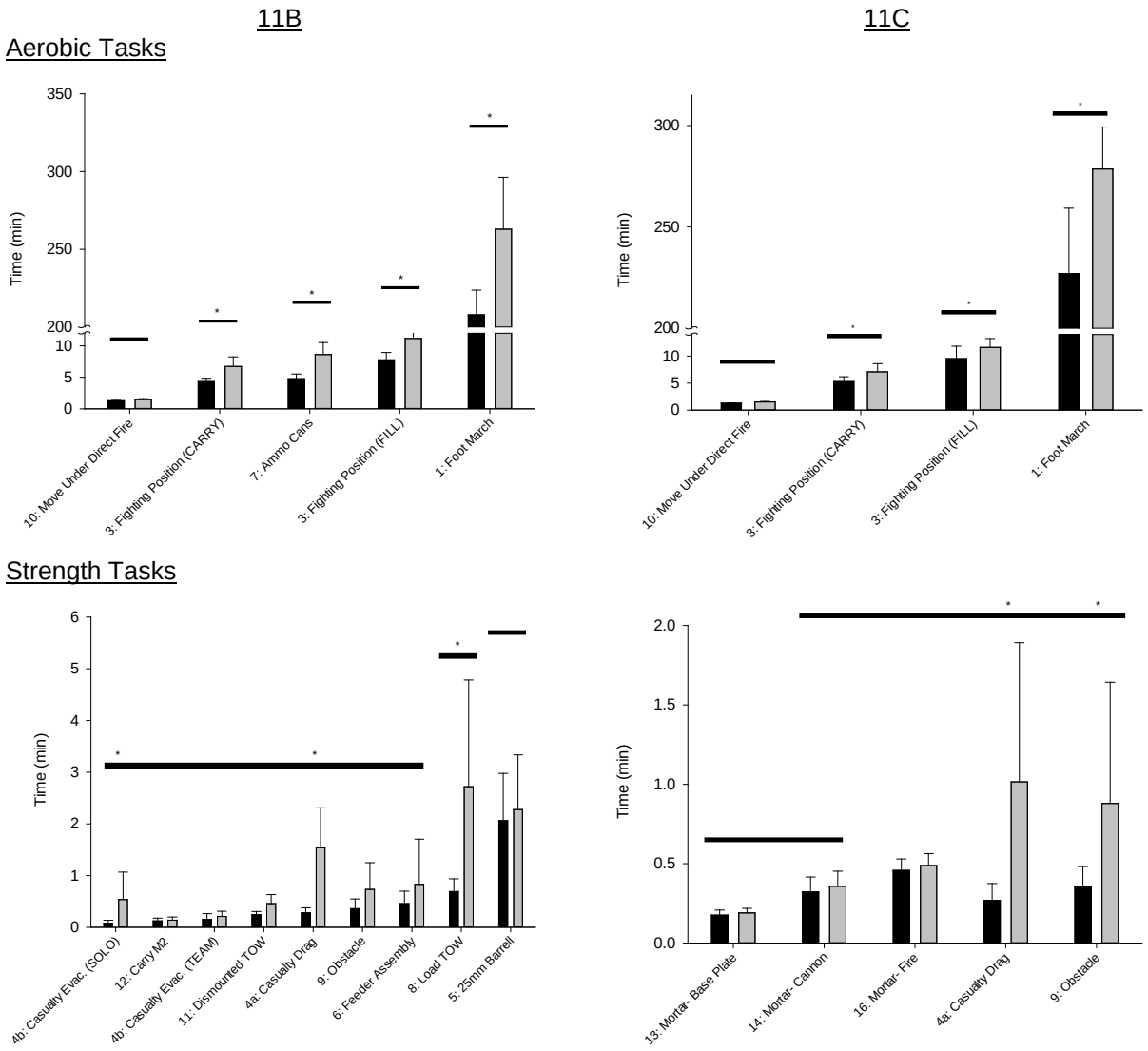
Figure 1.10. Engage Targets with a .50 Caliber M2 Machine Gun (Task 12)

Figure 1.11. Image of Lay a Mortar- Emplace Base Plates (Task 13)

Figure 1.12. Image of Lay a Mortar- Emplace Cannon (Task 14)

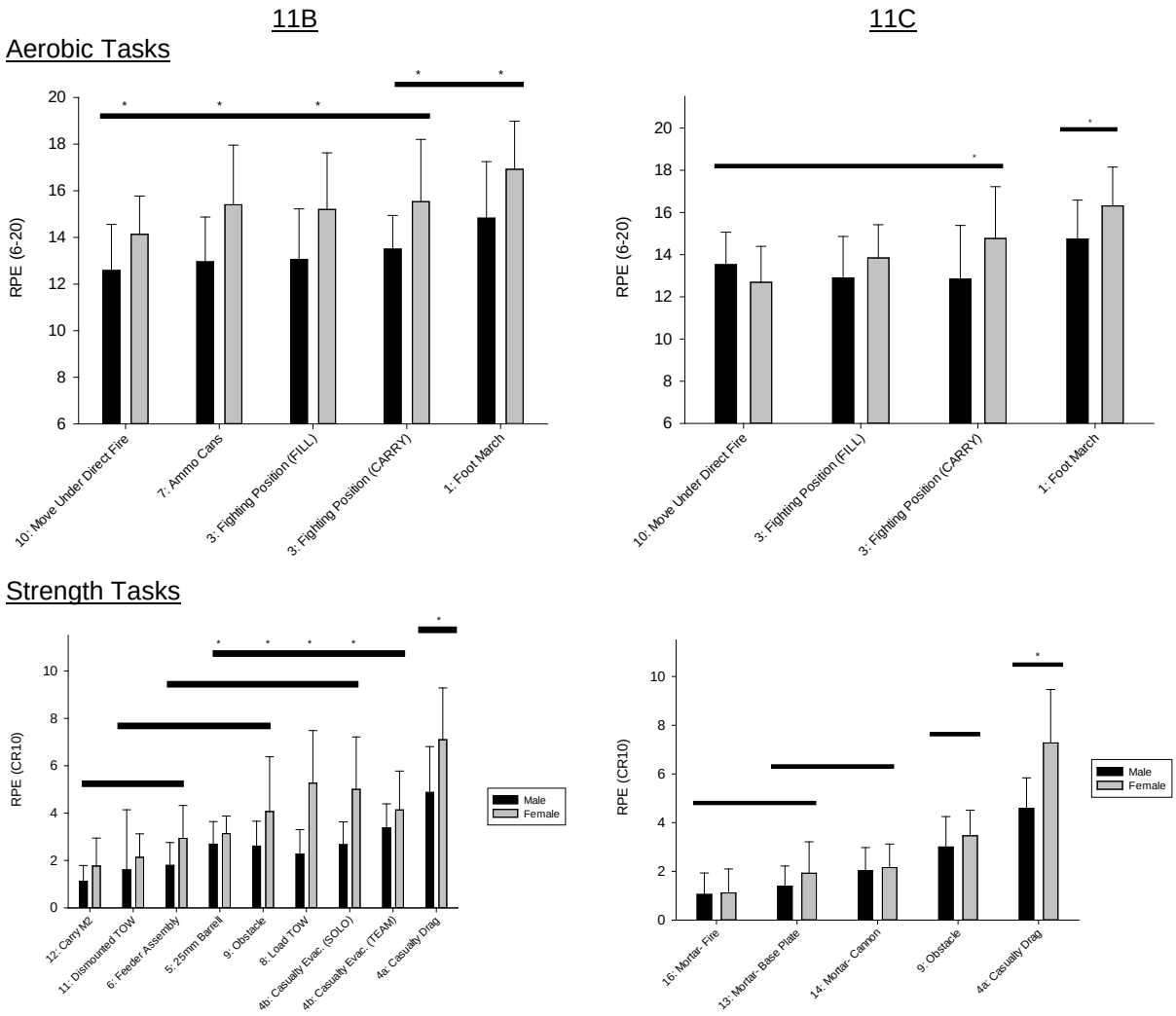
Figure 1.13. Image of Fire a Mortar (Lift and Hold Round, Place in Tube) (Task 16)

Figure 1.14. Time to Completion for Aerobic (TOP) and Strength (BOTTOM) Tasks



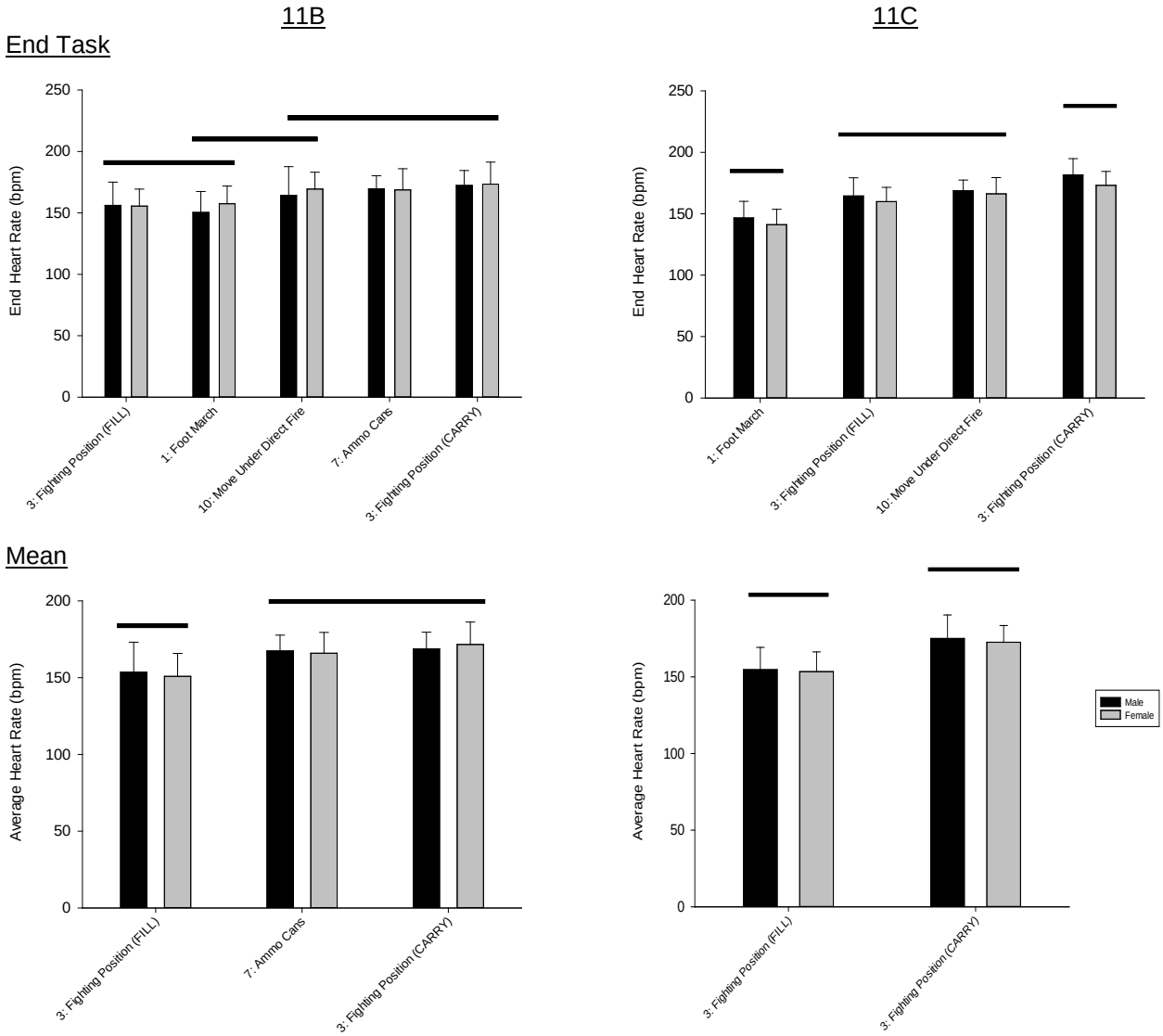
Horizontal bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks.

Figure 1.15. Rate of Perceived Exertion (RPE) for Aerobic (TOP) and Strength (BOTTOM) Tasks



Horizontal bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks.

Figure 1.16. End Task (TOP) and Mean (BOTTOM) Heart Rates for Aerobic Tasks

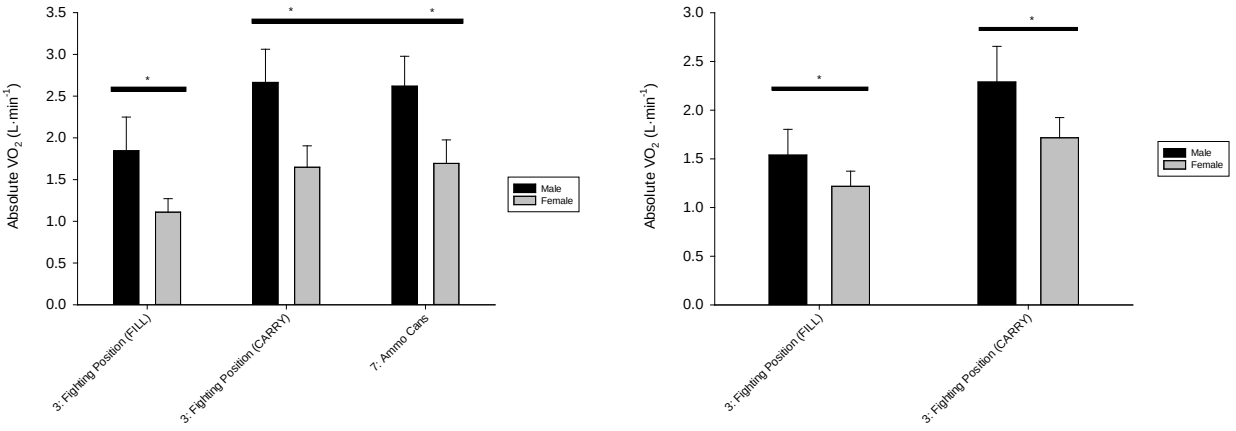


Horizontal bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks. Mean HR only shown for tasks recorded using a metabolic system.

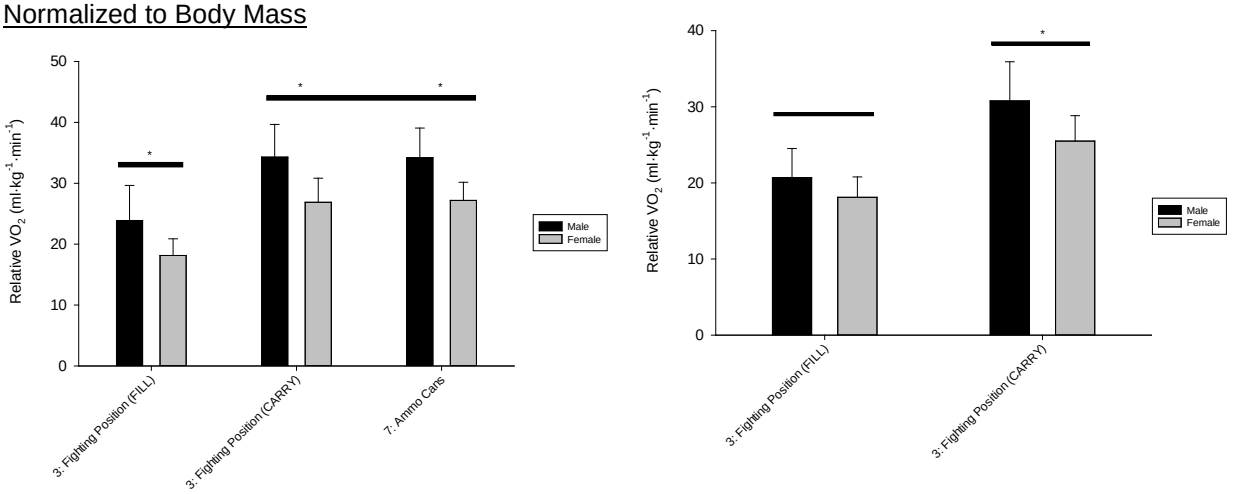
Figure 1.17. Average Absolute (TOP), Body-Mass Normalized (MIDDLE), and Predicted VO_2max Normalized (BOTTOM) Rate of Oxygen Consumption during Aerobic Tasks

11B 11C

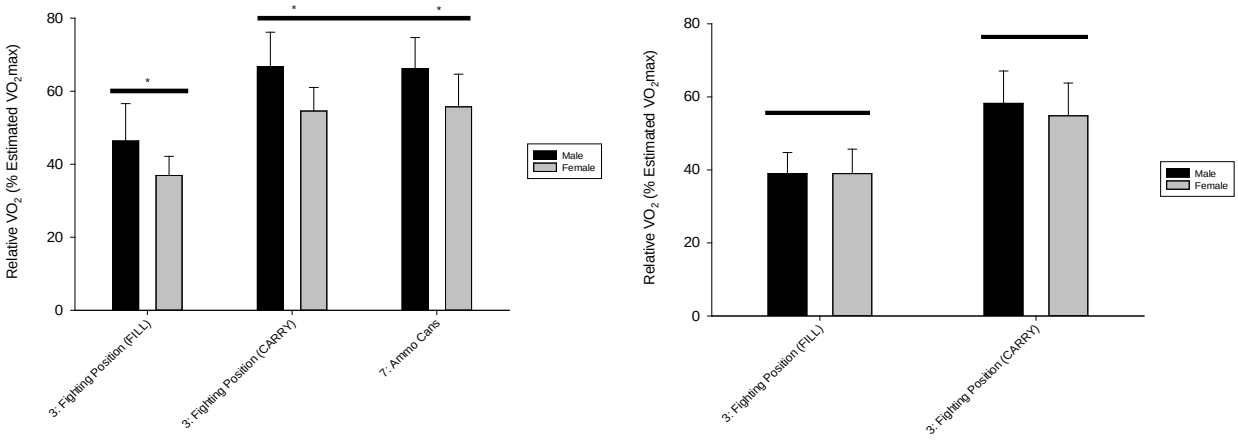
Absolute



Normalized to Body Mass

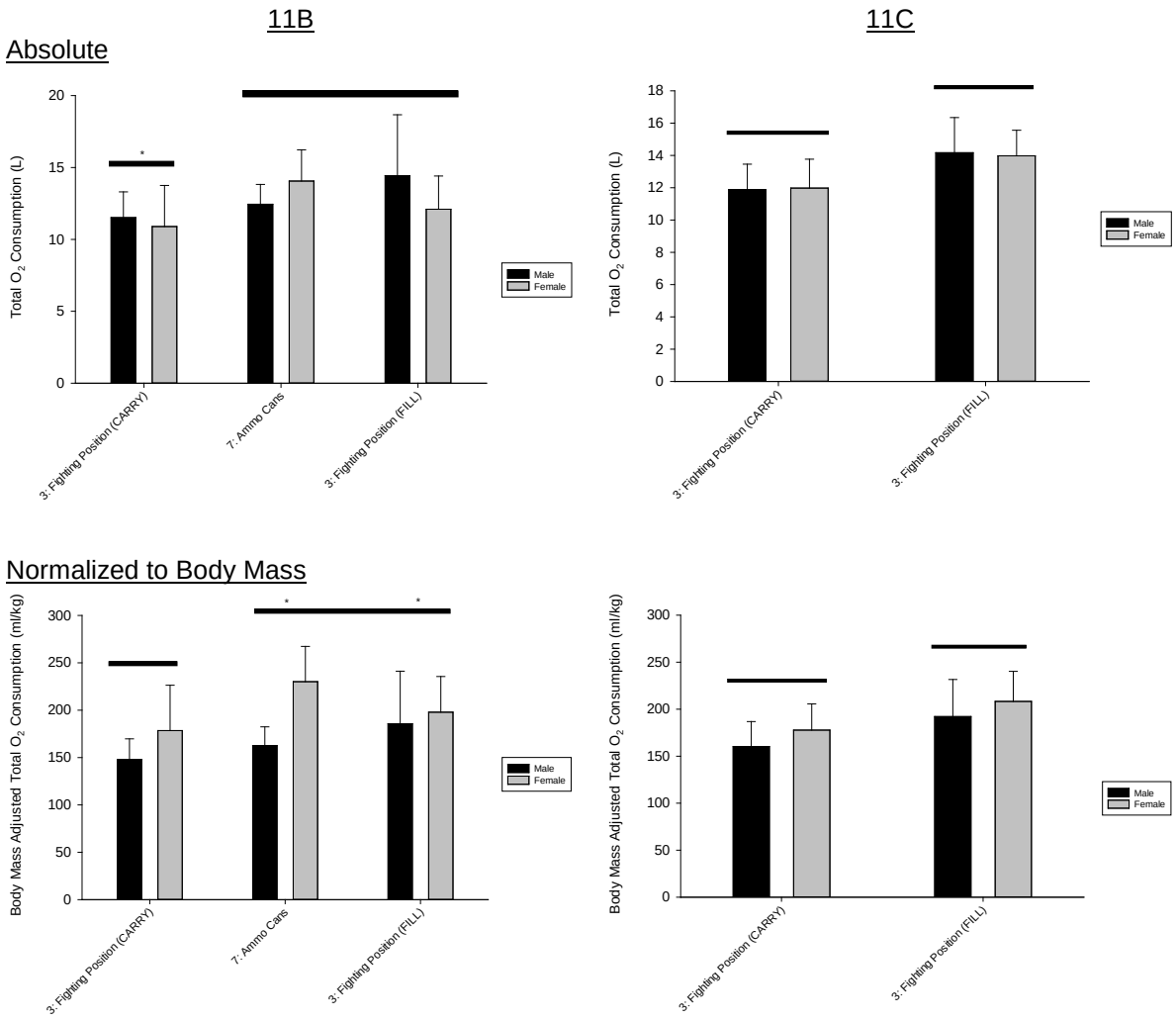


Normalized to Predicted VO_2 max



Horizontal Bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks.

Figure 1.18. Absolute (TOP) and Body-Mass Normalized (BOTTOM) Total Oxygen Consumption during Aerobic Tasks



Horizontal Bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks.

Study 2: Criterion Task Development and Reliability

STUDY 2: INTRODUCTION

In Study 1, the physical demands of the critical tasks for the Infantry MOSs were defined and compared across tasks. The large number of critical tasks identified for both MOSs (15) required the down-selection of the task list to remove redundancies and include only the most physically demanding tasks within each task category (i.e., pulling, lifting, load carriage) and energy system (aerobic, strength, power). During this process, the frequency of task performance both in training and while deployed was considered, as well as the criticality of the task, both to the mission and to the safety of others. The selected tasks became the criterion measure tasks for the Infantryman and Infantryman- Indirect Fire MOSs. In order to develop a valid test to predict performance on these criterion measure tasks, a standardized simulation of each task was developed. These task simulations had to meet a number of requirements. The simulations must test individuals, not teams. Thus, any tasks involving more than one person needed to be deconstructed into a one person task. The task simulations must allow for a range of scores to show differences between Soldiers and cannot simply be a pass/fail. Each test should measure unique physical capabilities, be safe and easy to administer, and require minimal skill or learning. In order to test large numbers of Soldiers, the test should, as much as possible, be time efficient and require minimal and available equipment. Most importantly, the test needs to be reliable. Each Soldier must receive the same score every time they test.

CRITERION TASK SELECTION PROCESS AND SUBJECT MATTER EXPERT (SME) APPROVAL

The twelve 11B and eight 11C physically demanding tasks from Study 1 were divided into five groups based on the physical domains of the tasks: heavy drag, load carriage, repetitive lift and carry, quick movement/agility, and maximal heavy lift. Based on the physical demands measured in Study 1, tasks from each physical domain were selected to be criterion measure tasks. For both MOSs, the following tasks were selected to represent a physical domain: casualty drag (heavy drag), foot march (load carriage), build a fighting position (repetitive lift and carry), and move under fire (quick movement/agility). The sandbag carry was selected as the repetitive lift and carry for both MOSs because it was measured to be among the tasks with the highest ratings of perceived exertion, average heart rate, and rates of oxygen consumption. Overall, each task that was selected is unique, important in protecting the Soldier, and frequently performed on missions in the field for these MOSs.

In addition, the 11B and 11C also had separate MOS-specific tasks. For the 11B, removing a casualty from a vehicle turret was selected for the heavy lift. The casualty evacuation is the heaviest weight the 11Bs would be expected to lift, the task can be modified and assessed as an individual task with a range of scores, and is critical for the safety of other Soldiers. For the 11C, the heaviest single lift was the mortar emplace base plate, with a prorated weight of 68 lb. However, since sandbags are more readily

available, and the weight of two 35-lb sandbags (from the fighting position) is 70 lb, it was proposed that lifting 2 sandbags would sufficiently capture all heavy lift tasks.

A summary of the criteria for selecting the heavy lift task, lift and carry task, and load carriage tasks are summarized in Tables 2.1 and 2.2 for the 11B and 11C, respectively. Thus, the final tests selected were the casualty evacuation (11B only), casualty drag (11B & 11C), sandbag carry (11B & 11C), move under fire (11B & 11C), and foot march (11B & 11C). Three tests were truncated in order to optimize the time required for testing. With the sandbag carry, it was decided to truncate the task from the original 26 bags to 16 bags, as the VO_2 repetition curve from Study 1 indicates Soldiers reached steady state by the completion of approximately 13 bags (Figure 2.1). The weight of the sandbags was increased to 40 lb, which was the upper end of the 30-40 lb range for sandbags provided by the task statements. This allowed the task to more closely mimic the ammo can carry (45 lb) while maintaining fidelity with the sandbag carry. Thirty seconds was determined to be the maximal time for the dummy drag, as 80% of the Soldiers could complete the 15m within that timeframe (Figure 2.2). Finally, the distance for the foot march was shortened based on data collected on four other MOSs (unpublished data) and conversations with SMEs about reducing injuries and trainability of a foot march.

On 14 October 2014, a video teleconference (VTC) was held between USARIEM researchers and the Infantry School SMEs. The SMEs were briefed on an overview of the project, the results from the physiological testing and focus groups, followed by USARIEM's plan for testing Infantry Soldiers performance on the selected criterion tasks. The SMEs were then asked if they agreed with the criterion tasks selected, how the criterion tasks would be simulated, and if they had any concerns. All of the decisions regarding selection of the criterion tasks and changes to their format were reviewed with the 12 SMEs during the VTC. All of the SMEs agreed with most of the criterion tasks selected and the task simulation methods as described by USARIEM personnel (See Appendix E for minutes of the VTC presented to SMEs). However, the SMEs requested that USARIEM replace the sandbag lift with casualty evacuation for 11C heavy lift. USARIEM agreed to their request.

STUDY 2: METHODS

RELIABILITY TESTING

Data were collected at Joint Base Lewis-McChord, WA from May 5-16, 2014 (Group Alpha) and at Ft. Carson, CO December 8-19, 2014 (Groups Bravo & Charlie). A total of 149 active duty Soldiers (79 males, 70 females) were recruited for participation in this portion of the study. These Soldiers were split evenly between both installations such that about 25 males and 25 females participated at each. At Joint Base Lewis-McChord Soldiers were part of either the 7th Infantry Division or the 593rd Expeditionary Sustainment Command, and at Ft. Carson, Soldiers were part of the 4th Infantry Division. Soldiers held a number of different MOSs. The sample size was determined by using the sample size estimation formula of Hopkins 2000 (16) and data

on repetitive lifting tasks from Pandorf 2003 (24), which indicated that 37 Soldiers would be needed to see a difference in scores at the $p<0.05$ level.

Soldiers were briefed on all of the tasks prior to consenting. Following consent and screening, participating Soldiers were asked to complete an information sheet that contained demographics and task performance history. Anthropometrics (height, weight) were also collected prior to testing.

Participating Soldiers performed the casualty evacuation, sandbag carry and the casualty drag 4 times, with each task being completed once per testing session, with at least 10 minutes rest between tasks. The order of testing the three tasks was randomized on day 1 and repeated on days 2-4. Each testing session was separated by 24-72 hours. The foot march was performed 2 times, one week apart and on separate days from the rest of the tasks. All aspects of the testing (instructions, uniform, etc.) were matched as closely as possible at each testing session. All testing instructions and data sheets for Study 2 can be found in Appendix I and J, respectively.

CRITERION TASK DESCRIPTIONS

Group Alpha: Common MOS Tasks

Prepare a Fighting Position (11B & 11C; Repeated Lift and Carry)

Soldiers lifted and carried 16 sandbags weighing 40 lb while wearing a fighting load minus the weapon (approximately 71 lb). Sandbags were carried 10 m and placed on the floor in a 4x2x2 position as quickly as possible. Soldiers were instrumented with a heart rate monitor. Time to complete the task was collected.

Casualty Drag (11B & 11C; Heavy Drag)

In order to ensure a score for all participants, the casualty drag was modified from the task previously described in Study 1 (Task 4a-drag a casualty to immediate safety). Soldiers dragged the simulated casualty (approximately 270 lb) up to 15 m as fast as they could in 30 seconds, while wearing a fighting load with a weapon (approximately 83 lb). If the Soldier failed to pull the casualty 15 m in 30 seconds, the distance the casualty was dragged was measured. Scores were calculated as the velocity (m/s) at which the dummy was moved.

Casualty Evacuation from a Vehicle(11B; Maximal Heavy Lift)

This task was simulated using a platform with a hole designed to simulate the hatch of a BFV and heavy bag to simulate the casualty. A heavy bag, the same model used in Study 1, was about the same length as the average torso and head of a Soldier. The bag was placed in the hole with the handles of the bag level with the platform (see Figure 2.3).

Prior to initiating the task, each Soldier practiced proper lifting technique using a pair of kettlebells. Then on the platform, while wearing a fighting load minus the weapon (approximately 71 lb), Soldiers squatted and grasped the handles of the heavy bag, then stood up and pulled the bag through the hole in

the platform. Soldiers were required to place the heavy bag onto the platform for successful task completion. An initial load of 50 lb was used for additional familiarization and warm-up. With the successful completion of each lift, the weight of the simulated casualty was increased in 10, 20 or 30lb increments. Following at least 3 minutes of rest at the higher loads (>80% one repetition maximum), the process was repeated until the Soldier reached volitional fatigue, failed to lift the bag during two consecutive attempts, or a maximum load of 210 lb was reached. The maximum load represented the weight of an average Soldier wearing a Vehicle Crewman Uniform. If Soldiers were not able to lift the bag following an increment of more than 20- or 30 lb, the Soldier was allowed to test on the skipped weights (i.e., 10 or 20 lb less than the failed attempt). The maximal load successfully lifted was recorded. .

Group Bravo: MOS Specific Tasks

Move Under Fire Simulation (11B & 11C; Agility)

During this task, Soldiers wore a fighting load (approximately 83 lb) and carried a simulated weapon at the ready. Soldiers began the task in the prone position. Upon command, Soldiers sprinted approximately 6.6 m to a marker and assume the predetermined position for that marker (either the kneeling or prone position). They remained in this position for 5 seconds. Upon signal, Soldiers would get up and sprint to the next marker and assume the predetermined position for that marker. The order of the positions was kneel, kneel, prone. This was repeated until they sprinted a total of 100 m (15 rushes). The course is diagramed in Figure 2.4. Soldiers were instructed to run through the finish line. Time to complete the task was recorded.

Group Charlie: Foot March

Foot March (11B & 11C; Load Carriage)

The load carriage simulation requires Soldiers to complete a movement of 4 miles, while wearing the basic Soldier uniform, personal protective equipment (to include weapon), and 24-hour sustainment load (approximately 103 lb). Soldiers were instructed to complete the task as quickly as possible while walking on a supervised course. Neither running nor doing the 'airborne shuffle' were allowed. Soldiers were allowed to take breaks as needed. Soldiers were instrumented with a timing chip (SPORTident Model SIAC1, Arnstadt, Germany). Time to completion was recorded.

STATISTICAL ANALYSES

All statistics were calculated using SPSS Version 20 (IBM Corporation, Armonk, New York). Significance was set at the $p<0.05$ level. Descriptive statistics were calculated for each trial to characterize group performance for each task across trials. The statistical approach to determining the reliability was based on the method by Spiering et al (35) in determining reliability of other military-relevant tasks.

Two-Way (sex x trial) repeated measures analysis of variance (ANOVA) was employed for each test to evaluate the presence of a learning effect between trials (2, 35). Tukey's post-hoc multiple comparison tests was applied to detect significant pairwise differences when significant trial differences were detected by the repeated measures ANOVAs. While there was evidence for a significant learning effect for a number of the tasks ($p<0.05$); however, this did not differ by gender, so data were collapsed by gender for all analyses. Reliability coefficients and their associated 95% confidence intervals (95% CI) were examined across trials to determine whether levels of reliability stabilize after a given number of trials. This procedure facilitated specific recommendations for numbers of practice sessions needed prior to administration of the performance tests for scoring.

Random error in the measurements was assessed as relative reliability and absolute reliability (2). Relative reliability was assessed with intraclass correlation coefficients (ICCs) while absolute reliability was assessed using Standard Error of Measurement (SEM) and 95% limits of agreement (95% LOA). ICCs were calculated using a two-way random effects, single-measure reliability model. SEMs are reported in both in absolute units and as a percentage of the mean. The 95% LOA was calculated as either the 95% ratio LOA of the test-retest error if the error of the test-retest data scaled with the mean was random (as determined by a Bland-Altman plot), or as the absolute 95% LOA if the Bland-Altman plot indicated the test-retest error was homoscedastic.

STUDY 2: RESULTS

Characteristics of the Soldiers tested are provided in Table 2.3. Soldiers were members of 48 different MOSs (including 11B and 11C). Enlisted Soldiers ranged from E2-E7, and there were three officers (two O1, one O2).

Reliability Testing

Mean scores for each of the task simulations during each test session are provided in Table 2.4. For the Common MOS tasks, the average weight for the casualty evacuation was 154.0 ± 22.1 lb, average time for the sandbag carry was 2.10 ± 0.61 minutes, and average velocity for the casualty drag was 1.07 ± 0.36 m/s. Significant improvements in score were recorded during the second tests of the sandbag carry and casualty evacuation compared to their first attempt, indicating a possible learning effect. There was, however, no additional difference in the scores during the third and fourth trials. There were no significant differences in individual scores across trials for the casualty drag.

For the MOS Specific tasks, the average time for the move under fire was 2.26 ± 0.23 min. Significant improvements between trials occurred between the first and second trial.

The average time for the foot march was 80.29 ± 12.09 minutes. There were no significant changes in performance across trials.

Reliability data are presented in Table 2.5. ICCs of the tasks ranged from 0.76 (95% CI: 0.61-0.86) for the foot march to 0.96 (95% CI: 0.94-0.98) for the casualty evacuation. In terms of the absolute reliability tests, the SEMs ranged from 3% of the mean to 12%. The 95% LOAs were 33% for the sandbag carry time, 0.35 m/s for the casualty drag, 25.7 lb for the casualty evacuation, 0.16 minutes for the move under fire, and 16.34 minutes for the foot march.

STUDY 2: DISCUSSION

This study established the reliability of the criterion tasks to be used in the development of a testing battery for Infantry Soldiers.

Task Selection

The five tasks selected represent a mix of physical requirements. Included are a long-duration load carriage, a repeated lift and carry, a heavy lift, a heavy drag, and quick movement/agility. Criterion tasks used by other countries have included a similar combination of tasks. For example, the physical performance batteries developed by the United Kingdom (28) and Australia (3) both include load carriage, jerry can carry, and a maximal box lift. The Australian (3) and Canadian (6) batteries also include tasks of agility, such as combat rushes.

Learning Effects

While the casualty drag and foot march did not show indications of a learning effect, there is evidence for one on the sandbag carry, casualty evacuation and move under fire. There was a significant improvement in sandbag carry times and casualty evacuation weights between the first and second days. There was, however, no additional improvement over any of the following days.

Prior to testing of all tasks, Soldiers were given a brief familiarization and practice. For the sandbag carry, Soldiers were given a chance to lift a sandbag and determine their preferred grip. For the casualty evacuation, Soldiers were given a brief safety demonstration on proper lifting technique, practice on a pair of kettlebells, and then a gradual increase in the weight using the heavy bag until they reached their maximum load. Additional familiarization or improvement in the test instructions could mitigate this learning effect. For implementation purposes, a practice should be provided, a wider range of acceptable scores should be accepted, or both.

Reliability

We used three measures of reliability in this study: ICC, SEM, and 95% LOA. The ICC is an indicator of relative reliability. High ICCs are indicative of a test which is able to consistently rank participants, independent of actual score (i.e. the order of completing the task relative to their peers). As such, all of the criterion tasks had ICCs with upper bounds of their 95% CI >0.80. The test with the lowest ICC (0.76 (95% CI: 0.61-0.86)) was the foot march. The literature does not contain consistent guidelines as to what an acceptable cut-off score is for reliability. Literature values suggest that an

ICC > 0.75 is considered acceptable for clinical research (39); however ,the authors are unaware of any legally acceptable standard.

Our two measures of absolute reliability (SEM & 95% LOA) provide an indication of the variability between repeated tests, independent of participants rank in the sample. The SEM is a traditionally used measure of reliability which describes the general variability of the sample around its true value. It is difficult to interpret this value's meaning on the reliability of an individual's score or delineate specific cut-offs of what is acceptable reliability. Another measure to assess the absolute reliability is the 95% LOA, which treats the data as a population of test-retest differences (2) and calculates test-retest differences for 95% of the population. Absolute LOA are used when there would be uniform error across all scores (e.g., ± 5 lb for both a score of 100 and 200 lb), while Ratio LOA is used when the results indicate individuals with a higher score would have greater error (e.g., ± 5% of the score: ± 5 lb for a score of 100 lb, ± 10 lb for a score of 200 lb). Thus, acceptability of the 95% LOA depends on the minimal necessary precision for the test score. When using these criterion tests to develop a predictive battery, the 95% LOAs should be taken into account as cut-scores are developed.

Reliability of the tests was comparable to those observed during reliability of other soldiering task simulations. The learning effect of the sandbag carry and casualty evacuation are similar to those previously observed during repeated box lift and carry (24, 35) and 1RM maximal box lifts (35). The ICC of 0.76 and SEM of 7% for the foot march were similar to the ICC of 0.81 and SEM of 5% observed during a 3.2 kg load carriage trial (35). Likewise, the reliability of the 15-m casualty drag in the present study (ICC 0.90, SEM 11%) were similar to those observed while dragging a casualty 50m (ICC 0.86, SEM 9%) (35). The greater reliability observed during a lift task than a carry task is consistent with the findings during a previous attempt at developing a physical employment battery for the Army (23).

Limitations

When interpreting the reliability of these tasks, a number of factors need to be considered. First, the sandbag carry, casualty evacuation, and casualty drag tasks were performed inside of a motor pool, protected from the elements. They were also performed at approximately the same time of day with trained researchers. Thus, the data represents the reliability of these tests under those same conditions. Likewise, the foot march and move under fire were completed outdoors. There was no precipitation and temperatures varied from 1-14°C on testing days. Under differing weather conditions or courses, the reliability may be less.

There are several other factors which could increase or decrease the reliability we observed. Any prior training of Soldiers, soreness or discomfort (both prior to testing or as a result of the testing), or changes in motivation could have an effect. These factors were known a priori by research staff and steps were taken to control their impact (e.g., use of the same instructions, warm-up and practice prior to actual task).

While every attempt was made to control for these factors, it is unlikely that their influence was completely removed.

STUDY 2: CONCLUSIONS

The tasks reported in this chapter show high reliability. They have also been approved by SMEs as accurately capturing the physical demands of all tasks performed by their respective MOSs. Thus, they seem appropriate for use in the development of a predictive battery to select 11B and 11C Soldiers for training.

STUDY 2: RECOMMENDATIONS

- The five criterion tasks for the Infantry MOSs include prepare a fighting position, casualty drag, casualty evacuation from a vehicle, move under fire, and the foot march. These tasks were approved by SMEs and show generally high reliability. They are appropriate to be used for development of a predictive test; however the absolute reliability should be considered when developing cut-scores.

- Additional familiarization and/or improvements to test instructions should be applied to the sandbag carry, casualty evacuation and move under fire tasks in order to minimize any learning effect.

- This approach to determining the reliability of soldiering tasks may be useful for additional tasks.

Table 2.1. Factors Considered during Down-Selection of 11B Criterion Measure Tasks

Heavy Lifting Tasks						
	Obstacle (Wt.: BW)	**Engage Targets (Wt.: 76.5 lb)**	**25mm Barrel (Wt.: 53.5 lb)**	**Feeder Assembly (Wt.: 59 lb)**	**Load TOW (Wt.: 71 lb)**	**BFV Casualty Evac (Wt.: 103 lb)**
Covers weight range of other heavy lifting tasks						X
Common to other Combat MOS			X	X	X	X
Can be Individual Test				X	X	X
Minimal Skill or Training	X		X			X
Minimal Equipment	X					X
Critical to Safety and/or Mission Success	X					X

Repeated Lift and Carry Tasks				
	Sandbag Fill (Wt.: 35 lb)	**Ammo Can Carry (Wt.: 45 lb)**	**Sandbag Carry (Wt.: 35 lb)**	
Greater Perceived Exertion		X	X	
Greater Heart Rate		X	X	
Greater Energy Cost		X	X	
Common to other Combat Arms MOSs	X	X	X	
Equipment Readily Available	X		X	
Requires Significant Grip Strength			X	

BW: Body weight in uniform

Table 2.2. Factors Considered during Down-Selection of 11C Criterion Measure Tasks

Heavy Lifting Tasks				
	Obstacle (Wt.: BW)	**Fire Mortar (Wt.: 29 lb)**	**Emplace Cannon (Wt.: 55 lb)**	**Emplace Base Plate (Wt.: 68 lb)**
Covers weight range of other heavy lifting tasks				
Common to other Combat MOS				
Can be Individual Test		X		
Minimal Skill or Training	X		X	
Minimal Equipment	X			
Critical to Safety and/or Mission Success	X	X	X	X

BW: Body weight in uniform

Table 2.3. Soldier Characteristics: Study 2

Group Alpha: Common MOS Tasks
Sandbag Carry, Casualty Drag, and Casualty Evacuation

	Males (n=25)	**Females (n=25)**	**p-value**
Age (years)	24.6 ± 4.8	25.0 ± 4.3	0.80
Height (cm)	180.5 ± 7.3	165.7 ± 6.1	<0.01
Mass (kg)	84.9 ± 9.8	67.2 ± 8.3	<0.01
Time in Military (years)	3.4 ± 3.8	2.9 ± 3.0	0.67
Time in MOS (years)	2.7 ± 2.8	2.6 ± 2.1	0.91
Number Deployed (%)	10 (40%)	7 (28%)	–
Time Deployed (years) *for only those who have deployed*	0.9 ± 0.2	1.3 ± 0.6	0.04
Army Physical Fitness Test Score (points)	266.1 ± 22.8	266.0 ± 31.1	0.99
Push-ups (# / 2 min)	67.6 ± 12.2	42.8 ± 12.1	<0.01
Sit-ups (# / 2 min)	67.8 ± 11.8	70.4 ± 11.4	0.44
Two-Mile Run Time (min)	14.1 ± 1.8	16.6 ± 1.9	<0.01
Predicted VO_2max (ml/kg/min)	51.7 ± 5.1	49.1 ± 6.3	0.12

Group Bravo: MOS Specific Tasks
Move Under Direct Fire

	Males (n=25)	**Females (n=25)**	**p-value**
Age (years)	24.3 ± 4.1	22.6 ± 3.0	0.11
Height (cm)	178.9 ± 6.6	164.3 ± 7.3	<0.01
Mass (kg)	82.5 ± 9.8	65.2 ± 8.6	<0.01
Time in Military (years)	3.7 ± 3.2	2.9 ± 2.7	0.29
Time in MOS (years)	3.3 ± 2.2	2.5 ± 2.3	0.24
Number Deployed (%)	13 (52%)	7 (28%)	–
Time Deployed (years) *for only those who have deployed*	1.1 ± 0.6	1.5 ± 1.2	0.36
Army Physical Fitness Test Score (points)	267.8 ± 20.3	272.2 ± 26.5	0.51
Push-ups (# / 2 min)	67.7 ± 9.5	46.5 ± 11.7	<0.01
Sit-ups (# / 2 min)	72.4 ± 10.3	70.0 ± 10.7	0.45
Two-Mile Run Time (min)	14.1 ± 1.1	16.5 ± 1.3	<0.01
Predicted VO_2max (ml/kg/min)	52.4 ± 3.8	49.9 ± 4.4	0.04

Table 2.3. Soldier Characteristics: Study 2 (continued)

Group Charlie: Foot March	**Males (n=29)**	**Females (n=20)**	**p-value**
Age (years)	23.0 ± 3.3	25.3 ± 4.7	0.05
Height (cm)	176.9 ± 6.5	169.1 ± 6.6	<0.01
Mass (kg)	80.2 ± 12.1	68.6 ± 7.9	<0.01
Time in Military (years)	3.3 ± 2.4	2.7 ± 1.7	0.33
Time in MOS (years)	3.0 ± 2.4	2.6 ± 1.7	0.47
Number Deployed (%)	16 (55%)	9 (45%)	–
Time Deployed (years) *for only those who have deployed*	1.1 ± 0.7	0.9 ± 0.3	0.42
Army Physical Fitness Test Score (points)	270.1 ± 19.0	266.6 ± 23.5	0.57
Push-ups (# / 2 min)	71.8 ± 11.1	43.3 ± 11.4	<0.01
Sit-ups (# / 2 min)	71.7 ± 10.1	68.4 ± 13.9	0.35
Two-Mile Run Time (min)	13.3 ± 2.8	15.8 ± 4.0	0.01
Predicted VO_2max (ml/kg/min)	53.6 ± 4.4	48.6 ± 5.8	<0.01

Table 2.4. Performance (Mean ± SD) During Repeated Measurements of Criterion Task Simulations

Test		n	Trial 1	n	Trial 2	n	Trial 3	n	Trial 4
Sandbag Carry (min)	**M**	25	1.73 ± 0.25*	25	1.62 ± 0.22	25	1.68 ± 0.21	25	1.70 ± 0.23
	F	25	2.71 ± 0.80*	25	2.60 ± 0.74	25	2.40 ± 0.51	25	2.42 ± 0.49
Casualty Drag (m/s)	**M**	25	1.41 ± 0.26	25	1.39 ± 0.25	25	1.32 ± 0.26	25	1.31 ± 0.24
	F	25	0.79 ± 0.25	25	0.78 ± 0.22	25	0.78 ± 0.22	25	0.78 ± 0.19
Casualty Evac (lb)	**M**	24	186 ± 28*	24	195 ± 26	24	196 ± 26	25	198 ± 25
	F	25	106 ± 34*	25	113 ± 27	25	117 ± 32	25	119 ± 31
Move Under Fire (min)	**M**	25	2.14 ± 0.08*	25	2.12 ± 0.11	24	2.09 ± 0.09	22	2.12 ± 0.10
	F	24	2.45 ± 0.26*	24	2.42 ± 0.20	22	2.40 ± 0.23	21	2.39 ± 0.26
Foot March (min)	**M**	29	76.8 ± 5.84	29	74.6 ± 9.32	27	72.1 ± 7.65	20	74.4 ± 9.05
	F	21	92.7 ± 11.3	19	89.7 ± 12.6	17	86.3 ± 11.5	13	85.4 ± 12.4

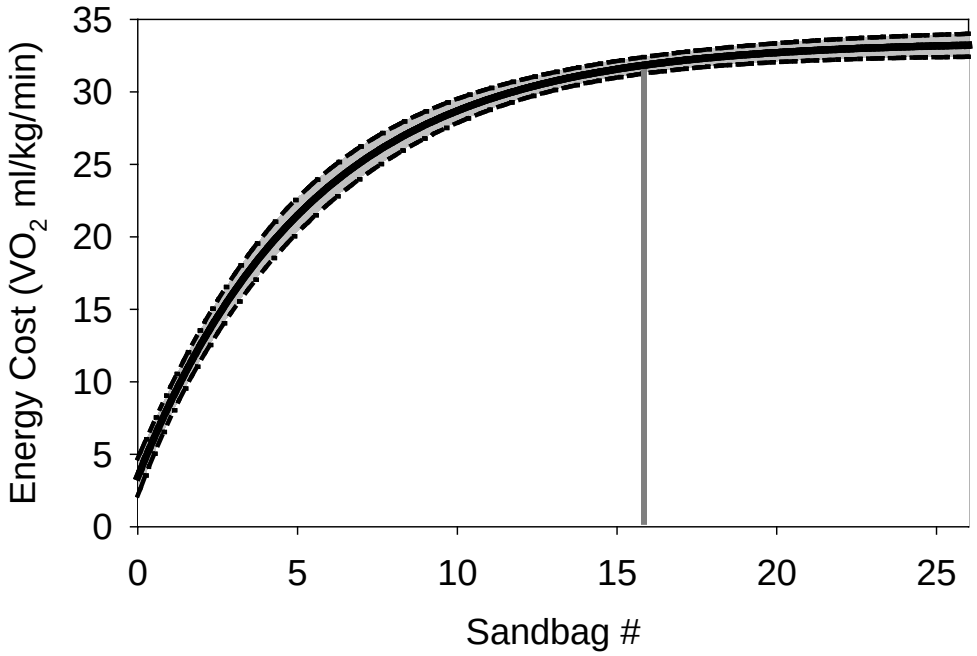
* Significantly different from following trial, $p<0.05$

Table 2.5. Relative and Absolute Reliability of Criterion Task Simulations

Test	n	Trial Comparison	Relative	Absolute		
			ICC (2,1) [95%CI]	SEM (% of Mean)	95% LOA	95% Ratio LOA
Sandbag Carry (min)	50	1 vs 2	0.87 [0.78-0.92]	0.27 (12%)	0.75	
		2 vs 3	0.85 [0.75-0.91]	0.25 (12%)		33%
Casualty Drag (m/s)	50	1 vs 2	0.90 [0.83-0.94]	0.13 (11%)	0.35	
Casualty Evac (lb)	49	1 vs 2	0.94 [0.90-0.97]	15.25 (10%)	32.9	
		2 vs 3	0.96 [0.94-0.98]	9.26 (6%)	25.7	
Move Under Fire (min)	49	1 vs 2	0.90 [0.82-0.94]	0.08 (3%)	0.21	
	46	2 vs 3	0.93 [0.88-0.96]	0.06 (3%)	0.16	
Foot March (min)	48	1 vs 2	0.76 [0.61-0.86]	5.89 (7%)	16.34	

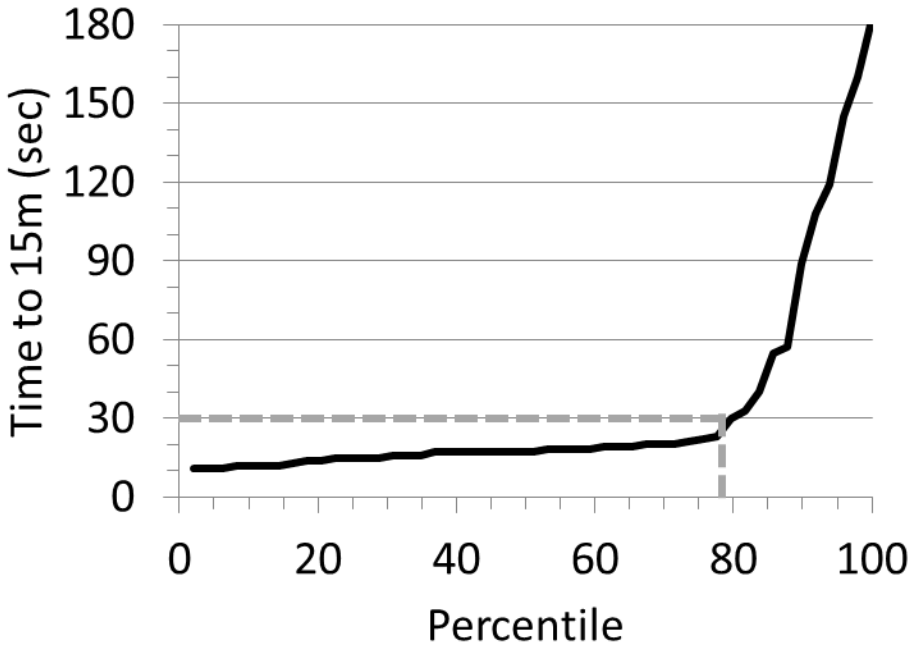
Due to a significant learning effect for sandbag carry, casualty evacuation, and move under fire , 1 vs 2 indicate reliability including learning effect, while 2 vs 3 is without a learning effect.

Figure 2.1. Energy Cost over Time of the Sandbag Carry Task from Study 1



Solid line: Mean
Vertical line: Proposed Cutoff
Shaded area: 95% Confidence Interval of Mean

Figure 2.2. Distribution of Dummy Drag Times from Study 1



Dashed line represents maximal time allowed for criterion testing.

Figure 2.3. Diagrams and Photos of the Casualty Evacuation Simulation

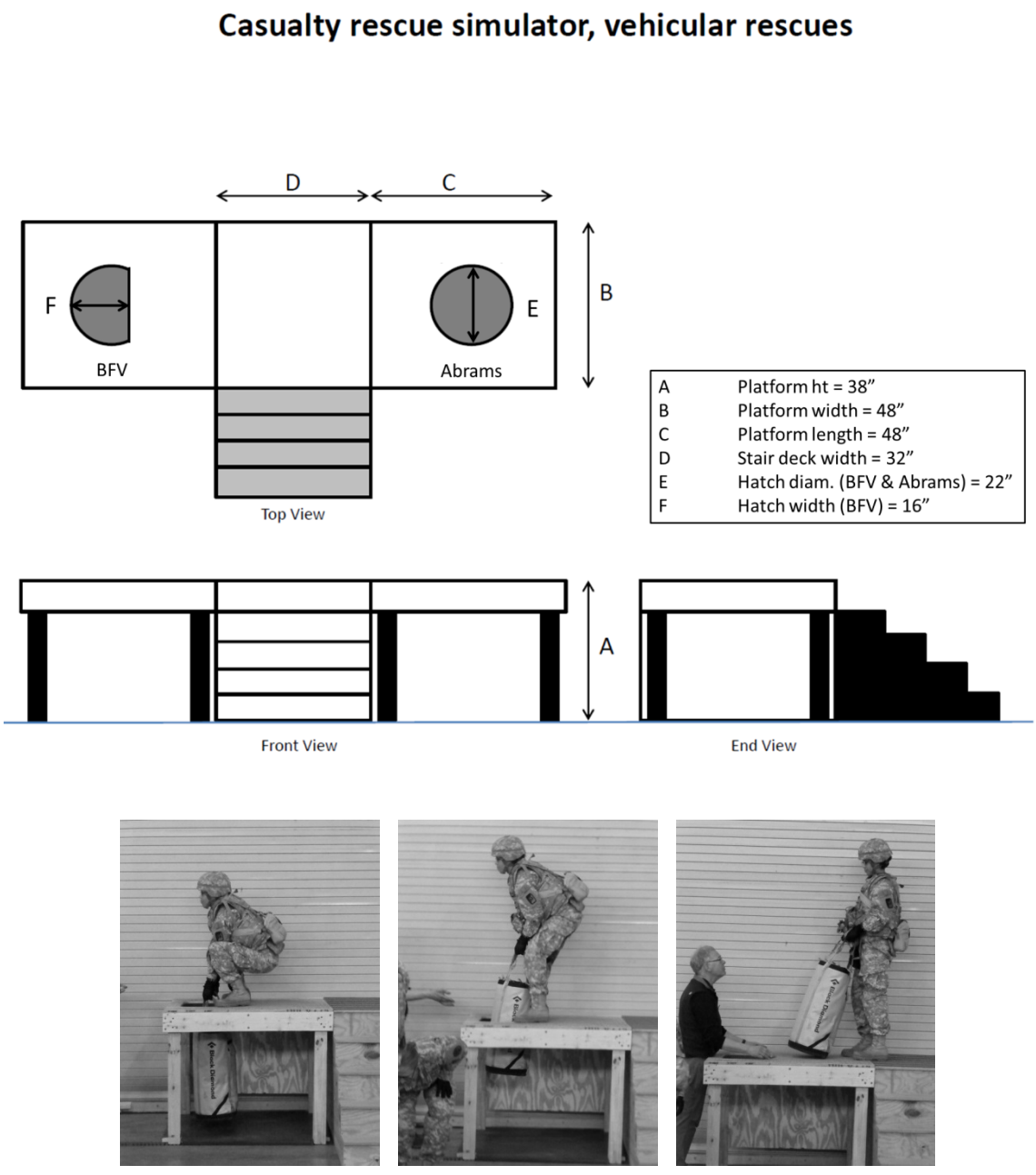
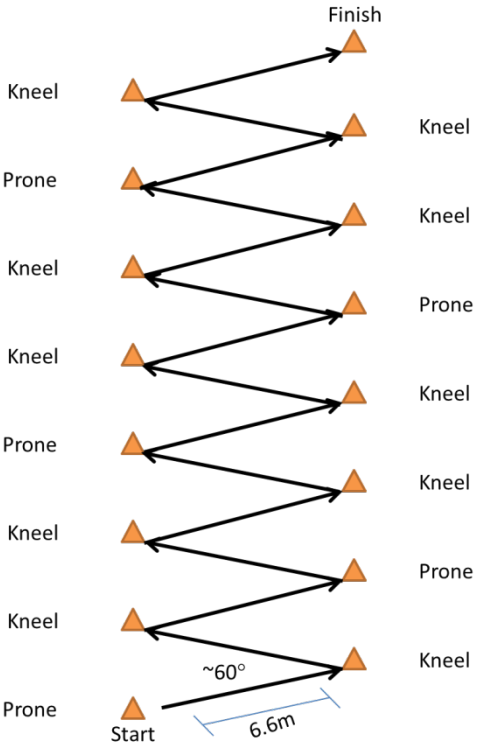
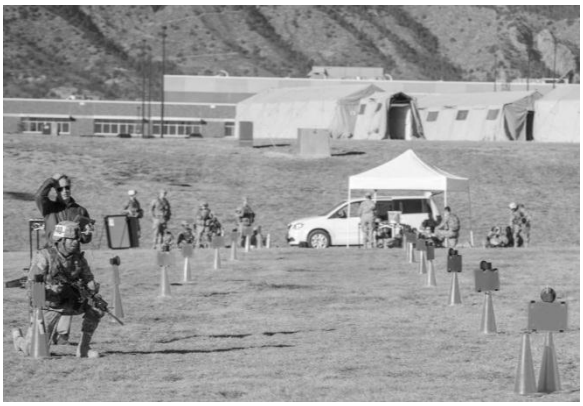


Figure 2.4. Diagram and Photos of the Move Under Fire Simulation





Study 3: Predictor Test Development

STUDY 3: INTRODUCTION

As it is not usually an efficient use of time and resources to employ the actual job task to determine physical readiness or success in a MOS, basic predictor tests that do not assess learned skills are better suited for these purposes. For example, devoting a BFV (or even a mock BFV) for performance prediction tests in a Military Entrance Processing Station (MEPS) would require a large amount of space, and would likely pose a risk of injury to the recruit. In addition, use of predictor tests that include skills that are learned in training or on the job do not comply with the EEOC Uniform Guidelines on Employee Selection Procedures (1978).

Pre-employment test batteries are becoming more common for entry into militaries across the globe. Physical employment test batteries have been (or are currently being) developed by the Armed Forces of Australia (26), Canada (6, 9), and the United Kingdom (28, 29). The physical employment batteries developed for military personnel by these other countries are provided in Table 3.1. Predictor tests range from those highly associated to the original task, such as the weight load march and jerry can carry of the Australians (3), to much simpler tasks, such as static lift and 1.5-mile run from the UK (5, 28). Table 3.2 contains a meta-analysis of screening tests highlighting the fitness domains for military-related job tasks. These physical employment test batteries were developed using a research approach similar to the strategy outlined by Payne & Harvey (25), which is currently accepted as the best paradigm for development of pre-employment screening tests. The batteries developed for these other militaries can serve as a template on which to develop similarly validated standards for U.S. Army Soldiers.

Limited information is available to determine the relationship between field-expedient physical tests and MOS-specific task performance of United States Soldiers. This may be due to the current lack of well-defined physical performance standards or criterion tasks for the combat arms MOSs. Previous work has shown that the combination of anthropometrics, body composition, and isometric upright pull may be predictive of performance in the most physically demanding MOSs; however these tests were not implemented (32, 37). Furthermore, these predictive models included sex and anthropometric data, which would no longer be considered legallydefensible as pre-employment measures. Thus, the purpose of this study was to identify a battery of reliable, field-expedient physical tests to predict criterion task performance for the 11B and 11C MOSs.

STUDY 3: METHODS

Data were collected from April 7-20, 2015 at Ft. Carson, CO, and May 27-June 8 at Ft. Stewart, GA. A total of 372 active duty Soldiers (180 Male, 192 Female) were recruited for participation in this portion of the study. Characteristics of the Soldiers tested are provided in Table 3.3. Enlisted Soldiers ranged from E1-E7, and there were two female officers (two O2). Soldiers were of the 4th Infantry Division (Ft. Carson) and

3rd Infantry Division (Ft. Stewart). All male Soldiers held the 11B Infantryman or 11C Infantryman-Indirect Fire MOSs, while the female Soldiers were members of 40 different MOSs.

Soldiers were briefed on all of the tasks prior to consenting. Following consent and screening, participating Soldiers were asked to complete an information sheet that contained demographics and task performance history. Each Soldier's height and weight in ACUs were collected prior to testing.

Sample size estimates were run using SamplePower 3.0.1 (IBM Corp, Armonk, New York). For any single task, 55 subjects will be sufficient for 80% power to detect significance of simple regressions with a moderate effect size (R^2=0.13) at an alpha of 0.05 (8). To establish the ability of the predictive tests to determine performance in the criterion tasks, a sample size of 90 subjects allows for 80% power to detect statistical significance for predictive tests which includes a 5-variable regression at a moderate effect size (R^2=0.13, (8)). A sample of females was also included in order to test for any differential effects of sex.

TESTING OVERVIEW

The 11B and 11C performed the same five criterion tasks and 14 predictor tests. The five criterion tasks were the tactical movement, prepare a fighting position- sandbag carry, casualty drag, casualty evacuation, and move under direct fire. The following are the 14 predictive tests that were administered: beep test, Illinois agility test, standing long jump, handgrip, upright pull at 38 cm, medicine ball put, isometric biceps curl, 1-minute sit-up, 1-minute push-up, powerball throw, 300m sprint, squat lift, resistance pull with a sled, and arm cycle ergometer test.

TESTING PROCEDURES

All criterion tasks from both MOSs were administered as described in Study 2 (see previous chapter). All testing instructions and data sheets for Study 3 can be found in Appendix K and L, respectively. The selected predictor tests administered are as follows:

Beep Test

Soldiers continuously ran between two lines 20 m apart in time to recorded beeps. Soldiers began standing behind one of the lines facing the second line. When instructed by a recording, they began running at a slow pace. Soldiers continued running between the two lines, placing at least one foot over the opposite line and turning when signaled by the recorded beeps. After each minute, a tone indicated an increase in speed, and the beeps became closer together. If the line was not reached before the beep sounded, the Soldier was given a warning and continued to run to the line, turned and tried to catch up with the pace within two more beeps. The test was stopped when the Soldier failed to reach the line for two consecutive beeps after a warning. The total number of shuttles completed was recorded (21).

Illinois Agility Test (Figures 3.1)
The length of the course is 10 m and the width (distance between the start and finish points) is 5 m. Four cones were used to mark the start, finish and the two turning points. Another four cones were placed down the center an equal distance apart. Each cone in the center was spaced 3.3 m apart. Soldiers began by lying prone (head to the start line) with their hands by their shoulders. On the 'Go' command the stopwatch was started, and the Soldier got up as quickly as possible and ran around the course in the direction indicated, without knocking over the cones. Time to complete the course was recorded (14).

Standing Long Jump
Soldiers stood behind a line marked on the ground with feet slightly apart. A two foot take-off and landing was used, with swinging of the arms and bending of the knees to provide forward drive. Soldiers attempted to jump as far as possible, landing on both feet without falling backwards. Three attempts were allowed. The two furthest distances jumped (cm) were averaged (19).

Handgrip
Soldiers held a handgrip dynamometer (Jamar Plus+, Sammons Preston, Bolingbrook, IL) in their hand, with the elbow at a right angle and at the side of the body. The handle of the dynamometer was adjusted such that the base rested on first metacarpal (heel of palm), while the handle rested on middle of four fingers. When ready, Soldiers squeezed the dynamometer with maximum isometric effort for about 3-5 seconds. No other body movements were allowed. Three trials were given for each hand. The highest two trials (kg) on each side were averaged (1).

Upright Pull at 38 cm
The Soldier assumed a squatting position with their buttocks against a wall, head and shoulders up and arms extended while grasping the handle of the dynamometer in a mixed grip. On command, the Soldier pushed down by extending the knees and pulled up by extending the hips to exert maximum force on the handle. The peak force produced was recorded. Soldiers were given a minimum of three trials, with about 1-minute rest in between each trial. If there was more than a 10% difference in the three scores, they were given up to two additional trials. The highest two trials within 10% of each other were averaged to determine an overall score (18).

Medicine Ball Put
Soldiers sat with their back firmly against a chair placed against a wall, while holding a 2-kg medicine ball with both hands. On command, the Soldier touched his/her chest with the ball and pushed it as far forward as possible. The distance between the landing point and the front of the chair was measured. Soldiers were given two practices and three attempts. The average of two furthest distances (cm) of the three attempts was used for analysis (15).

Isometric Biceps Curl
Soldiers stood on a wooden platform holding onto a bar with palms facing up, elbows at right angle and forearms parallel to the floor. The bar was attached to a chain attached to the platform, and an inline dynamometer with a force display recorded force production. On command Soldiers pulled upward on the bar maximally for 3-5 seconds. The highest two of three trials were averaged for record (31).

One Minute Sit-Up
The sit-up test used the same rules as the APFT (38), with the exception that the test was only one minute in duration. Briefly, Soldiers began by lying on their back with the knees bent at a 90-degree angle. Their feet could be up to 12 inches apart and were held down by a second individual. Soldier's fingers were interlocked behind their head. On the command 'go,' the sit-up was started by raising the upper body forward to or beyond the vertical position (meaning that the base of the neck is above the base of the spine), and then the body was lowered until the bottom of the shoulder blades and the backs of the hands touched the ground. Soldiers performed as many sit-ups as possible in one minute.

One Minute Push-Up
The push-up test used the same rules as the APFT (38), with the exception that the test was only one minute in duration. Briefly, Soldiers began with their arms straight, hands a comfortable distance apart, and body straight. Soldier's feet could be up to 12 inches apart. On the command 'go,' the push-up was started by bending elbows and lowering the body until the upper arms were at least parallel to the ground. Soldiers then returned to the starting position. Soldiers performed as many push-ups as possible in one minute.

Powerball Throw
The Powerball Throw test involved throwing a 20-lb medicine ball for a maximum distance to measure total body power. Soldiers began the test by standing with their heels on the starting line and facing the opposite direction in which the ball would be thrown. They held the ball with both hands and while keeping their arms extended they brought the ball down between their legs with bent knees. In one motion, they threw the ball up and back over their head. The distance from the starting line to the point at which the ball landed was measured. Soldiers completed two practice throws and three trials for record. If there was more than a 10% difference in the two highest scores, they were provided up to two additional trials. If Soldiers stepped backwards over the throwing line from which the throw distance was measured prior to releasing the ball, the trial was repeated (36).

300 M Sprint

Soldiers ran 300 m around a track as quickly as possible. Prior to testing, Soldiers were allowed time to warm up and stretch. Times (min) were collected using a stopwatch.

Squat Lift

This test is intended to measure lower body strength. The lifts were performed using pairs of weights (dumbbells) ranging from 25-110 lb (total weight: 50-220 lb). The Soldiers were provided instructions on proper lifting technique prior to beginning the test. Beginning by standing with their feet shoulder-width apart Soldiers squatted and grasped the handles of the weights at their sides, and performed a squat lift. A warm up weight of 50 lb, two 25-lb dumbbells, were used for three lifts and coaching was provided to ensure safe lifting technique. The weight started at 60 lb increased by 20 lb (10 lb per dumbbell), with at least 1 minute of rest between trials, until the Soldier could no longer lift the dumbbell with proper lifting technique or they reached the maximum weight of 220 lb.

Resistance Pull

To assess total body pulling power, Soldiers held the handle of a 24-kg kettlebell attached with a strap to a plate loaded sled (approximately 95-100 lb) (Magic Carpet Sled, Spud, Inc., Columbia, SC) and pulled it for 20 m and/or 90 seconds, which ever came first. Soldiers were instructed to pull the kettlebell attached to the strap while stepping backwards as quickly as possible. A maximum time limit of 90 seconds was set. If the Soldier failed to pull the sled a distance of 20 m in the 90 seconds allotted time, the distance completed was measured and recorded. Time to complete and distance were recorded and converted to speed for imputation into the predictive model(s).

Arm Cycle Ergometer Test (Figure 3.2)

Soldiers cranked an Arm Ergometer (Model 881E, Monark AB, Varberg, Sweden) as fast as possible, for two minutes. The workload was fixed at 50 watts. Soldiers were in a kneeling position facing the Arm Ergometer with the center crank adjusted to shoulder height. The total number of revolutions was recorded (12, 13).

Subject Matter Expert Observations:

Subject Matter Experts (SMEs) were identified by TRADOC to observe and rate each Soldier's performance as they completed each of the criterion task simulations (Appendix M). The SMEs were not in the supervisory chain of participating Soldiers. The purpose of these ratings was to rate the speed (pace) and ability of each Soldier to determine where their performance fell in comparison to other Soldiers in that MOS.

STATISTICAL ANALYSES

Descriptive statistics were calculated for each task to characterize group performance on each test. Correlation coefficients appropriate to score distributions were computed to quantify strength of association among test variables.

Criterion task test scores were converted to Z-scores in order to create a common scale for all criterion tasks. Z-scores for the tactical movement, sandbag carry and move under direct fire were inverted so that better scores were greater numbers. For each individual, the Z-scores for all criterion tasks of their MOS were summed to create a total criterion task performance score. Multiple linear regression models were developed using forward stepwise procedures to produce equations predicting the total criterion task score, with each model using the field-expedient physical performance tests as predictor variables. Several models were developed to provide several courses of action depending on the availability of funding and equipment. For each model, secondary analyses were performed in order to identify predictive ability of the model for each individual criterion task. Additional statistical analyses can be found in Appendix N.

STUDY 3: RESULTS

11B Pre-Employment Screening Tests

Summaries and distributions of scores for the criterion job tasks are provided in Table 3.4. Z-score distributions for the criterion job tasks, as well as the total summed performance Z-score, are provided in Table 3.5. For the predictor tests, summaries and distributions are shown in Table 3.6.

11C Pre-Employment Screening Test

Summaries and distributions of scores the criterion job tasks are provided in Table 3.7. Similar Z-score distributions for the criterion job tasks, as well as the total summed performance Z-score, are provided in Table 3.8. For the predictor tests, summaries and distributions are shown in Table 3.9.

11B Prediction Models

Bivariate correlation amongst the criterion tasks and predictor tests are provided in Table 3.10. The non-significant correlations included the sit-ups with the following criterion tasks: foot march, sandbag carry, casualty drag, and casualty evacuation. All other correlations were significant ($p \geq 0.05$)

Five performance predictor models (Table 3.11) were developed using data from 190 Soldiers for whom complete datasets were available:

- The first model included all of the predictor tests with the following predictor tests as significant predictors (Full Model Adjusted $R^2=0.81$, $p<0.01$): medicine ball put, squat lift, beep test, arm ergometer, and standing long jump.

- A second model consisted of four significant predictors: medicine ball put, squat lift, beep test, and arm ergometer (Full Model Adjusted R^2=0.81, p<0.01).
- The third and fourth models omit the arm ergometer, as the cost of the device may be prohibitive, and any other equipment which would require routine calibration (as requested by Mr. Brinkley, G3/5/7 TRADOC). These models excluded the arm ergometer, handgrip, upright pull, and biceps curl tests as potential covariates The five significant predictors in the third model were the medicine ball put, squat lift, beep test, resistance pull, and 1-minute push-ups (Full Model Adjusted R^2=0.81, p<0.01).
- The fourth model used no calibrated equipment, but consisted of four significant predictors: medicine ball put, squat lift, beep test, and resistance pull (Full Model Adjusted R^2=0.80, p<0.01).
- The final model consisted of tests which only required a stopwatch and tape measure. This model included standing long jump, 1-minute push-ups, 1-minute sit-ups, and beep test (Full Model Adjusted R^2=0.63, p<0.01).

Correlations of the five models with the individual criterion tasks ranged from r=0.57-0.87, with the foot march having the lowest correlations (r=0.57-0.67) and the casualty evacuation (r=0.72-0.87) having the highest. Notably, all of the predictors for each model were significantly predictive of at least one of the individual criterion tasks. Summaries of all of the models, as well as their correlations with individual criterion tasks are provided in Table 3.12.

11C Prediction Models

Bivariate correlation amongst the criterion tasks and predictor tests are provided in Table 3.13. Most of the correlations amongst the criterion tasks and predictor tests were significant. Similar to the 11B, non-significant correlations included the sit-ups with the following criterion tasks: foot march, sandbag carry, casualty drag, and casualty evacuation.

Five performance predictor models (Table 3.14) were developed using data from 182 Soldiers for whom complete datasets were available:

- The first model included all of the predictor tests with the following predictor tests as significant predictors (Full Model Adjusted R^2=0.81, p<0.01): medicine ball put, squat lift, arm ergometer, standing long jump, and 1-minute push-ups.
- A second model consisted of four significant predictors: medicine ball put, squat lift, arm ergometer, and standing long jump (Full Model Adjusted R^2=0.81, p<0.01).
- The third and fourth models omit any calibrated equipment. The five significant predictors in the third model were the medicine ball put, squat

lift, Illinois agility test, 1-minute push-ups, and resistance pull (Full Model Adjusted R^2=0.81, p<0.01).
- The fourth model used no calibrated equipment, but consisted of four significant predictors: medicine ball put, squat lift, Illinois agility test, and 1-minute push-ups (Full Model Adjusted R^2=0.80, p<0.01).
- The final model consisted of tests which only required a stopwatch and tape measure. This model included standing long jump, 1-minute push-ups, Illinois agility test, and 1-minute sit-ups (Full Model Adjusted R^2=0.65, p<0.01).

Correlations of the 5 models with the individual criterion tasks ranged from r=0.59-0.87, with the foot march having the lowest correlations (r=0.59-0.68) and the casualty drag (r=0.70-0.87) and casualty evacuation (r=0.72-0.85) having the highest. Notably, all of the predictors for each model were significantly predictive of at least one of the individual criterion tasks. Summaries of all of the models, as well as their correlations with individual criterion tasks are provided in Table 3.15.

STUDY 3: DISCUSSION

This study validated the ability of 14 simple physical tasks to predict performance of at least one of the MOS-specific criterion tasks. From those tests, a collection of 10 potential testing models were constructed to predict physical performance on the 11B and 11C criterion tasks. All 10 (five 11B, five 11C) of the models have $R^2 \geq 0.60$, the generally accepted lower limit for such models.

INDIVIDUAL PREDICTORS

Of the 14 predictor tests, 13 were significantly predictive of all criterion tasks. The only exception was the sit-ups test. One possible explanation is that while sit-up performance may be correlated with overall fitness (7), it is not a specific measure of any one aspect of fitness relevant to the selected criterion tasks for these MOSs. Sit-up testing primarily assesses muscular endurance of the abdominals and hip flexors. While muscular endurance of the abdominals and hip flexors may support performing a task by aiding in the ability to carry a load for long distances, it is unlikely to be a significant limiting factor in this task.

PREDICTION MODELS- 11B

For the 11B, five possible outcome models were provided multiple situations. All five of the models showed significant predictive power and were stronger than a model based solely on APFT performance (R^2 = 0.47, data not shown). While not exactly the same, most of the models capture similar fitness requirements to those developed by other countries (Table 3.16).

The first model, which included all the covariates, is the best predictor of performance on the criterion tasks based on the predictors tested (R^2 = 0.81). This test

battery includes the medicine ball put, squat lift, beep test, arm ergometer, and standing long jump. Notably, this model consists of tests that capture five different aspects of fitness. The medicine ball put tests upper body power; squat lift tests lower body strength; beep test captures aerobic capacity; arm ergometer captures upper body endurance; and standing long jump tests lower body power. While this model is optimal from a predictive viewpoint, it does not take into account any limitations in terms of space, budget, or training and maintenance required to use some the equipment. The arm ergometer is space efficient, accurate and may be feasible for use in a limited number of test sites; however, purchasing and maintaining the equipment for a large number of sites may not be realistic. The medicine ball put requires about a 3-m high ceiling and a 10- to 15-m open area as a landing site for the medicine ball. The squat lift test requires the use of several heavy dumbbells in order to be performed, which could be expensive. The beep test does not require a lot of equipment; however, it does demand a large stretch of space (over 20 m in length).

The second model includes all covariates and provides four predictor tests (R^2 = 0.81). This second testing battery maintains the same predictive power as the first model while using one less predictor test. This model includes medicine ball put, squat lift, beep test, and arm ergometer. The space requirement to administer both the medicine ball put and beep test may not always be available at all testing sites. Additionally, the expense of both the arm ergometer and squat lift testing equipment must be considered.

The third and fourth models maintain equivalent predictive power as the first two models (R^2 = 0.81 and 0.80, respectively) while eliminating the need for the arm ergometer in order to reduce the cost of collecting equipment. Additionally, all the tests used may be readily purchased at a sporting goods store. The third model resulted in a test battery that included the medicine ball put, squat lift, beep test, resistance pull (lower body strength), and 1-minute push-ups (upper body strength and endurance). The fourth model includes the medicine ball put, squat lift, beep test, and resistance pull. For these models, the expense of the squat lift equipment and the sled for the resistance pull must still be considered, even if the arm ergometer is not included.

The fifth and final model eliminates the need to purchase any equipment other than a stop watch and a tape measure using four predictor tests (R^2 = 0.63). This model produced a test battery that includes standing long jump, 1-minute push-ups, 1-minute sit-ups, and beep test. There was a significant decrease in predictive power from the previously mentioned models to this current model, but the predictive power is still above the generally accepted cut score. This set of predictor tests require minimal equipment resulting in a cost-effective model; however, the space requirement is still needed for the beep test.

PREDICTION MODELS- 11C

For the 11C, five possible prediction models were provided to help predict performance of the selected 11C criterion tasks. All of the models showed significant

predictive power, and were much stronger than a model based solely on APFT performance for (R^2=0.50, data not shown).

The first model, which included all the covariates, is the best predictor of performance on the criterion tasks based on the predictors tested (R^2 = 0.81). This test battery includes the medicine ball put, squat lift, arm ergometer, standing long jump, and 1-minute push-ups. Notably, this model consists of tests that capture multiple aspects of fitness. The medicine ball put tests upper body power; squat lift tests lower body strength; arm ergometer captures upper body endurance; standing long jump tests lower body power; and 1-minute push-ups assess upper body strength and endurance. While this model is optimal from a predictive viewpoint, it does not take into account any limitations in terms of space, budget, or training and maintenance required to use some the equipment. The arm ergometer is space efficient, accurate and may be feasible for use in a limited number of test sites; however, purchasing and maintaining the equipment for a large number of sites may not be realistic. The squat lift could also be expensive due to the number of dumbbells required to administer the test. Also, the medicine ball put requires about a 3-m high ceiling and a 10- to15- m open area as a landing site for the medicine ball.

The second model includes all covariates and provides four predictor tests (R^2 = 0.81). This second testing battery maintains the same predictive power as the first model while using one less predictor test. This model includes medicine ball put, squat lift, arm ergometer, and standing long jump. The space requirement to administer the medicine ball put is not always available at all testing sites. Additionally, the expenses of the arm ergometer and squat lift equipment must be considered.

The third and fourth models maintain equivalent predictive power as the first two models (R^2 = 0.81 and 0.80, respectively) while eliminating the need for the arm ergometer in order to reduce the cost of collecting equipment. Additionally, all the tests used may be readily purchased at a sporting goods store. The third model resulted in a test battery that included the medicine ball put, squat lift, Illinois agility test (lower body movement quality), 1-minute push-ups (upper body strength and endurance), and resistance pull (lower body strength). The fourth model includes the medicine ball put, squat lift, Illinois agility test, and 1 -minute push-ups. For these models, the expenses of the numerous dumbbells (squat lift) and sled (resistance pull) must still be considered as well as the space required for the medicine ball put.

The fifth and final model eliminates the need to purchase any equipment other than a stop watch and a tape measure using four predictor tests (R^2 = 0.65). This model produced a test battery that includes standing long jump, 1-minute push-ups, Illinois agility test, and 1-minute sit-ups. There was a significant decrease in predictive power from the previously mentioned models to this current model, but the predictive power is still above the generally accepted cut score. This set of predictor tests require minimal equipment resulting in a cost-effective model.

ESTABLISHMENT OF CUT POINTS AND FOLLOW-UP

Once a predictive model is selected, the next step will be the identification of acceptable cutoffs for each predictor test. First, for each of the criterion tasks, a minimum acceptable score for the safe and efficient performance of each criterion task simulation will need to be determined. The determination of this score should include several elements including requirements of the job task and trainability of an incoming recruit. Requirements of the job can be established by TRADOC based on the needs and training of the Army. Since these predictive tests are to be administered to incoming recruits and not Soldiers who currently retain the MOS, it will be necessary to account for the ability to train an incoming recruit in One Station Unit Training (OSUT). Improvements of up to 6% in VO_2peak and lower body strength have been shown following eight weeks of Basic Combat Training (BCT) (33).

From here, it will be possible to identify cut-scores for the predictive tests. It may be necessary to adjust the cut-scores to optimize the number of individuals who are incorrectly identified as passing or failing a test. By selecting a higher standard to represent a superior performance, this will decrease the number of false positives (i.e., people who pass the test battery but would not be successful in the MOS) but also increase the number of false negatives (i.e., people who fail the test battery but would be successful in the MOS). Along with values for the cut-scores, the type of cut-offs need to be established as well. For testing batteries, such as the ones presented in this report, there are three main types of cut scores: multiple hurdle, compensatory, and hybrid (13). For a multiple hurdle test, a potential recruit would need to reach a minimum score on each test to pass the test (e.g., scoring at least 60/100 points on all four tests). With the compensatory model, recruits must reach a total score based on the predictors, but they may make up for a poor performance on one predictor with a better performance on another (e.g., requiring a total score of 240 points on four tests scored out of 100 points). The hybrid combines these two approaches, where there is a minimal acceptable score on each test, but the total score must be greater than the sum of the acceptable scores (e.g., scoring 50/100 points on all four tests and requiring a total score of 240).

After implementation of this test battery, long-term observation of Infantry recruits is crucial for the full validation of the model. The test should be administered to all Soldiers entering the 11B and 11C MOSs and these Soldiers should be tracked throughout their first term of enlistment. The information recorded should include success/failure and time in Initial Military Training, performance on critical tasks, injuries, attrition from the Army, Enlisted Evaluation Reports and reclassification to other MOSs. The entry standards for the test battery must be adjusted based on these data. This will require creation of an on-line database, standardized measurement and recording of these data, and periodic longitudinal analyses of the data.

LIMITATIONS

It should be noted that the models developed for both the 11B and 11C MOSs are discrete testing batteries. It is not possible to simply replace one test for another.

While any given predictor has the core fitness domain (such as upper-body endurance) that it captures, each test also has unique features. For example, push-ups and the arm-ergometer both capture upper body endurance, but due to their differing methodology, if one was substituted for the other, the result may not be an optimal test battery.

The models developed all depend on one important element: the correct selection of the criterion tasks. The job performance score being predicted is based on the five 11B and 11C criterion tasks. While our research indicates that these are the appropriate criterion tasks and capture many aspects of the physically demanding tasks of the Infantry MOSs, it is possible that there are critical aspects of other tasks not being captured, especially if the job requirements change over time. In the future, it may be necessary to revise the model if the task demands change due to changes in nature of the physical demanding tasks.

STUDY 3: CONCLUSIONS

The present study developed five models for the 11B and five models 11C MOSs in order to effectively predict performance on MOS-specific criterion tasks that were identified in Studies 1 and 2. For the 11B, the strongest model included medicine ball put, squat lift, beep test, arm ergometer, and standing long jump predictor tests. The strongest model for the 11C included medicine ball put, squat lift, arm ergometer, standing long jump, and 1-minute push-ups predictor tests. The other models that are provided serve as sufficient alternatives based on cost, feasibility, and equipment availability.

STUDY 3: RECOMMENDATIONS

- The Army should select one of the provided designated MOS models, based on the equipment availability and willingness to purchase for use.

    - The five models for 11B were (from best to worst predictive ability):
        - medicine ball put, squat lift, beep test, arm ergometer, and standing long jump
        - medicine ball put, squat lift, beep test, and arm ergometer
        - medicine ball put, squat lift, beep test, resistance pull, and 1-minute push-ups
        - medicine ball put, squat lift, beep test, and resistance pull
        - standing long jump, 1-minute push-ups, 1-minute sit-ups, beep test

    - The five models for 11C were (from best to worst predictive ability):
        - medicine ball put, squat lift, arm ergometer, standing long jump, and 1-minute push-ups
        - medicine ball put, squat lift, arm ergometer, and standing long jump
        - medicine ball put, squat lift, Illinois agility test, 1-minute push-ups, and resistance pull
        - medicine ball put, squat lift, Illinois agility test, and 1-minute push-ups
        - standing long jump, 1-minute push-ups, Illinois agility test, and 1-minute sit-ups

- Follow-up studies should confirm the validity of this model in a separate group of Soldiers.
- In order to establish cut-points, acceptable scores on the criterion tasks need to be verified and/or established, which can then be used to identify critical scores on the predictor tests.
- The predictive test model should be administered through a series of Soldiers entering BCT or Advanced Individual Training (AIT), and continued through the early years of their career, in order to establish the accuracy of the model. Follow-ups should be considered on a routine basis to ensure the continued acceptability of the prediction model.
- Before selecting on of the above testing batteries, models that incorporate the same test of other Combat Arms MOSs (i.e., 12B, 13B, 13F, 19D, 19K,) should be explored and considered for use as the Pre-Employment Screening Test.

OVERALL RECOMMENDATIONS

- The Infantry MOSs contain a number of physically demanding tasks. Given these high demands, a pre-enlistment test battery would be beneficial in preventing injuries and misclassifications.
- The Army should institute either one of the predictive test batteries presented herein, or wait until the completion of this study to institute a test battery common to all Combat Arms MOSs.
- Once a test battery is instituted, it will be necessary to perform short-term follow-up assessments to ensure the success of the models in preventing injuries and reclassifications of new Army recruits. Acceptable passing scores may need to be adjusted in order to optimize the model to prevent these negative outcomes.
- Periodic review of the physically demanding tasks of Infantry MOSs should be considered. If a new task is identified with greater physiological demands, or one of the currently identified criterion tasks is deemed no longer representative of the physical demands, redevelopment of the models should be considered.

Table 3.1. Physical Pre-Employment Test Batteries Developed by the Armed Forces of Australia, Canada, and the United Kingdom

Country	Soldiering task tests	Field-expedient tests
Australia (3)	<u>All Corps</u> • Load Carriage • Combat Rushes • Jerry Can Carry • Heavy Equipment Lift <u>Artillery</u> • All Corps + moving ammunition for a M777A2 conducting a 10-round fire for effect <u>Infantry</u> • All Corps + Casualty Drag	<u>All Corps</u> • Weight Load March • Fire and Movement • Jerry Can Carry • Box Lift and Place <u>Artillery</u> • All Corps + repeatedly lift and carry 10m an inert artillery round <u>Infantry</u> • All Corps + Simulated Casualty Drag
Canada (6, 9, 30)	• Escape to Cover • Sandbag Fortification • Pickets and Wire Carry • Picking and Digging • Vehicle Extrication • Stretcher Carry	• Sandbag Lift • Intermittent Loaded Shuttles • 20-M Rushes • Sandbag Drag
United Kingdom (5, 28, 29)	• Jerry Can Carry • Load Carriage • Single Ammo Box Lift	• 1.5-Mile Run/Beep Test • Jerry Can Carry • Static Lift • Sit-up • Push-up

Table 3.2. Soldier Characteristics: Study 3

11B Cohort	**Males (n=94)**	**Females (n=96)**	**p-value**
Age (years)	22.7 ± 3.4	24.4 ± 5.0	0.01
Height (cm)	179.8 ± 6.5	166.1 ± 6.3	<0.01
Mass (kg)	85.2 ± 12.3	67.6 ± 10.5	<0.01
Time in Military (years)	2.5 ± 2.5	3.0 ± 2.6	0.12
Time in MOS (years)	2.4 ± 2.4	2.9 ± 2.5	0.14
Number Deployed	11 (12%)	6 (6%)	.
Time Deployed (years) *for only those who have deployed*	2.3 ± 1.1	2.5 ± 0.8	0.66
Army Physical Fitness Test Score (points)	258.9 ± 27.6	262.3 ± 30.0	0.44
Push-ups (# / 2 min)	65.4 ± 13.0	42.9 ± 9.6	<0.01
Sit-ups (# / 2 min)	72.0 ± 10.6	69.7 ± 10.5	0.16
Two-Mile Run Time (min)	15.2 ± 8.0	16.4 ± 4.2	0.21
Predicted VO_2max (ml/kg/min^{-1})	48.5 ± 22.5	49.8 ± 12.1	0.63
11C Cohort	**Males (n=86)**	**Females (n=96)**	**p-value**
Age (years)	22.7 ± 3.4	24.4 ± 5.0	0.01
Height (cm)	179.0 ± 6.9	166.1 ± 6.3	<0.01
Mass (kg)	85.2 ± 15.5	67.6 ± 10.5	<0.01
Time in Military (years)	3.3 ± 3.0	3.0 ± 2.6	0.57
Time in MOS (years)	3.2 ± 2.9	2.9 ± 2.5	0.38
Number Deployed	13 (15%)	6 (6%)	.
Time Deployed (years) *for only those who have deployed*	2.4 ± 0.9	2.5 ± 0.8	0.89
Army Physical Fitness Test Score (points)	252.3 ± 27.8	262.3 ± 30.0	0.03
Push-ups (# / 2 min)	65.3 ± 11.1	42.9 ± 9.6	<0.01
Sit-ups (# / 2 min)	71.5 ± 9.9	69.7 ± 10.5	0.26
Two-Mile Run Time (min)	14.8 ± 1.1	16.4 ± 4.2	<0.01
Predicted VO_2max (ml/kg/min^{-1})	49.6 ± 4.9	49.8 ± 12.1	0.91

Table 3.3. Raw Criterion Task Performance (11B)

		Foot March Time (min) [a]			Sandbag Carry Time (min) [a]			Move Under Fire Time (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		94	96	190	94	96	190	94	96	190
Mean		76.91	92.12	84.59	1.68	3.02	2.35	2.28	2.62	2.45
SD		7.00	13.50	13.19	.28	1.14	1.07	0.15	0.24	0.26
Minimum		91.23	138.80	138.80	2.88	7.92	7.92	2.65	3.42	3.42
Percentiles	**5**	90.20	114.57	105.93	2.17	5.65	4.68	2.57	3.06	2.93
	10	86.97	105.93	102.67	2.03	4.68	3.63	2.50	2.93	2.83
	25	81.20	101.79	91.23	1.78	3.40	2.73	2.37	2.77	2.62
	50	76.54	91.15	81.39	1.68	2.71	2.03	2.27	2.58	2.40
	75	71.67	82.03	74.80	1.47	2.25	1.67	2.18	2.44	2.27
	90	67.88	75.88	70.64	1.37	2.02	1.45	2.12	2.34	2.15
	95	66.85	73.15	67.88	1.30	1.83	1.37	2.07	2.30	2.10
Maximum		63.05	69.40	63.05	1.18	1.60	1.18	2.00	2.07	2.00

		Casualty Evac Weight (lb)			Casualty Drag Speed (m/s)		
		M	**F**	**C**	**M**	**F**	**C**
n		94	96	190	94	96	190
Mean		209	146	177	1.13	0.44	0.78
SD		6	34	40	0.29	0.32	0.46
Minimum		170	70	70	0.12	0.03	0.03
Percentiles	**5**	210	90	110	0.75	0.05	0.08
	10	210	110	110	0.82	0.08	0.14
	25	210	120	140	0.93	0.18	0.40
	50	210	140	210	1.13	0.42	0.82
	75	210	170	210	1.26	0.66	1.15
	90	210	190	210	1.47	0.82	1.32
	95	210	210	210	1.55	1.03	1.48
Maximum		210	210	210	2.23	1.55	2.23

M: Male; F: Female; C: Combined
[a]Scores inverted so faster times = higher percentile

Table 3.4. Criterion Task Performance Converted to Z-Scores (11B)

		Foot March Time (min) [a]			Sandbag Carry Time (min) [a]			Move Under Fire Time (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		94	96	190	94	96	190	94	96	190
Mean		0.28	-1.09	-0.41	0.48	-1.02	-0.28	0.38	-1.03	-0.33
SD		0.63	1.21	1.18	0.32	1.26	1.19	0.54	0.95	1.05
Minimum		-1.05	-5.15	-5.15	-0.97	-6.16	-6.16	-0.95	-4.21	-4.21
Percentiles	**5**	-0.87	-3.01	-2.39	-0.06	-3.74	-2.96	-0.73	-2.68	-2.22
	10	-0.66	-2.39	-2.08	0.12	-2.96	-1.85	-0.44	-2.22	-1.95
	25	-0.09	-1.90	-0.99	0.35	-1.53	-0.69	0.12	-1.66	-0.94
	50	0.31	-0.97	-0.14	0.49	-0.65	0.12	0.48	-0.88	-0.20
	75	0.74	-0.20	0.46	0.71	-0.17	0.49	0.76	-0.32	0.48
	90	1.08	0.39	0.83	0.82	0.12	0.73	0.96	0.00	0.80
	95	1.18	0.63	1.08	0.90	0.29	0.82	1.17	0.15	1.03
Maximum		1.52	0.96	1.52	1.04	0.58	1.04	1.71	1.03	1.71

		Casualty Evac Weight (lb)			Casualty Drag Speed (m/s)			Summed Z-Sum		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		94	96	190	94	96	190	94	96	190
Mean		0.54	-1.17	-0.32	0.44	-1.18	-.38	2.12	-5.49	-1.73
SD		0.16	0.95	1.09	0.64	0.75	1.07	1.40	3.67	4.72
Minimum		-0.47	-3.28	-3.28	-1.69	-2.35	-2.35	-0.99	-17.21	-17.21
Percentiles	**5**	0.56	-2.69	-2.39	-0.43	-2.22	-2.02	-0.39	-11.99	-9.43
	10	0.56	-2.39	-2.05	-0.30	-2.02	-1.86	0.29	-9.43	-8.41
	25	0.56	-1.93	-1.26	0.05	-1.80	-1.32	1.09	-7.92	-5.22
	50	0.56	-1.26	0.56	0.36	-1.30	-0.28	2.32	-5.22	-0.42
	75	0.58	-0.47	0.56	0.77	-0.72	0.36	2.99	-3.05	2.34
	90	0.58	0.05	0.58	1.18	-0.26	0.86	3.82	-0.85	3.29
	95	0.58	0.56	0.58	1.47	0.23	1.19	4.37	-0.24	3.82
Maximum		0.58	0.79	0.79	2.99	1.47	2.99	5.76	2.61	5.76

M: Male; F: Female; C: Combined

[a]Z-Scores inverted so faster (shorter) times = positive Z-score

Table 3.5. Predictor Test Performance (11B)

		Beep Test Shuttles (#)			Medicine Ball Put (cm)			Illinois Agility Test (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		94	96	190	94	96	190	94	96	190
Mean		63	42	52	648.85	419.58	533.01	0.33	0.36	0.34
SD		18	12	19	74.36	56.44	132.41	0.03	0.03	0.03
Minimum		20	17	17	480.00	315.00	315.00	0.26	0.29	0.26
Percentiles	**5**	35	23	24	519.50	342.00	351.50	0.28	0.31	0.29
	10	42	26	31	561.00	351.50	368.75	0.29	0.32	0.30
	25	52	34	40	595.00	377.25	409.50	0.30	0.34	0.32
	50	63	42	51	651.00	410.25	527.00	0.32	0.36	0.34
	75	76	50	63	691.00	448.00	651.00	0.34	0.38	0.37
	90	89	58	81	757.50	509.00	700.75	0.37	0.39	0.39
	95	94	65	89	777.50	531.50	757.50	0.40	0.40	0.40
Maximum		103	74	103	849.50	577.00	849.50	0.41	0.42	0.42

		Upright Pull (lb)			Biceps Curl (lb)			Standing Long Jump (cm)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		94	96	190	94	96	190	94	96	190
Mean		329.78	199.03	263.71	99.17	60.51	79.63	205.0	160.9	182.7
SD		53.62	35.62	79.68	19.74	10.26	24.90	28.2	21.6	33.4
Minimum		213.00	123.50	123.50	59.30	33.60	33.60	114.5	115.0	114.5
Percentiles	**5**	242.60	140.25	151.30	73.00	45.45	47.55	162.0	122.5	130.0
	10	257.80	151.30	168.00	79.00	47.55	50.85	172.0	130.5	138.3
	25	299.00	174.05	196.85	87.80	52.28	59.10	185.0	145.3	159.0
	50	328.75	197.35	252.25	95.60	60.08	75.68	205.0	162.3	180.5
	75	362.65	224.38	328.70	109.50	67.60	95.45	220.5	175.3	204.0
	90	399.65	243.05	368.88	123.80	74.20	111.38	245.5	188.5	229.3
	95	426.30	263.45	399.65	141.70	78.55	123.80	256.0	198.5	245.5
Maximum		489.15	286.15	489.15	168.15	83.75	168.15	263.0	204.0	263.0

		Push-Ups (#)			Resistance Pull (m/s)			Powerball Throw (cm)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		94	96	190	94	96	190	94	96	190
Mean		50	30	40	0.85	0.24	0.54	602.7	339.4	469.6
SD		11	8	14	0.25	0.19	0.38	125.2	85.5	169.7
Minimum		21	14	14	0.20	0.00	0.00	388.5	166.5	166.5
Percentiles	**5**	32	17	18	0.40	0.01	0.05	398.0	209.0	230.0
	10	38	18	22	0.49	0.05	0.10	464.5	230.0	264.3
	25	42	25	29	0.72	0.12	0.18	507.5	271.8	332.0
	50	49	30	39	0.85	0.18	0.50	587.5	332.5	450.0
	75	56	37	49	1.00	0.33	0.85	673.0	390.5	586.0
	90	62	40	60	1.18	0.51	1.08	789.5	449.0	695.3
	95	67	41	62	1.28	0.60	1.18	823.5	493.0	789.5
Maximum		83	50	83	1.34	0.83	1.34	964.0	580.0	964.0

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.5. Predictor Test Performance (13B) (continued)

		Sit-Ups (#)			Arm Ergometer (Rev / 2min)			Handgrip Sum (lb)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		94	96	190	94	96	190	94	96	190
Mean		46	45	46	264.9	199.3	231.7	217.28	132.45	174.42
SD		7	6	6	29.1	34.0	45.6	41.01	25.77	54.49
Minimum		18	31	18	149.0	104.0	104.0	146.70	81.15	81.15
Percentiles	**5**	38	35	36	217.0	148.0	154.0	163.35	92.50	99.35
	10	39	37	39	224.0	154.0	168.0	169.20	99.35	108.33
	25	42	40	41	250.0	175.5	199.0	186.35	113.78	130.65
	50	46	45	45	268.5	200.0	231.0	212.15	131.00	168.18
	75	51	49	50	285.0	217.0	271.0	241.15	150.85	211.50
	90	54	53	54	299.0	245.0	289.0	265.35	168.10	246.85
	95	56	55	55	305.0	265.0	299.0	281.10	181.35	265.35
Maximum		64	62	64	321.0	288.0	321.0	388.35	207.30	388.35

		300m Sprint (min) [a]			Squat Lift (lb)		
		M	**F**	**C**	**M**	**F**	**C**
n		94	96	190	94	96	190
Mean		0.88	1.05	0.97	220	161	190
SD		0.10	0.11	0.14	3	37	39
Minimum		0.68	0.83	0.68	200	80	80
Percentiles	**5**	0.74	0.89	0.76	220	100	120
	10	0.76	0.91	0.79	220	120	120
	25	0.80	0.98	0.87	220	140	160
	50	0.87	1.04	0.95	220	160	220
	75	0.94	1.12	1.05	220	190	220
	90	1.00	1.18	1.13	220	220	220
	95	1.06	1.25	1.22	220	220	220
Maximum		1.25	1.46	1.46	220	220	220

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.6. Raw Criterion Task Performance (11C)

		Foot March Time (min) [a]			Sandbag Carry Time (min) [a]			Move Under Fire Time (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		86	96	182	86	96	182	86	96	182
Mean		76.74	92.12	84.85	1.70	3.02	2.40	2.29	2.62	2.46
SD		6.28	13.50	13.17	0.31	1.14	1.08	0.16	0.24	0.26
Minimum		96.60	138.80	138.80	2.65	7.92	7.92	2.91	3.42	3.42
Percentiles	**5**	87.95	114.57	105.93	2.22	5.65	4.68	2.52	3.06	2.93
	10	82.92	105.93	102.70	2.07	4.68	3.63	2.50	2.93	2.83
	25	80.13	101.79	91.83	1.93	3.40	2.75	2.38	2.77	2.62
	50	76.80	91.15	81.36	1.67	2.71	2.06	2.28	2.58	2.43
	75	72.40	82.03	75.70	1.47	2.25	1.67	2.18	2.44	2.28
	90	68.22	75.88	71.03	1.35	2.02	1.43	2.10	2.34	2.15
	95	66.45	73.15	68.78	1.18	1.83	1.35	2.05	2.30	2.10
Maximum		65.62	69.40	65.62	1.10	1.60	1.10	1.93	2.07	1.93

		BFV Cas Evac Weight (lb)			Casualty Drag Speed (m/s)		
		M	**F**	**C**	**M**	**F**	**C**
n		86	96	182	86	96	182
Mean		208	146	175	1.12	0.44	0.76
SD		8	34	40	0.30	0.32	0.46
Minimum		170	70	70	0.15	0.03	0.03
Percentiles	**5**	190	90	110	0.68	0.05	0.08
	10	210	110	110	0.85	0.08	0.14
	25	210	120	140	0.93	0.18	0.31
	50	210	140	190	1.15	0.42	0.77
	75	210	170	210	1.30	0.66	1.15
	90	210	190	210	1.46	0.82	1.37
	95	210	210	210	1.52	1.03	1.46
Maximum		210	210	210	1.98	1.55	1.98

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.7. Criterion Task Performance Converted to Z-Scores (11C)

		Foot March Time (min) [a]			Sandbag Carry Time (min) [a]			Move Under Fire Time (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		86	96	182	86	96	182	86	96	182
Mean		0.29	-1.09	-0.44	0.45	-1.02	-0.32	0.35	-1.03	-0.38
SD		0.57	1.21	1.18	0.35	1.26	1.20	0.58	0.95	1.05
Minimum		-1.55	-5.15	-5.15	-0.69	-6.16	-6.16	-2.07	-4.21	-4.21
Percentiles	**5**	-0.75	-3.01	-2.39	-0.10	-3.74	-2.96	-0.51	-2.68	-2.22
	10	-0.29	-2.39	-2.08	0.05	-2.96	-1.86	-0.30	-2.22	-2.07
	25	-0.01	-1.90	-1.11	0.19	-1.53	-0.70	0.05	-1.66	-0.95
	50	0.29	-0.97	-0.13	0.47	-0.65	0.06	0.34	-0.88	-0.20
	75	0.69	-0.20	0.38	0.72	-0.17	0.47	0.69	-0.32	0.34
	90	1.06	0.39	0.81	0.85	0.12	0.74	1.10	0.00	0.76
	95	1.21	0.63	1.01	1.04	0.29	0.84	1.22	0.15	1.10
Maximum		1.29	0.96	1.29	1.14	0.58	1.14	1.67	1.03	1.67

		BFV Cas Evac Weight (lb)			Casualty Drag Speed (m/s)			Summed Z-Sum		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		86	96	182	86	96	182	86	96	182
Mean		0.51	-1.17	-0.38	0.40	-1.18	-0.43	2.00	-5.49	-1.95
SD		0.22	0.95	1.09	0.66	0.75	1.06	1.59	3.67	4.73
Minimum		-0.47	-3.28	-3.28	-1.63	-2.35	-2.35	-2.68	-17.21	-17.21
Percentiles	**5**	-0.03	-2.69	-2.39	-0.45	-2.22	-2.02	-0.72	-11.99	-9.43
	10	0.56	-2.39	-2.05	-0.36	-2.02	-1.86	-0.11	-9.43	-8.53
	25	0.56	-1.93	-1.26	0.02	-1.80	-1.40	0.88	-7.92	-5.71
	50	0.56	-1.26	0.05	0.38	-1.30	-0.37	2.07	-5.22	-0.80
	75	0.58	-0.47	0.56	0.81	-0.72	0.38	3.25	-3.05	2.01
	90	0.58	0.05	0.58	1.14	-0.26	0.91	4.02	-0.85	3.29
	95	0.58	0.56	0.58	1.41	0.23	1.14	4.56	-0.24	3.76
Maximum		0.58	0.79	0.79	2.39	1.47	2.39	5.86	2.61	5.86

M: Male; F: Female; C: Combined

[a]Z-Scores inverted so faster (shorter) times = positive Z-score

Table 3.8. Predictor Test Performance (11C)

		Beep Test Shuttles (#)			Medicine Ball Put (cm)			Illinois Agility Test (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		86	96	182	86	96	182	86	96	182
Mean		62	42	51	616.90	419.58	512.82	0.32	0.36	0.34
SD		15	12	17	74.08	56.44	118.35	0.02	0.03	0.03
Minimum		29	17	17	453.50	315.00	315.00	0.28	0.29	0.28
Percentiles	**5**	39	23	26	511.00	342.00	351.50	0.28	0.31	0.29
	10	44	26	31	526.50	351.50	367.50	0.29	0.32	0.30
	25	51	34	40	560.00	377.25	408.00	0.30	0.34	0.32
	50	59	42	50	616.75	410.25	510.00	0.32	0.36	0.34
	75	73	50	62	660.50	448.00	610.00	0.33	0.38	0.36
	90	83	58	73	702.50	509.00	666.00	0.36	0.39	0.38
	95	89	65	80	772.50	531.50	694.00	0.37	0.40	0.39
Maximum		105	74	105	829.00	577.00	829.00	0.38	0.42	0.42

		Upright Pull (lb)			Biceps Curl (lb)			Standing Long Jump (cm)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		86	96	182	86	96	182	86	96	182
Mean		329.00	199.03	260.44	99.11	60.51	78.75	201.6	160.9	180.1
SD		51.42	35.62	78.37	17.79	10.26	24.03	24.1	21.6	30.5
Minimum		216.90	123.50	123.50	57.75	33.60	33.60	142.5	115.0	115.0
Percentiles	**5**	241.65	140.25	151.30	73.80	45.45	47.55	170.0	122.5	130.5
	10	260.80	151.30	167.75	76.65	47.55	50.80	174.0	130.5	138.5
	25	301.25	174.05	194.75	86.35	52.28	58.75	184.5	145.3	158.5
	50	327.10	197.35	242.13	98.98	60.08	73.90	199.3	162.3	177.5
	75	361.05	224.38	321.15	108.50	67.60	98.05	217.0	175.3	199.5
	90	395.80	243.05	362.40	126.35	74.20	110.05	234.5	188.5	217.5
	95	431.45	263.45	395.15	132.95	78.55	124.00	248.5	198.5	234.0
Maximum		462.10	286.15	462.10	141.10	83.75	141.10	260.5	204.0	260.5

		Push-ups (#)			Resistance Pull (m/s)			Powerball Throw (cm)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		86	96	182	86	96	182	86	96	182
Mean		51	30	40	0.87	0.24	0.54	594.6	339.4	460.0
SD		11	8	14	0.28	0.19	0.40	113.5	85.5	161.9
Minimum		31	14	14	0.17	0.00	0.00	302.5	166.5	166.5
Percentiles	**5**	33	17	18	0.34	0.01	0.05	395.0	209.0	230.0
	10	39	18	22	0.52	0.05	0.09	459.0	230.0	263.0
	25	43	25	29	0.69	0.12	0.17	522.5	271.8	324.0
	50	50	30	39	0.90	0.18	0.47	590.8	332.5	438.5
	75	57	37	49	1.05	0.33	0.87	667.0	390.5	572.0
	90	66	40	59	1.23	0.51	1.08	762.5	449.0	689.0
	95	72	41	64	1.33	0.60	1.22	788.0	493.0	754.0
Maximum		85	50	85	1.53	0.83	1.53	830.5	580.0	830.5

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.8. Predictor Test Performance (11C) (continued)

		Sit-Ups (#)			Arm Ergometer (Rev / 2 min)			Handgrip Sum (lb)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		86	96	182	86	96	182	86	96	182
Mean		45	45	45	267.1	199.3	231.3	210.41	132.45	169.29
SD		6	6	6	36.0	34.0	48.7	34.85	25.77	49.42
Minimum		32	31	31	162.0	104.0	104.0	132.50	81.15	81.15
Percentiles	**5**	36	35	36	202.0	148.0	154.0	150.60	92.50	99.35
	10	37	37	37	221.0	154.0	167.0	162.00	99.35	107.00
	25	41	40	41	244.0	175.5	195.0	189.20	113.78	129.15
	50	44	45	45	270.0	200.0	225.5	209.05	131.00	160.68
	75	49	49	49	291.0	217.0	271.0	238.50	150.85	207.30
	90	54	53	54	312.0	245.0	299.0	249.90	168.10	242.75
	95	55	55	55	327.0	265.0	312.0	256.15	181.35	248.80
Maximum		60	62	62	339.0	288.0	339.0	298.65	207.30	298.65

		300m Sprint (min) [a]			Squat Lift (lb)		
		M	**F**	**C**	**M**	**F**	**C**
n		86	96	182	86	96	182
Mean		0.88	1.05	0.97	217	161	187
SD		0.09	0.11	0.13	12	37	40
Minimum		0.72	0.83	0.72	160	80	80
Percentiles	**5**	0.74	0.89	0.77	200	100	120
	10	0.77	0.91	0.81	200	120	120
	25	0.82	0.98	0.88	220	140	160
	50	0.88	1.04	0.96	220	160	220
	75	0.93	1.12	1.05	220	190	220
	90	0.98	1.18	1.13	220	220	220
	95	1.02	1.25	1.19	220	220	220
Maximum		1.19	1.46	1.46	220	220	220

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.9. Correlations amongst Criterion Tasks and Predictor Tests (11B)

	Foot March	Sandbag Carry	Move Under Fire	Casualty Evacuation	Casualty Drag
Beep Test	-0.47**	-0.48**	-0.60**	0.49**	0.45**
Med Ball Put	-0.60**	-0.65**	-0.60**	0.78**	0.80**
Illinois Agility	0.38**	0.53**	-0.61**	-0.48**	-0.41**
Upright Pull	-0.55**	-0.63**	-0.59**	0.75**	0.81**
Biceps Curl	-0.53**	-0.60**	-0.53**	0.73**	0.77**
SLJ[1]	-0.46**	-0.61**	-0.69**	0.63**	0.61**
Push-Up	-0.50**	-0.52**	-0.71**	0.60**	0.57**
Resistance Pull	-0.61**	-0.64**	-0.53**	0.76**	0.82**
Powerball Throw	-0.55**	-0.62**	-0.52**	0.73**	0.77**
Sit-Up	-0.11	-0.04	-0.29**	0.04	0.03
Arm Ergometer	-0.58**	-0.69**	-0.59**	0.69**	0.66**
Handgrip (sum)	-0.56**	-0.60**	-0.52**	0.71**	0.78**
300m Sprint	0.47**	0.55**	0.66**	-0.55**	-0.53**
Squat Lift	-0.58**	-0.71**	-0.51**	0.81**	0.75**

**p<0.01; *p<0.05
[1]Standing Long Jump

Table 3.10. Regression Results of Full Predictive Models: Unstandardized Coefficients (11B)

	Best 5-Predictor Model		**Best 4-Predictor Model**		**No Calibrated Equipment(5)**		**No Calibrated Equipment (4)**		**Stopwatch and Tape Measure Only**	
Tests Excluded from Model			*Arm Ergometer*		*Arm Ergometer, Handgrip, Upright Pull, Biceps Curl*		*Arm Ergometer, Handgrip, Upright Pull, Biceps Curl*		*Arm Ergometer Handgrip Upright Pull Biceps Curl Medicine Ball Put Powerball Squat Lift*	
	ß	**Std. Error**	**ß**	**Std. Error**			**ß**	**Std. Error**	**ß**	**Std. Error**
Constant	-24.34**	0.977**	-22.94**	0.84**	-18.93**	1.09**	-19.45**	1.09**	-12.23**	1.77**
Med Ball Put	0.01**	0.002**	0.01**	0.002**	0.01*	0.003*	0.01**	0.002**		
Squat Lift	0.04**	0.01**	0.04**	0.01**	0.04**	0.01**	0.04**	0.01**		
Beep Test	0.04**	0.01**	0.05**	0.01**	0.05**	0.01**	0.06**	0.01**	0.04**	0.02**
AE[1]	0.02**	0.01**	0.02**	0.01**						
SLJ[2]	0.02**	0.01**							0.06**	0.01**
Resist. Pull					2.88**	0.85**	2.47**	0.85**		
Push-Ups					0.05**	0.02**			0.14**	0.02**
Sit-Ups									-0.17**	0.04**
R-squared	**0.82**		**0.81**		**0.81**		**0.81**		**0.64**	
Adj. R-squared	**0.81**		**0.81**		**0.81**		**0.80**		**0.63**	
Std. Error of Measurement	**2.05**		**2.084**		**2.07**		**2.10**		**2.87**	

[1]Arm Ergometer
[2]Standing Long Jump

n=190; * p<0.05, ** p<0.01 for covariates.
p<0.01 for all full models.
Covariates not shown did not significantly contribute to any models.

Table 3.11. Regression Results of Predictive Models: Predictive Capabilities (11B)

		All Tests Combined Full Model Adj. R^2	Individual Test r				
			Foot March	Sandbag Carry	Move Under Fire	Casualty Evac	Casualty Drag
Best 5-Predictor Model	Med Ball Put + Squat Lift + Beep Test + AE[1] + SLJ[2]	**0.81**	0.67	0.78	0.74	0.87	0.84
Best 4-Predictor Model	Med Ball Put + Squat Lift + Beep Test + AE[1]	**0.81**	0.67	0.77	0.71	0.86	0.84
No Arm Ergometer Model: 5-Predictor = No Calibrated Equipment Model: 5 Predictor	Med Ball Put + Squat Lift + Beep Test + Resist. Pull + Push-ups	**0.81**	0.67	0.75	0.76	0.86	0.86
No Arm Ergometer Model: 4-Predictor = No Calibrated Equipment Model: 4 Predictor	Med Ball Put + Squat Lift + Beep Test + Resist. Pull	**0.80**	0.67	0.75	0.71	0.87	0.96
Stopwatch & Tape Measure Only Model	SLJ[2] + Sit-ups + Push-ups + Beep Test	**0.63**	0.57	0.67	0.77	0.72	0.69

[1]Arm Ergometer

[2]Standing Long Jump

Table 3.12. Correlations amongst Criterion Tasks and Predictor Tests (11C)

	Foot March	Sandbag Carry	Move Under Fire	Casualty Evacuation	Casualty Drag
Beep Test	-0.46**	-0.48**	-0.58**	0.50**	0.45**
Medicine Ball Put	-0.63**	-0.68**	-0.64**	0.77**	0.82**
Illinois Agility	0.48**	0.560**	0.58**	-0.59**	-0.57**
Upright Pull	-0.58**	-0.66**	-0.62**	0.76**	0.78**
Biceps Curl	-0.60**	-0.67**	-0.59**	0.76**	0.77**
SLJ[1]	-0.50**	-0.61**	-0.64**	0.64**	0.64**
Push-Up	-0.53**	-0.54**	-0.68**	0.61**	0.58**
Resistance Pull	-0.61**	-0.64**	-0.51**	0.75**	0.83**
Powerball Throw	-0.31**	-0.626**	-0.49**	0.74**	0.80**
Sit-Up	-0.02	0.06	-0.21**	-0.02	-0.02
Arm Ergometer	-0.61**	-0.66**	-0.61**	0.67**	0.69**
Handgrip (sum)	-0.63**	-0.65**	-0.56**	0.73**	0.77**
300m Sprint	0.51**	0.55**	0.60**	-0.58**	-0.58**
Squat Lift	-0.57**	-0.68**	-0.48**	0.78**	0.74**

**p<0.01; *p<0.05
[1]Standing Long Jump

Table 3.13. Regression Results of Full Predictive Models: Unstandardized Coefficients (11C)

Tasks Excluded from Model	**Best 5-Model**		**Best 4-Model**		**No Calibrated Equipment (5)** *Arm Ergometer, Handgrip, Upright Pull, Biceps Curl*		**No Calibrated Equipment (4)** *Arm Ergometer, Handgrip, Upright Pull, Biceps Curl*		**Stopwatch and Tape Measure Only (4)** *Arm Ergometer, Handgrip, Upright Pull, Biceps Curl, Medicine Ball Put, Powerball Throw, Squat Lift*	
	ß	**Std. Error**	**ß**	**Std. Error**	**ß**	**Std. Error**	**ß**	**Std. Error**	**ß**	**Std. Error**
Constant	-24.98**	1.049**	-25.57**	1.015**	-10.30**	0.118**	-10.73**	2.886**	-0.90	4.844
Med Ball Put	0.01**	0.003**	0.01**	0.003**	0.12**	0.00**	0.02**	0.002**		
Squat Lift	0.04**	0.006**	0.04**	0.006**	0.04**	0.01**	0.04**	0.01**		
Push-Ups	0.03*	0.017*			0.06*	0.02**	0.05**	0.02**	0.13**	0.02**
AE[1]	0.02**	0.005**	0.03**	0.005**						
SLJ[2]	0.02**	0.008**	0.03**	0.008**					0.05**	0.01***
Illinois Agility					-21.54**	6.48**	-25.02**	6.41**	-33.89**	9.40**
Resistance Pull					1.87*	0.77*				
Sit-Ups									-0.09*	0.03*
R-squared	**0.82**		**0.81**		**0.81**		**0.80**		**0.66**	
Adj. R-squared	**0.81**		**0.81**		**0.81**		**0.80**		**0.65**	
Std. Error of Measurement	**2.05**		**2.07**		**2.09**		**2.12**		**2.79**	

[1]Arm Ergometer
[2]Standing Long Jump

n=182; * p<0.05, ** p<0.01 for covariates.
p<0.01 for all full models.
Covariates not shown did not significantly contribute to any models.

Table 3.14. Regression Results of Predictive Models: Predictive Capabilities (11C)

		All Tests Combined	Individual Test r				
		Full Model Adj. R^2	Foot March	Sandbag Carry	Move Under Fire	Casualty Evac	Casualty Drag
Best 5-Predictor Model	Med Ball Put + Squat Lift + AE[1] + SLJ[2] + Push-ups	**0.81**	0.68	0.77	0.74	0.85	0.85
Best 4-Predictor Model	Med Ball Put + Squat Lift + AE[1] + SLJ[2]	**0.81**	0.68	0.77	0.71	0.85	0.85
No Arm Ergometer Model: 5-Predictor = No Calibrated Equipment Model: 5 Predictor	Med Ball Put + Squat Lift + Illinois Agility + Push-ups + Resist. Pull	**0.81**	0.67	0.76	0.74	0.85	0.87
No Arm Ergometer Model: 4-Predictor = No Calibrated Equipment Model: 4 Predictor	Med Ball Put + Squat Lift + Illinois Agility + Push-ups	**0.80**	0.67	0.76	0.74	0.85	0.95
Stopwatch & Tape Measure Only Model	SLJ[1] + Push-ups + Illinois Agility + Sit-ups	**0.65**	0.59	0.70	0.75	0.72	0.70

[1]Arm Ergometer
[2]Standing Long Jump

Table 3.15. Physical Domains of Current and Proposed Military Employment Testing Batteries

		Strength	Power	Muscular Endurance	Aerobic Capacity	Agility
Existing Test Batteries	**Australia** (3)	Box Lift and Place		Jerry Can Carry Weight Load Carry	Weight Load Carry	Fire and Movement
	Canada (6, 9)		Sandbag Drag	Sandbag Lift Intermittent Loaded Sandbags	Sandbag Lift Intermittent Loaded Sandbags	20m Rushes
	United Kingdom (5, 28, 29)	Static Lift		Jerry Can Carry 2-Minute Push-Up 2-Minute Sit-Up	1.5-Mile Run	
Proposed 11B Test Batteries	**Best 5-Model**	Squat Lift	Med Ball Put SLJ[1]	2-Minute AE[2]	Beep Test	
	Best 4-Model	Squat Lift	Med Ball Put	2-Minute AE[2]	Beep Test	
	Sporting Goods, No Ergometer (5)	Squat Lift	Med Ball Put Resistance Pull	1-Minute Push-Up	Beep Test	
	Sporting Goods, No Ergometer (4)	Squat Lift	Med Ball Put Resistance Pull		Beep Test	
	Stopwatch & Tape Measure (5)		Med Ball Put SLJ[1]	1-Minute Push-Up 1-Minute Sit-Up		
Proposed 11C Test Batteries	**Best 5-Model**	Squat Lift	Med Ball Put SLJ[1]	2-Minute AE[2] 1-Minute Push-Up		
	Best 4-Model		Med Ball Put SLJ[1]	2-Minute AE[2] 1-Minute Push-Up		
	Sporting Goods, No Ergometer (5)	Squat Lift	Med Ball Put Resistance Pull	1-Minute Push-Up		Illinois Agility
	Sporting Goods, No Ergometer (4)	Squat Lift	Med Ball Put	1-Minute Push-Up		Illinois Agility
	Stopwatch & Tape Measure (4)		SLJ[1]	1-Minute Push-Up 1-Minute Sit-Up		Illinois Agility

[1]Standing Long Jump
[2]Arm Ergometer

Figure 3.1. Schematic of the Illinois Agility Test

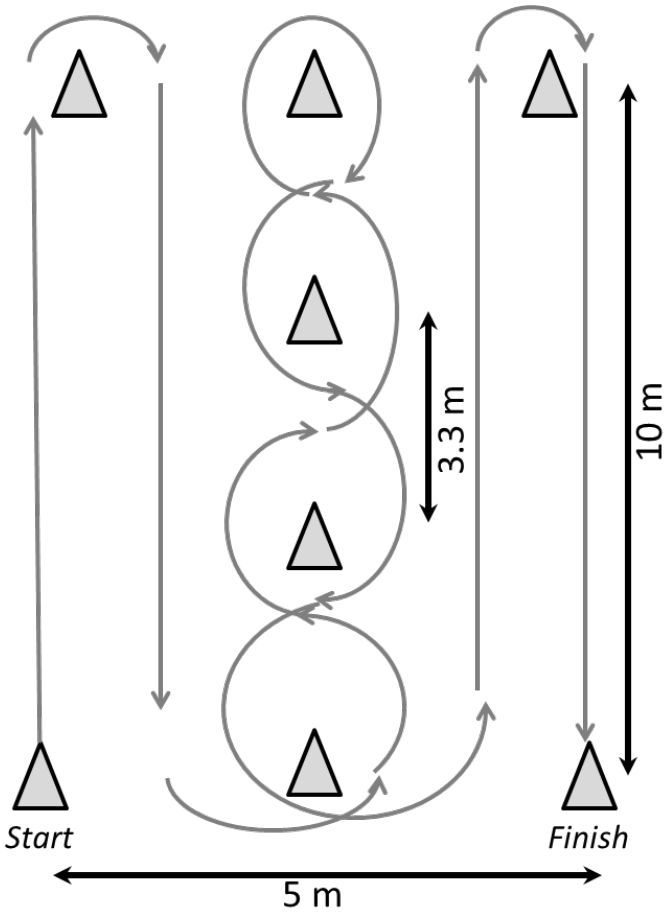


Figure 3.2. Image of Arm Ergometer Test

CONCLUSIONS

This set of three studies used best practices set out by Payne and Harvey to develop a physical testing battery for Armor. Study 1 identified the most physical demanding tasks. Of the physically demanding tasks listed by SMEs for each MOS, five tasks were identified as capturing the physical demands for the 11B and 11C Soldiers. The foot march captured load carriage; BFV casualty evacuation captured heavy lifting; sandbag carry captured repeated lifting and carrying, and the casualty drag captured heavy drags, and the move under fire captured quick movement/agility. Following approval of the task selection by SMEs, task simulations were developed and reliability of the tasks was determined in Study 2. Finally, five models, using different sets of predictor tests, were developed for each MOS in Study 3.

The 5 models for 11B were (from best to worst predictive ability):

- medicine ball put, squat lift, beep test, arm ergometer, and standing long jump
- medicine ball put, squat lift, beep test, and arm ergometer
- medicine ball put, squat lift, beep test, resistance pull, and 1-minute push-ups
- medicine ball put, squat lift, beep test, and resistance pull
- standing long jump, 1-minute push-ups, 1-minute sit-ups, beep test

The 5 models for 11C were (from best to worst predictive ability):

- medicine ball put, squat lift, arm ergometer, standing long jump, and 1-minute push-ups
- medicine ball put, squat lift, arm ergometer, and standing long jump
- medicine ball put, squat lift, Illinois agility test, 1-minute push-ups, and resistance pull
- medicine ball put, squat lift, Illinois agility test, and 1-minute push-ups
- standing long jump, 1-minute push-ups, Illinois agility test, and 1-minute sit-ups

The models presented herein are developed specifically using information from the Armor studies. Additional studies were conducted using Soldiers from the Combat Engineers (12B), Field Artillery (13B, 13F), and Armor (19D, 19K). When these studies are compiled, one overarching test battery of five to seven tests to cover all seven MOSs will need to be developed in order to complete the tasking from TRADOC. While this final model may not be optimized for any one MOS, it will provide a testing battery able to identify candidates for each of the seven MOS.

RECOMMENDATIONS

- The Infantry MOSs contain a number of physically demanding tasks. Given these high demands, a pre-enlistment test battery would be beneficial in preventing injuries and misclassifications.
- The Army should institute either one of the predictive test batteries presented herein, or wait until the completion of this study to institute a test battery common to all Combat Arms MOSs.
- Once a test battery is instituted, it will be necessary to perform short-term follow-up assessments to ensure the success of the models in preventing injuries and reclassifications of new Army recruits. Acceptable passing scores may need to be adjusted in order to optimize the model to prevent these negative outcomes.
- Periodic review of the physically demanding tasks of Infantry MOSs should be considered. If a new task is identified with greater physiological demands, or one of the currently identified criterion tasks is deemed no longer representative of the physical demands, redevelopment of the models should be considered.

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APPENDIX A. LIST OF PARTICIPANTS ON REVIEW PANEL FOR DEVELOPING TASK STANDARDS FOR INFANTRY SOLDIERS

Infantry School SMEs

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MAJ Jimmy Ross
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CSM James Hardy
SGM James Pearson
MSG Heath Pottiger
SFC Brian Waldo
SFC Christopher Ryffe
MSG(R) Gary Fox
MSG(R) Michael Chambers
SFC (R) Michael Ramirez

Branch Review Panel

MG Michael Linnington, CG, MDW
BG Wayne Grigsby, DCG-O, 1st Armored Division
BG Martin Schweitzer, DCG-O, 82nd Airborne Division
BG Gary Volesky, Chief, US Army PAO
COL Douglas Cardinale, Commander, 2nd ABCT, 3rd ID
COL Omar Jones, Commander, 2nd ABCT, 4th ID
COL Gregory Sierra, Command Selectee, 3rd ABCT, 4th ID
COL Scott Jackson, Command Selectee, 2nd ABCT, 3rd ID
COL Hugh Bair, Commander, 3rd SBCT, 2nd ID
COL Timothy Watson, Commander, 4th IBCT(A), 82nd Abn Div
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CSM Andrew Spano, 2nd Infantry Division
CSM Cedric Burns, 2nd Battalion, 7th Infantry Regiment

APPENDIX B. UNIFORM LOAD VARIANT

Soldier Load

Uniform 12.4 lbs

Boots	5.00
ACU	3.20
Multi tool	0.50
Rigger Belt	0.50
Patches	0.49
Patrol Cap	0.48
ID Tags	0.38
Undershirt	0.35
Gloves	0.25

12.4 lbs

Eye Pro	0.25
Notebook	0.25
Drawers	0.20
Socks	0.20
Wrist Watch	0.19
Ear Plugs	0.13
Chapstick	0.01
ID Card	0.01

Personal Protective Equipment and Weapon (PPE) 63.03 to 77.60 lbs*

100 oz Hydration system (With Water)	7.10
Fighting Load Carrier	1.25
30 round magazine pouch (3 x 0.25)	0.75
Hand grenade pouch (2) with (2) M67 Fragmentation Grenades	1.86
Lensatic Compass w/case	0.27
Individual First Aid Kit (IIFAK)	1.08
Mag light flashlight w/2 ea AA battery	0.24
Infrared signal beacon, PHOENIX w/Battery	0.70
Ballistic Knee/Elbow Pads	0.79
Visual/Language Translator Card	0.01
Casualty Feeder Report/ Witness Statement	0.01
Advanced Combat Helmet (ACH)	3.25
Helmet Cover w/camouflage cover band	0.28
Night Vision goggle mounting plate	0.20
Ballistic Protection Goggles (ESS)	0.15
M4 Carbine w/fully loaded magazine	7.50

M68- CCO w/ battery	0.71
3 point sling	0.30
Back-Up Iron Sight	0.32
M-4 RAS & Fwd Pistol Grip	1.55
5.56mm Magazine with 30 rounds each (6 ea)	6.42
Sure Fire light w/ battery	0.50
PAQ-4C w/batteries	0.90
	36.14

IOTV w/ neck/groin protector	11.69-19.63*
Enhanced Small Arms Protective Inserts	7.60-14.20*
Enhanced Side Ballistic Insert set with Side Plate Carrier	7.60
	63.03 to 77.57 lbs

Uniform 12.4 lbs + PPE 63.03 to 77.57 lbs*
= Fighting Load 75.43 to 89.97 lbs*

V1, 5 Sep 2013

* see slide 4, Weights for IOTV Gen II

Soldier Load - <24 hour Sustainment Load

Sustainment Load Carried in Assault Pack

Assault Pack w/ waist pack	4.2
2QT Canteen w/Cover and Sling w/water	4.15
Liner Poncho	1.14
Poncho	1.05
Improved Rain suit Top	1.7
Improved Rain suit Bottom	1.7
Neck Gaiter	1
Meal Ready To Eat 1 ea (1.50/0.68 kg)	1.5
Undershirt moisture wicking x 1 ea	0.35
Socks x 1 pr	0.2
Improved Cleaning Kit	1.6
Flexi Cuffs (4 large per soldier)	0.04
Chemlight (2per)	0.04
Water purification tablets	0.02
Camo Face Paint	0.02
VS17 Panel (small)	0.3
	19.0 lbs

Uniform	12.4
PPE	63.03 to 77.57 *
+ <24 Hr Sustainment Load	19.0
Approach March Load	94.43 to 108.97 lbs*

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* see slide 4, Weights for IOTV Gen II

APPENDIX C. TASK DESCRIPTION SLIDES PROVIDED BY TRADOC

Task 1: Conduct Tactical Movement
11B, 11C, 19D, 19K, 13F, 12B

Task: Conduct a 12 Mile (20KM) Tactical Movement

Condition: Wearing / Carrying 94 – 109 lbs Evenly Distributed Across the Entire Body

Standard: Complete in not less than 8.5 or more than 24 hours; the movement will be conducted in two 6 mile (9.7KM) segments with mandatory hourly halts and a mandatory 30 minute rest at the halfway point

Conduct Tactical Movement
Carry a fighting and sustainment load and remain able to fight at conclusion of march of 12 miles per day.

Weight: 94-109 lbs Horizontal Distance: 24 km Vertical Distance: Terrain Dependant Time: 24 hours	Weight: 94-109 lbs is combined weight of Basic Soldier Uniform (12 lbs), PPE (63.03 to 77.57 lbs), and <24 hour sustainment load (19 lbs) Horizontal Distance: Army Standard for Tactical Movement is 3-4 km per hour. 12 miles per day is representative of 2 Combat Patrols (6 miles out and 6 miles back (9.7.M out/9.7km back)) from Combat Outposts and Joint Security Sites Time: 8.5 -24 hours

-This is an individual event.
--Soldiers will be encouraged to maintain a pace of 1.5 MPH (2.4kph) which will allow them to complete each leg in 4 hours.
- Soldiers will have mandatory rest halts at designated check points.

V1, 5 Sep 2013

Task 2: Employ Hand Grenades
11B, 11C, 19D, 19K, 13B, 13F, 12B

Task: Employ Hand Grenades

Condition: Wearing / Carrying 63.65 to 78.19** lbs Fighting Load(no weapon) and given two M69 Practice Hand Grenades

Standard: Throw at least one Hand Grenade 30 meters

Employ Hand Grenades
Throw hand grenade to engage enemy forces

Weight: 1 lb Horizontal Distance: 30 m Vertical Distance: N/A Time: N/A	Weight: M67 Fragmentation Grenade or M69 Practice Hand Grenade Horizontal Distance: Doctrinally, the Army considers 30 m to be hand grenade range, 30 m engages a 35 m target

*Weight range based on difference for sizes XS-4XL of uniform items & body armor
** 63.65 to 78.19 lbs is fighting load minus 11.78 lbs for M4 & items attached to the M4

V1, 5 Sep 2013

Task 3: Prepare a Fighting Position (Fill and Emplace Sandbags)
11B, 11C, 19D, 19K, 13B, 13F, 12B

Task: Fill Sandbags

Condition: Wearing / Carrying 63.65 to 78.19** lbs Fighting Load(-) (no weapon) and given entrenching tool, 26 empty sandbags, sufficient fill

Standard: 26 sandbags filled 55-60% full in 52 minutes

Fill Sandbags **Dig, lift, and shovel 11 lbs scoops of dirt in bent, stooped or kneeling position into sandbags.**	
Weight: 11 lbs Horizontal Distance: N/A Vertical Distance: 0.75 m Time: 52 minutes	Weight: 11 lbs is combined weight of e-tool and average weight of various soil compositions Vertical Distance: 0.75 meters is height of a sandbag, 3-5 scoops of dirt fill one sandbag One hasty fighting position (without overhead cover) uses 26 sand bags Time: 2 minute average to fill a sandbag

Task: Carry / Emplace Sandbags
Condition: Wearing / Carrying 64–80* lb Fighting Load(-) (no weapon) and given 26 sandbags (55-60% full)
Standard: Hasty fighting position (without overhead cover) built in 26 minutes 10 meters from the original position of the sandbags

Carry/Emplace Sandbags **Lift 30-40 lb sandbags waist to shoulder high, carry them 10 m and emplace**	
Weight: 30-40 lbs Horizontal Distance: 10 m Vertical Distance: 1 m to 1.5 m Time: 26 minutes	Weight: Based on soil composition and bags filled 55-60%, a sandbag weighs 30-40 lbs Horizontal Distance: 10 meters is farthest distance carried from fill point without a vehicle Vertical Distance: Waist to shoulder height Time: 1 minute to carry/emplace a sandbag

*Weight range based on difference for sizes XS-4XL of uniform items & body armor
** 63.65 to 78.19 lbs is fighting load minus 11.78 lbs for M4 & items attached to the M4

V1, 5 Sep 2013

Task 4a: Drag a Casualty to Immediate Safety (Dismounted)
11B, 11C, 19D, 19K, 13B, 13F, 12B

Task: Individually Drag a Casualty to Immediate Safety

Condition: Wearing / Carrying 75.43 to 89.97 lbs* Fighting Load and given a casualty (~188 lbs) with an 83 lbs Fighting Load for a total weight of ~271 lbs

Standard: Casualty dragged 15 meters.

Evaluator's Note: See Next Slide

Soldier on the Ground **Individually lift, drag, and carry a casualty to a safe location; casualty is in harm's way**	
Weight: ~271 lbs Horizontal Distance: 15 m Vertical Distance: 0.5-2 m Time: As quickly as possible	Weight: ~188 lbs incapacitated Soldier with an 83 lb Fighting Load Horizontal Distance: 15m is approximately half the distance a Soldier could move during a 3-5 second rush Vertical Distance: 0.5 - 2 m is height Soldier would carry or drag casualty.

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Task 4b: Remove a Casualty from a Vehicle* (Mounted)
11B, 19D, 13F, 12B

Task: Remove a Casualty from a Vehicle*; Three Soldier Task

Condition: See Next Slide

Standard: Casualty removed from Vehicle*

*** 11B, 19D, 13F:** BFV, Stryker
*** 12B:** BFV or Buffalo (Type of Unit Dependant)

Lift from the Inside of a Vehicle **Three Soldiers perform this task from a BFV, Stryker, or Buffalo**	
Weight: ~207 lbs (prorated ~103.5 ls) Horizontal Distance: 1-2 m Vertical Distance: 1.5 m Time: 2 Minutes	Weight: ~188 lbs incapacitated Soldier with 19 lbs of Vehicle Crewman Uniform and equipment Horizontal Distance: 1.5 m is the height from the commander's seat to the top of the turret Vertical Distance: To clear vehicle

Three Soldiers perform this task; two on the vehicle and one inside. The two Soldiers on the vehicle lift the vast majority of the casualty's weight. The Soldier in the vehicle primarily guides the casualty.

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Task 5: Maintain 25mm Gun on a BFV – Install the Barrel
11B, 19D, 13F, 12B

Task: Install an M242 25mm Barrel on the M242 Gun on a BFV; Two Soldier Task

Condition: Wearing / Carrying 75.43 to 89.97 lbs* Fighting Load and given a BFV with an M242 Gun and an M242 25mm Barrel

Standard: Barrel is carried 25 meters and lifted onto BFV hull

Armor Standard: Barrel is carried 3 meters and lifted onto BFV hull

Lift an M242 25mm Barrel onto the Deck of a BFV	
- Removal of M242, 25mm barrel - Required during maintenance and during remedial action misfire procedures	

Lift 107 Pounds 1 Meter and Carry 3 Meters or 25 Meters as Part of a 2 Soldier Team	
Weight: 107 lbs (prorated 53.5 lbs) Horizontal Distance: 3 m or 25 m Vertical Distance: 1 m Time: n/a	Weight: Barrel weighs 107 lbs Horizontal Distance: Barrel to BFV Vertical Distance: BFV hull

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*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 6: Maintain 25mm Gun on BFV – Remove Feeder Assembly
11B, 19D, 13F, 12B

Task: Remove the M242 Feeder Assembly from the M242 Gun on a BFV

Condition: Wearing / Carrying 30-44* lbs (IOTVC with ESAPI and ESBI, CVC/ACH Helmet) and given a BFV with an M242 Gun and an M242 Feeder Assembly

Standard: Feeder assembly properly removed

Remove the M242 Feeder Assembly

- Required during maintenance and during remedial action misfire procedure

Lift 59 Pounds 6 Inches and Carry 1 Meter While Seated	
Weight: 59 lbs Horizontal Distance: 1 m Vertical distance: 6 in Time: N/A	Weight: M242 Feeder Assembly weighs 59 lbs

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 7: Load 25mm HEI-T Ammunition Can on BFV
11B, 19D, 13F, 12B

Task: Load 30 25mm High-Explosive Incendiary Tracer (H-EIT) Ammo Cans onto a BFV

Condition: Wearing / Carrying 63.65 to 78.19** lbs Fighting Load(-) (no weapon) and given a BFV and 30 Ammo Cans with 45 Rounds of H-EIT per can

Standard: 30 Ammunition Cans carried 15 meters and loaded onto BFV 75.43 to 89.97 lbs*

Lift 45 Pounds Waist High and Carry 5 or 15 Meters	
Weight: 45 lbs Horizontal Distance: 15 m Vertical distance: 1 m Time: N/A	Weight: One 25mm ammunition can weighs 45 lbs (contains 45 rounds) Basic Load (25mm) for a BFV is 900 rounds (30 ammunition cans) Horizontal Distance: 15 m is an estimated safe distance between the back of the BFV and the ammunition supply point or ammunition carrier Vertical Distance: 1 m is waist high

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor
** 63.65 to 78.19 lbs is fighting load minus 11.78 lbs for M4 & items attached to the M4

Task 8: Load the TOW Missile Launcher on BFV
11B, 19D

Task: Load TOW-2B Aero (BGM-71F6) Missile into a BFV Mounted TOW Weapon System

Condition: Wearing / Carrying 64–80* lb Fighting Load(-) (no weapon) and given a BFV with a TOW Missile Launcher and 2 TOW-2B Aero (BGM-71F6) Missiles

Standard: 2 Missiles properly loaded

Lift 65 Pounds 1 Meter and Carry 2 Meters	
Weight: 65 lbs Horizontal Distance: 2 m Vertical Distance: 1 m Time: N/A	Weight: TOW-2B Missile weighs 65 lbs Vertical Distance: Rear of launcher lowers to ~1 m from floor of crew compartment

*Weight range based on difference for sizes XS-4XL of uniform items & body armor
** 63.65 to 78.19 lbs is fighting load minus 11.78 lbs for M4 items attached to the M4

V1, 5 Sep 2013

Task 9: Move Over, Through, or Around Obstacles
11B, 11C

Task: Move Over, Through, or Around Obstacles; Scale / Climb 2 Meter Vertical Obstacle with Assistance

Condition: Wearing / Carrying 75.43 to 89.97 lbs* fighting load. If necessary, equipment may be removed, but must be worn / carried after obstacle is cleared

Standard: Obstacle successfully negotiated, with assistance from other squad members (if needed). Last Soldier must be pulled up, not pushed over (if needed) for realism.

Scale and Climb a 2 Meter Vertical Obstacle With Assistance	
Weight: 75.43 to 89.97* lbs Horizontal Distance: Varies Vertical Distance: 2 m Time: n/a	Weight: Fighting Load weighs 75.43-89.97* lbs Vertical Distance: Typical natural or manmade obstacle

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 10: Move Under Direct Fire
11B, 11C

Task: Move Under Direct Fire (Rise from a Prone, Kneeling, or Crouched Position; Sprint 3 to 5 Seconds; Return to a Prone, Kneeling, or Crouched Position)

Condition: Wearing / Carrying 75.43 to 89.97 lbs* Fighting Load
75.43 to 89.97
Standard: Sprint 100 meters (in 3 to 5 second increments)

Rise from a Prone, Kneeling, or Crouched Position; Sprint for 3 to 5 Seconds with 75.43 to 89.97 lbs* Fighting Load; Then Return to a Prone, Kneeling, or Crouched Position

Weight: 75.43 to 89.97* lbs Horizontal Distance: 100 m Vertical Distance: n/a Time: n/a	Weight: Fighting Load weighs 75.43 to 89.97* lbs Horizontal Distance: Move out of targeting range

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 16: Fire a 120mm Mortar
11C

Task: Fire a Mortar (Lift Round, Hold for up to 10 Seconds, Place in Tube)

Condition: Wearing / Carrying 46* lbs (Uniform Below) and given a 120mm Mortar and 5 120mm HE rounds

Standard: All rounds fired in 1 minute 15 seconds

Uniform

Body Armor w/ Neck/Groin Protector (Size Large)
Enhanced Small Arms Protective Inserts (Size Large)
Enhanced Side Ballistic Insert Set w/ Side Place Carrier
100 oz Hydration System (w/ Water)
Advanced Combat Helmet (ACH) w/ Night Vision Goggle Mounting Plate, and Helmet Cover w/ Band
Ballistic Protection Goggles (ESS)
Ballistic Knee and Elbow Pads
Visual/Language Translator Card
Casualty Feeder Report/Witness Statement

Lift 29 Pound Round 2 Meters, Hold for up to 10 Seconds, Place it in the End of the Gun Tube

Weight: 29 lbs Horizontal Distance: n/a Vertical Distance: 2 m Time: 15 Seconds per round; 75 seconds total	Weight: Heaviest round (120mm HE) is 29 lbs Vertical Distance: 2 m is the height at maximum elevation - Ability to hold round for up to 10 seconds is required to conduct "time on target" and "coordinated illumination" missions. Only applies to the first round.

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 11: Prepare a Dismounted TOW Firing Position
11B

Task: Load a TOW-2B Aero (BGM-71F6) Missile into a Ground Mounted TOW Weapon System

Condition: Wearing / Carrying 64–80* lbs (no weapon) and given TOW Missile Launcher and 1 TOW 2B Missiles in the stowage rack of a HMMWV located 15 meters from dismounted TOW launcher.

Standard: 1 TOW-2B (BGM-71F6) Missiles properly loaded into TOW Tube

Lift 65 Pound Round 1 Meter, Carry 15 Meters, and Place in Tube	
Weight: 65 lbs Horizontal Distance: 15 m Vertical Distance: 1 m Time: N/A	Weight: TOW 2B Missile weighs 65 lbs Replicate loading one Missile in dismounted launcher. Horizontal Distance: 15 m is safe distance between the firing position and the ammunition supply point or ammunition carrier Vertical Distance: Tube height

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 12: Engage Targets with a Caliber .50 M2 Machine Gun
11B

Task: Lift and Carry M2 HB Machine Gun; 2 Soldier Task

Condition: Wearing / Carrying 75.43 to 89.97 * lbs uniform, weapon, and PPE and given M2 HB Machine Gun with Tripod

Standard: M2 HB Machine Gun with Tripod is successfully lifted and moved from a primary position to an alternate position 10 meters away

Lift 153 Pound .50 Cal M2 Machine Gun 1 Meter and Carry 10 Meters as Part of a 2 Soldier Team	
Weight: 153 lbs (76.5 lbs pro-rated) Horizontal Distance: 10 m Vertical Distance: 1.5 m Time: n/a	Weight: M2 HB Machine Gun and tripod weigh 153 pounds (prorated 76.5lbs) Horizontal Distance: 10 m is distance to reposition gun between primary and alternate sector of fire in defense Vertical Distance: Shoulder height

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 13: Lay a 120mm Mortar – Emplace Base Plate
11C

Task: Lay a 120mm Mortar – Emplace Base Plate; 2 Soldier Task

Condition: Wearing / Carrying 75.43 to 89.97 * lb Fighting Load and given a 120mm Mortar Base Plate located 25 meters from emplacement site

Standard: Base Plate properly emplaced

Emplace Base Plate

- Base Plate is transported mounted to the side of the M1064A3 or on a specially designed trailer
- Base plate is dismounted and moved from the vehicle/trailer to the firing position
-Base plate is returned to storage positions when squad is ordered to displace from current firing position

Carry 136 Pounds, 25 Meters as Part of a 2 Soldier Team	
Weight: 136 lbs (prorated 68 lbs) Horizontal Distance: 25 m Vertical Distance: 1 m Time: Rapidly	Weight: 120mm mortar base plate weighs 136 lbs (prorated 68 lbs) Horizontal Distance: 25 meters is the minimum safe distance that the mortar would be emplaced from its carrier Vertical Distance: 1 m is waist height

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 14: Lay a 120mm Mortar – Emplace Cannon
11C

Task: Lay a 120mm Mortar – Emplace Cannon; 2 Soldier Task

Condition: Wearing / Carrying 75.43 to 89.97 * lb Fighting Load and given a 120mm Mortar Cannon located 25 meters from an emplaced 120mm Mortar Base Plate

Standard: Cannon properly emplaced

Emplace Cannon

- Cannon is lifted from vehicle or the ground and inserted into base plate by squad member
- Cannon is raised and rotated to attached bi-pod assembly
- Required every time mortar is placed into action at new firing position

Lift 110 Pounds 1.5 Meters and Carry 25 Meters as Part of a 2 Soldier Team	
Weight: 110 lbs (prorated 55 lbs) Horizontal Distance: 25 m Vertical Distance: 1.5 m Time: Rapidly	Weight: Cannon tube weighs 110 lbs Horizontal Distance: 25 meters is the minimum safe distance that the mortar would be emplaced from its carrier Vertical Distance: 1.5 meters raises cannon from surface to allow for attachment of bipod assembly

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

APPENDIX D. PRE-TESTING TRAINING SCHEDULE FOR POTENTIAL STUDY 1 PARTICIPANTS

	06-07FEB, 10 FEB	11-12FEB, 21 FEB	24-26 FEB	28 FEB, 03-04 MAR	05-07 MAR
	Week 1	**Week 2**	**Week 3**	**Week 4**	**Task Review**
11B	Introduction to Infantry Tasks (Welcome and Task Overview)	Gain proficiency of Infantry Tasks (Leadership Reaction Course)	Mastery of assigned Infantry Tasks (8 Mile Ruck)	Culminating Exercise/Validation Infantry Tasks (Obstacle Course)	Infantry Test Preparation and Review (Squad Competition and CCTT)
11C	Introduction to Infantry Tasks (Welcome and Task Overview)	Gain proficiency of Mortar Tasks (Leadership Reaction Course)	Mastery of assigned Mortar Tasks (8 Mile Ruck)	Culminating Exercise/Validation Mortar Tasks (Obstacle Course)	Mortar Test Preparation and Review (Squad Competition)

From 1-30 IN BN

APPENDIX E. MINUTES OF THE INFANTRY SUBJECT MATTER EXPERT BRIEFING FOR APPROVAL OF CRITERION TASKS

11B and 11C SME VTC
10/14/2014

Soldiers present
TRADOC G3/5/7
MAJ Richard Jones and Mr. Jack Myers

Office of the Chief of Armor (OCOA):
SGM Gregory Proft, SFC Jason Hansford, Mr. George DeSario

USARIEM Personnel:
Mrs. Marilyn Sharp, MAJ Bradley Warr, Dr. Jan Redmond, Dr. Stephen Foulis, and Mrs. Leila Walker

MAJ Jones stated the purpose of the meeting was to brief OCOI SMEs on the Infantry task simulations and obtain the approval of the Infantry Commandant. This was done in an effort to provide understanding, allow for additional input from the SMEs, and obtain support and approval from the SMEs. This information would ultimately be communicated to the Infantry Commandant, as a request for a Memorandum for Record declaring support from the Infantry Branch, in order for USARIEM to continue the planned research.

The final outcome of the Physical Demands Study will be to provide a battery of physical predictor tests to identify recruits who have the physical potential to succeed as Infantry Soldiers (11B/11C). The progress to date included the identification of the critical tasks and standards for these MOSs (OCOI in coordination with TRADOC), the verification of the tasks and standards (TRADOC), the conduct of Focus groups, and the measurement of the physiological demands of the tasks identified (USARIEM).

The following tasks were identified for the 11B MOS: Conduct a Tactical Movement; Employ a Hand Grenade; Prepare a Fighting Position (Fill and Emplace Sandbags); Drag a Casualty to Immediate Safety (Dismounted); Remove a Casualty from a Vehicle (Mounted); Lift, Carry, and Install the Barrel of a 25mm gun on the Bradley Fighting Vehicle (BFV); Remove the Feeder Assembly of a 25mm gun on the BFV; Load 25mm H-EIT Tracer Ammunition Cans onto the BFV; Load TOW Missile Launcher on BFV; Move Over, Through or Around Obstacles; Move Under Direct Fire; Prepare Dismounted TOW Firing Position; and Lift and Carry M2 .50 Caliber Machine Gun.

The following tasks were identified for the 11C MOS: Conduct a Tactical Movement; Employ a Hand Grenade; Prepare a Fighting Position (Fill and Emplace Sandbags); Drag a Casualty to Immediate Safety (Dismounted); Remove a Casualty from a Vehicle

(Mounted); Move Over, Through or Around Obstacles; Move Under direct Fire; Lift and Emplace Base Plate for a 120mm Mortar; Lift and Emplace Cannon for a 120mm Mortar; Lay a 120mm Mortar for Deflection and Elevation; and Fire a Mortar (Lift and Hold Round, Place in Tube).

It should be noted that USARIEM determined the hand grenade (11B/11C) was primarily skill based, rather than physically demanding, so this task was not considered in our analysis. Similarly, adjusting the deflection and elevation of a mortar was not nearly as difficult other lifting tasks, so it was not considered.

USARIEM measured the physical effort of Soldiers performing the tasks (11B: 24 males and 15 females, 11C: 19 males and 13 females). Measurements included timing, pacing, ratings of perceived effort, heart rate and physiological energy cost.

USARIEM initiated the task simulation process, but needed the input from SMEs to ensure the task simulations are representative of the real tasks, to ensure the most important tasks were represented and to set an entry level of performance on each of the simulations (i.e. time to completion, speed of movement, etc.).

There were a number of important considerations in the development of the task simulations:

a. Test individual physical capabilities
b. Allow for a range of scores to show differences between people- cannot be go/no-go.
c. Measure unique physical capabilities.
d. Tests must not endanger Soldiers.
e. Require minimal, readily available equipment.
f. Be reliable (same person gets same score on different days).
g. Require minimal skill and practice.
h. Be time efficient.

The tasks for each MOS were grouped into categories. OCOA representatives concurred with the categories. They also concurred that the Casualty Drag and Tactical Road March were important, unique capabilities that should be simulated and tested.

The 11B categories and tasks were:

a. Heavy Lifting: Evacuate a casualty from a Bradley Fighting Vehicle (BFV), install the barrel of a 25 mm gun on a BFV, remove the feeder assembly on the BFV, Load a TOW Missile into the launcher on a BFV, move over through or around obstacles, prepare dismounted TOW firing position, Lift and carry M2 .50 cal machine gun.
b. Repetitive Lifting and Carrying: Carry sandbags to prepare a fighting position, load 25mm ammunition.
c. Drag: Drag a casualty to immediate safety.
d. Load Carriage: Conduct a tactical movement.

e. Agility: Move under direct fire.

The 11C categories and tasks were:

a. Heavy Lifting: Move over through or around obstacles, lift and carry a 120 mm mortar base plate, lift and carry a 120 mm mortar cannon, and fire a mortar. The SMEs determine that evacuate a casualty from a Bradley Fighting Vehicle (BFV) should be added to the 11C task list.
b. Repetitive Lifting and Carrying: Carry sandbags to prepare a fighting position. SMEs suggested adding a mortar reload task to the lift and carry tasks for the 11Cs. They agreed to develop testable standards for this task to include the load lifted, the number of mortar 'tootsie rolls' typically carried, the distance typically carried, the time allowed for the reload and the number of mortar rounds total that one Soldier would be required to carry in one reload. This addition will need to be compared to the sandbag carry to determine which task is more physically demanding and the relationship between the two tasks. In addition, if this task is selected as one of the task simulations, additional reliability testing will be needed. USARIEM followed up with the OCOI regarding this task and determined that the load was significantly less than two sandbags. A performance standard (i.e. distance carried, number of repetitions, time limits) was not provided.
c. Drag: Drag a casualty to immediate safety.
d. Load Carriage: Conduct a tactical movement.
e. Agility: Move under direct fire.

For task categories with more than one task, the next step was to select the task that is the most physically demanding and/or the most mission critical. This is the task to be simulated. Based on the performance data collected, as well as practical considerations, USARIEM recommended tasks from each category.

The 11B tasks selected for simulation were:

a. Evacuate a casualty from a BFV. The weight of the casualty described in the task is as heavy or heavier than other items evaluated in this category. Additionally, evacuating a casualty is common to other MOSs, it can be tested individually, requires minimum skill, and is critical to the safety and success of the mission.
b. Carry sandbags to prepare a fighting position. The described task utilizes a 40-lb sandbag (a weight similar to 25mm ammunition cans). Preparing a fighting position is also common to many MOSs, the equipment is readily available, and is physically demanding (high heart rate and energy cost). Additionally, a unique characteristic of carrying sandbags is the requirement for significant grip strength.
c. Drag a casualty to immediate safety. This task is the only task in this category, and is considered both physically demanding and essential to the safety of the Soldier.

d. Conduct a tactical movement. This task is essential to the performance of a 11B, and is the only task of its type.
e. Agility: Move under direct fire.

The 11C tasks selected for simulation were:

a. Carry sandbags to prepare a fighting position. The described task utilizes a 40-lb sandbag (a weight similar to 25mm ammunition cans). Preparing a fighting position is also common to many MOSs, the equipment is readily available, and is physically demanding (high heart rate and energy cost). Additionally, a unique characteristic of carrying sandbags is the requirement for significant grip strength. The SMEs wanted to consider a mortar reload task instead of the sandbag carry as mentioned earlier.
b. Drag a casualty to immediate safety. This task is the only task in this category, and is considered both physically demanding and essential to the safety of the Soldier.
c. Conduct a tactical movement. This task is essential to the performance of a 11C, and is the only task of its type.
d. Move under direct fire.
e. The SMEs recommended adding the casualty evacuation task for the 11Cs.

The SMEs provided their analysis and feedback of the task simulations. They agreed that most of the simulations captured the essential physical demands of the tasks. A short description of each planned task simulation follows:

a. **Evacuate a Casualty Out of a BFV Gunner's Hatch.** This task will be simulated using a platform and a heavy bag. A heavy bag is a long bag with reinforced handles used for weight training. It is about the same length as the average torso and head of a Soldier. While wearing a fighting load minus the weapon (approximately 71 lb), a Soldier will squat, grasp the handles of the heavy bag level with the floor, then stand and pull the bag through the hole in the platform, which will be sized for a BFV gunner's hatch or an M1 Abrams loader's hatch. The heavy bag will be placed onto the platform for successful task completion. The initial load of 50 lb will be used for familiarization and warm-up. With the successful completion of the lift, the weight of the simulated casualty will be increased in 10-lb increments and the lift will be repeated until the participating Soldier reaches volitional fatigue or a max load of 210 lb, representing their maximal heavy lift ability for a casualty evacuation task. The final load will be recorded.

b. **Drag a Casualty**. While wearing a fighting load with a weapon (approximately 83 lb), Soldiers will drag a simulated casualty (approximately 270 lb) up to 15 m as fast as possible in 60 seconds. The time to completion will be recorded. If the Soldier fails to pull the casualty 15 m in 60 seconds, the distance the casualty was dragged will be measured.

c. **Sandbag Carry**. While wearing a fighting load minus the weapon (approximately 71 lb), Soldiers will lift and carry a total of 16 sandbags weighing 40 lb, carry them 10 m, and place them on the floor as quickly as possible. The time to completion will be recorded.

d. **Tactical Foot March.** The Soldiers will complete a movement of four miles, while wearing the basic Soldier uniform, personal protective equipment (to include weapon), and 24 hour sustainment load (approximately 103 lb). Soldiers will complete this task as quickly as possible while walking on a supervised course. Soldiers will not be allowed to run or do the airborne shuffle, but can take breaks as needed.

NOTE: The SMEs did not feel that a 4 mile foot march was an adequate simulation of the 12 mile Tactical Movement task. They reported 8 miles was the minimum distance that should be tested. USARIEM personnel are concerned that this will increase the injury incidence during testing, particularly since they will be doing many other tasks and tests on adjacent days. During USARIEM testing, all Soldiers who completed 3 miles were able to complete 12 miles with one exception. The soldier who did not complete the march stopped due to a previous injury. All other MOS SMEs (AR, FA, CE) agreed that a 4 mile foot march was adequate to test this capability, but the OCOI has the final word on what the task simulation should look like. The speed of movement was also discussed. OCOI personnel stated a 15 min mile would be the slowest allowable speed. This is based on their experience as well as the Foot March Manual. The Foot March manual (US Department of the Army, Field Manual 21-18: Foot Marches, Washington, DC, 1990) recommends 22 kg (or 30% body weight) for the fighting load and 33 kg (or 45% body weight) for the approach march load. The load for the task simulation is currently 47 kg. The Foot March Manual recommended speed for marching on road during daylight is 4 km/h, or 2.48 mph. Attached are figures containing frequency diagrams for the Soldiers we have tested performing 12 mile and 4 mile foot marches. The average speed for each was approximately 20 min/mile (3 mph). No soldier performed at a speed faster than 15 min/mile (4 mph) and the two Soldiers that were able to complete a 4 mile road march in less than 16 min/mile were unable to maintain that speed a week later when asked to repeat the task

e. **Move Under Fire.** Soldiers will be wearing a fighting load (approximately 83 lb) and carrying a weapon at the ready. The task is initiated in the prone position. Upon command, the Soldier will quickly stand and sprint approximately 5 to 8 m to a marker and assume the predetermined position for that marker (either the kneeling, crouched or prone position). They will remain in this position for approximately 5 seconds. Upon signal, Soldiers will get up and sprint approximately 5 to 8 m to the next marker and assume the predetermined position for that marker. This will be repeated until they have sprint a total of 100 m. Time to complete the task and each sprint will be recorded. Each testing session will take approximately 1-2 minutes.

In December 2014, a study will be conducted at Ft. Carson, CO to determine the reliability of Tactical Foot March and move under fire tasks. Reliability testing has previously been completed for the casualty drag, casualty evacuation and sandbag carry at JB Lewis-McChord in May 2014. The two Infantry tasks will be performed four (4) times over a two week period to determine if the scores change over repeated measurements.

In April 2015 at Ft Carson Co and June 2015 studies will be conducted at Ft Stewart, GA to identify simple physical fitness tests that can be used to predict performance on the task simulations. These predictor tests are likely to include tests such as a standing long jump, a medicine ball put, and a 300 m run. The data from the predictor tests will be used to create a predictive equation to predict Soldier performance on the task simulations. TRADOC will determine when and where these tests are conducted.

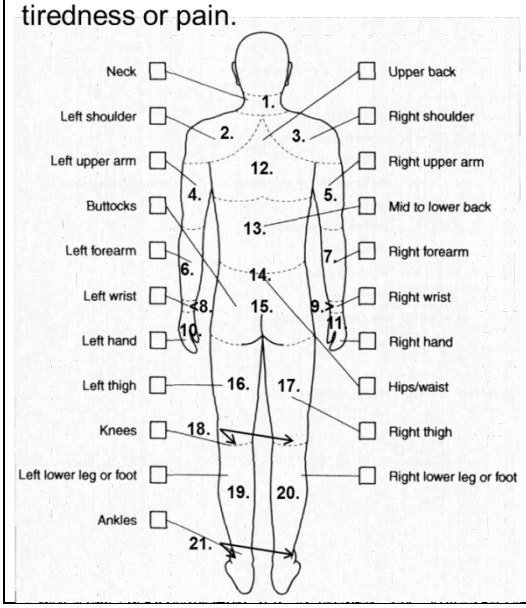
Prior to identifying suggested courses of action, SMEs must determine the minimal level of acceptable performance on each of the task simulations. For example, what is the longest acceptable time to complete the sandbag carry, the casualty drag, the foot march or the move under fire tasks? Once these have been agreed upon by the four Branch Proponents, the data can be appropriately analyzed.

We would like to thank the OCOI personnel for their time and for the important insights regarding our testing and task simulations.

APPENDIX F. SCALES USED DURING TESTING

Pain & Discomfort Scale ADAPTED FROM DIMOV ET AL *AIHAJ* 2000

The purpose of this scale is to identify the amount of discomfort you are experiencing in each region of your body. Discomfort includes any feelings of tiredness or pain.



Discomfort Scale

0: No Discomfort
1: Uncomfortable
2: Very Uncomfortable
3: Extremely Uncomfortable

Identify all regions in which you are currently feeling any discomfort and then rate that discomfort from 0-3.

If you are not experiencing any discomfort, you may skip that region.

Borg CR10 Scale

Brief Instruction: "During the job task, pay close attention to the exertion required for the physical work, which, should reflect your total amount of effort and fatigue. Don't be concerned with any one factor (e.g. duration, leg pain, shortness of breath); concentrate on your total body feeling of exertion. It's your own feeling that is important, not how it compares to other people or what other people think. Be as accurate as you can."

Continue for Initial Instruction:

"The scale goes from, "0, nothing at all," to "10, Extremely Hard," which is the main anchor, and is the hardest effort most people have ever experienced.

0 "Nothing at all" You are lifting no weight.

3 "Moderate" Task is not especially hard or difficult. It feels fine.

7 "Very Hard" You have to push yourself very much.

10 "Extremely Hard" You are doing as much as you possibly can do.

(Adapted from: Adapted from 1998 Borg HK, ACSM's Guidelines for Exercise Testing and Prescription 7th Edition, and Borg 1990 SJWEH - Psychophysical scaling with applications in physical work and the perception of Exertion)

0	Nothing at all
0.5	Extremely Light
1	Very Light
2	Light
3	Moderate
4	
5	Hard
6	
7	Very Hard
8	
9	
10	**Extremely Hard**

Borg 6-20 Scale

Brief Instruction: "During the job task, we want you to pay close attention to how hard you feel the physical work rate is. This feeling should reflect your total amount of exertion and fatigue, combining all sensations and feelings of physical stress, effort, and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling of effort and exertion that is important, not how it compares to other people or what other people think. Be as accurate as you can."

Continue for Initial Instruction:
"Look at this rating scale; we want you to use this scale from 6 to 20 where 6 means "no exertion at all," and 20 means "maximal exertion."

9 corresponds to "very light" exercise. For most healthy people it represents walking slowly at their own pace for several minutes.

13 corresponds to "somewhat hard" exertion, but it still feels OK to continue.

17 corresponds to "very hard" or difficult exercise. A healthy person can still go on but they really have to push themselves. It feels very strenuous and the person is very tired.

19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to appraise your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task."

(Adapted from: Adapted from 1998 Borg HK, ACSM's Guidelines for Exercise Testing and Prescription 7th Edition, and Borg 1990 SJWEH - Psychophysical scaling with applications in physical work and the perception of Exertion)

6	No exertion at all
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

APPENDIX G. TASK INSTRUCTIONS FROM STUDY 1

1. Conduct a Tactical Movement (Sustainment Load and Weapon)

The purpose of this task is to assess the physical demands of a tactical road march. In this task, you will walk at a pace of 1.5 to 2.0 miles per hour for 12 miles with 103 lb of equipment. We will issue you a heart rate monitor and a SPORTident stick. Some of you will also be issued a GPS. Please make sure the chest strap on your heart rate monitor is tight so it doesn't fall down while you are walking and that your heart rate is displayed on the watch. You will be weighed at the start, middle and end of the road march. Please stay well hydrated.

This is an individual event, so you do not have to walk in groups. If one of the Soldiers around you stops, and you don't need to stop, please continue walking. You will be started with your group of four soldiers. At the start you will place the SPORTident stick in the "CLEAR" station, then the "Start" Station, when it beeps your time will begin. Your pace on the course should be a walking pace of about 1.5 mph; do not run, jog or do the airborne shuffle.

Along the course there will be Control Stations at 3, 6 and 9 miles. You will take a mandatory break at these Control Stations. The break will be 10 minutes at mile 3, 30 minutes at mile 6 and 10 minutes at mile 9. You can rest longer at these Control Stations and you can rest at any time along the course. When you approach each control station you will insert the SPORTident stick into the station, and report your subject number, RPE, Pain Soreness and Discomfort and heart rate to the technician at the Control Station. (Review RPE & Pain Soreness and Discomfort Scales). You will be instructed to wait in a specific area. When your mandatory rest time is completed, you will be given a two minute warning and notified when the mandatory time is up. As you re-enter the course, you will insert your SPORTident stick into the exit station until it beeps and resume walking.

You will also pass checkpoints placed approximately every mile where your stick will beep. You don't need to do anything for these mileage checkpoints, just continue to walk.

There will be medics, water and latrines at each of the Control Stations. If you need medical assistance or cannot continue, please stop and wait for assistance. If you see someone who needs assistance, notify a medic or any test administrator on the course. In case of medical emergency, please call *********. If you stop for any reason, other than a medical emergency, please report back to the finish line. We need to determine why you stopped and collect the equipment from you.

Again, this is not a race. We are trying to determine what it takes to complete this task at the standard level of performance. Do you have any questions?

3. *Prepare a Fighting Position (Fill and Emplace Sandbags)*

The purpose of this task is to fill buckets with sand and emplace 26 sandbags into a fighting position. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. During the task, you will wear a face mask attached to a small device worn on your back called an Oxycon, which measures your energy consumption. When told to begin, you will fill 26 buckets with sand up to the taped line using an entrenchment tool. You will have 52 minutes to complete this portion of the task. After filling the buckets 26 times, you will rate how hard you worked during the task on a scale from 6-20. You will then move to the sandbag pile and carry 26 sandbags 10 m where you will build a fighting position. Keep the sandbags within the taped outline and place 3 bags on each of the 3 sides outlined on the floor. Place the remainder of the sandbags on top of the first rows. One side will only have two bags on the top row. You will have 26 minutes to complete this portion of the task. Upon completion of the sandbag carry, you will rate how hard you worked using the same scale from 6-20 (show scale, read instructions). You should perform both tasks at a pace at which you can complete the task while maintaining your safety. Do you have any questions?

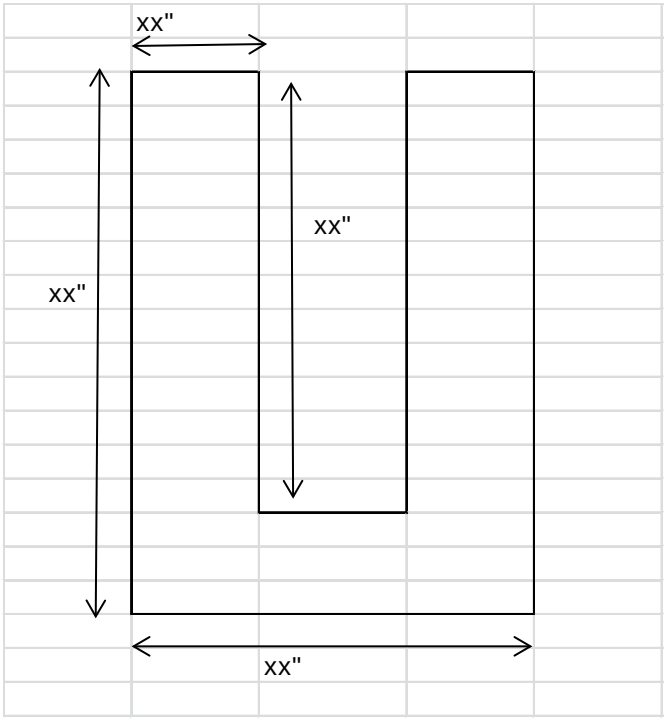


Figure A. Outline of fighting position.

4a. *Drag a Casualty to Immediate Safety (Dismounted)*

The purpose of this task is to assess the physical demands of dragging a casualty to safety. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When told to begin, you will drag a casualty weighing 270 lb a distance of 15 m as quickly as possible (from the 1st set of cones to the 2nd set of cones). The task isn't over until the casualty's feet cross the finish line. Upon completion of the task, we will record your heart rate and you will rate how hard you think you worked during the task on a scale from 0-10 (show scale, read instructions). You should perform the task at a pace at which you can complete the task while maintaining your safety. You will have 3 minutes to complete the test. If at any point you feel you are unable to continue, the test will be terminated. You will be given an opportunity to drag the dummy prior to performing the test to get a feel for the weight. Do you have any questions?

4b*. Remove a Casualty from a Vehicle (Mounted)*

Condition 1:

The purpose of this test is to assess the physical demands of evacuating a 207-lb casualty from a wheeled vehicle. Prior to beginning you will jog in place and stretch to warm up. You will perform this task under two conditions. In the first condition, you will be working with a partner. The casualty will weigh 207 lb, which is the weight of the average soldier wearing a modified fighting load. You will climb to the top of the BFV. You and your partner should squat or kneel down, grasp the shoulder straps and pull the casualty out through the commander's hatch. You will have 2 minutes to complete this task. Upon completion of the task, you will be asked to rate how hard you worked during the task on a scale from 0-10 (show scale, read instructions). Get into a good position for lifting to protect your lower back. If you feel any pain or discomfort, you should stop performing the task. Do you have any questions?

Condition 2:

When working alone, you will lift 103 lb, which represents 1/2 of the weight of an average Soldier wearing a modified fighting load. Prior to beginning you will jog in place and stretch to warm up. Again, you will squat or kneel down, grasp the shoulder straps and pull the casualty out through the commander's hatch. You will have 2 minutes to complete this task. Upon completion of each condition, you will be asked to rate how hard you worked during the task on a scale from 0-10 (show scale, read instructions). Get into a good position for lifting to protect your lower back. If you feel any pain or discomfort, you should stop performing the task. Do you have any questions?

5. *Lift, Carry, and Install the Barrel of a 25mm Gun on the Bradley Fighting Vehicle (BFV)*

The purpose of this task is to assess the physical demands of lifting, carrying, and installing the 107 lb. barrel of a 25mm Gun on a BFV. In this task, you and a partner will carry the 107 lb. barrel 25 m from the starting point to a BFV and lift it onto the hull of the BFV. One Soldier will support the barrel while the second soldier climbs up onto the hull. The Soldier on the hull will stabilize the barrel while the second soldier climbs up onto the hull. The barrel will be lifted and placed into the opening mount. Upon completion of the task, you will be asked to rate how hard you worked during the task on a scale from 0-10 (show scale and read instructions). It is important that you are careful with the equipment. You should perform the task at a pace at which you can complete the task while maintaining your safety. Do you have any questions?

6. *Remove the Feeder Assembly of a 25mm Gun on the Bradley Fighting Vehicle (BFV)*

The purpose of this task is to assess the physical demands of removing the M242 feeder assembly from the 25mm gun. When told to begin, you will remove the feeder assembly and place it on the floor of the vehicle on the spot marked with tape. Upon completion of the task, you will be asked to rate how hard you worked during the task on a scale from 0-10 (show scale and read instructions). You should perform the task at a pace at which you can complete the task while maintaining your safety. Do you have any questions?

7. *Load 25mm H-EIT Tracer Ammunition Cans onto the Bradley Fighting Vehicle*

The purpose of this task is to assess the physical demands of lifting, carrying and loading 30 25mm H-EIT Tracer Ammunition Cans onto a platform that simulates the tailgate of a BFV. Before we begin, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. You will wear a face mask attached to a small device worn on your back called an Oxycon, which measures your energy consumption. On command, you will lift one or two ammunition cans, carry them 15 m and place them onto a platform. Do not throw or drop the can on the platform or it will not count. You will repeat this until 30 cans have been moved. Upon completion of the task, you will be asked to rate how hard you worked during the task on a scale from 6-20 (show scale and read instructions). You should perform the task at a pace at which you can complete the task while maintaining your safety. At any point if you feel you are unable to continue, stop and tell the administrator. Do you have any questions?

8. *Load TOW Missile Launcher on PFV*

The purpose of this test is to assess the physical demands of loading 265-lb TOW Aero Missiles into the Bradley Fighting Vehicle Mounted TOW Weapon

System. In this task, you will remove the TOW from the storage rack and lift it ~1 m from the crew compartment into the launcher. You will then remove it and replace it in the storage rack. Repeat a second time. Time will stop when the second missile is properly loaded. Upon completion, you will assess your personal rating of physical exertion on a scale of 1-10 (show scale, read instructions). It is important that you are careful with the equipment. You should perform the task at a pace at which you can complete the task while maintaining your safety. Do you have any questions?

9. *Move Over, Through or Around Obstacles*

The purpose of this test is to assess the physical demands of climbing over an obstacle. When I signal to begin, you will attempt to clear this 2 m vertical obstacle. You may get assistance from one soldier on top of the obstacle and one at the base. Your equipment may be removed, but must still clear obstacle. Time will stop after clearing the obstacle. Upon completion, you will assess your personal rating of physical exertion on a scale of 1-10 (show scale, read instructions). You should perform the task at a pace at which you can complete the task while maintaining your safety. Do you have any questions?

10. *Move Under Direct Fire*

The purpose of this task is to move 100 m under direct fire. Make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch.

You will begin the test lying in a **prone** fighting position.

When told to begin, the first timing station will light up and beep, at which point the clock will start and you will then rise and sprint **15 m** to the **first** marker, touch it and assume a **kneeling** fighting position.

After 5 seconds, the **second** marker will light up and beep, and you will sprint **15m** to it, touch it and assume a **crouched** fighting position.

After 5 seconds the **third** marker will light up and beep, and you will sprint **10 m** to it, touch it and assume a **prone** fighting position.

After 5 seconds, the **fourth** marker will light up and beep, and you will sprint **10 m** to it, touch it and assume a **kneeling** fighting position.

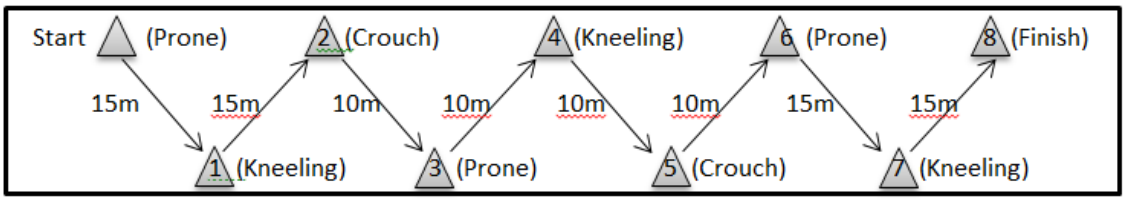
After 5 seconds the **fifth** marker will light up and beep, and you will sprint **10 m** to it, touch it and assume a **crouched** fighting position.

After 5 seconds, the **sixth** marker will light up and beep, and you will sprint **10 m** to it, touch it and assume a **prone** fighting position.

After 5 seconds, the **seventh** marker will light up and beep, and you will sprint **15 m** to it and touch it and assume a **kneeling** fighting position.

After 5 seconds, the **eighth** marker will light up and beep, and you will sprint **15 m** and touch it to **finish** the task.

Upon completion of the movement, you will rate how hard you worked on a scale of 6-20 (show scale & read instructions) and report your heart rate to the investigator. You should perform the task at a pace at which you can complete the task while maintaining your safety. Do you have any questions?



11. ***Prepare a Dismounted TOW Firing Position***

The purpose of this test is to assess the physical demands of loading a TOW Missile into a Ground Mounted TOW Weapon System. In this task, you will carry each one missile 15 m and properly install it in the dismounted TOW launcher. Time will stop when the missile is properly loaded. Upon completion, you will assess your personal rating of physical exertion on a scale of 1-10 (show scale, read instructions). It is important that you are careful with the equipment. You should perform the task at a pace at which you can complete the task while maintaining your safety. Do you have any questions?

12. ***Engage Targets with a Caliber .50 M2 Machine Gun***

The purpose of this task is to assess the physical demands of lifting and carrying .50 Caliber Machine Gun weighing 153 lb (prorated 76.5 lb) a distance of 10 m. Make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. On command, you will lift and carry the .50 Caliber Machine Gun 10 m. Time will stop when the gun has been successfully emplaced. Upon completion of the task, you will be asked to rate how hard you worked during the task on a scale from 0-10 (show scale and read instructions). You should perform the task at a pace at which you can complete the task while maintaining your safety. At any point if you feel you are unable to continue, stop and tell the administrator. Do you have any questions?

13 & 14. ***Emplace Base Plates and Cannon for a 120mm Mortar***

The purpose of this task is to assess the perceived physical effort of lifting and carrying for 25 m and emplacing a 136-lb baseplate and 110-lb cannon for a 120 mm mortar, as part of a two person team. Before we get started you should warm up by jogging in place and performing some light stretches. The instructor will give you and your partner a “3, 2, 1, Go.” You will lift and carry the base plate from the first set of cones 25 m to the second set of cones and place the base plate on the ground, at which point the time will stop. Upon completion, you will assess your personal rating of physical exertion on a scale of 1-10 (show scale, read instructions). Then you will repeat the same process with the cannon. You should perform the task at a pace at which you can complete the task while maintaining your safety. At any point if you feel you are unable to continue, the test will be terminated. Do you have any questions?

16. ***Fire a 120mm Mortar***

The purpose of this task is to assess the perceived physical effort of firing five 120 mm mortars (29 lb each). Before we get started you should warm up by jogging in place and performing some light stretches. The instructor will give a “3, 2, 1, Go.” You will lift and hold a round over cannon (~2 m high) for 10 seconds, at which point the instructor will say, “Good.” A detail with take the round from your hand and you will grab a second round from a detail and place it over the cannon, where a detail will take the round. This with repeat for 3 more rounds, such that a total of 5 rounds have been simulated to be fired. The clock will stop when the fifth round leaves your hands. You will have 75 seconds to complete the task. You are not allowed to step on/touch the baseplate, tripod or cannon doing so will result in a No-Go or repeat of the task simulation. Upon completion, you will assess your personal rating of physical exertion on a scale of 1-10 (show scale, read instructions). You should perform the task at a pace at which you can complete the task while maintaining your safety. At any point if you feel you are unable to continue, the test will be terminated. Do you have any questions?

APPENDIX H. QUESTIONNAIRES, SURVEYS, AND DATA SHEETS FROM STUDY 1

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 3- Prepare Fighting Position

Bag Number	Fill Sandbags (min:sec)
1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
9	:
10	:
11	:
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22	:
23	:
24	:
25	:
26	:

Bag Number	Carry Sandbags (min:sec)
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5	:
6	:
7	:
8	:
9	:
10	:
11	:
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22	:
23	:
24	:
25	:
26	:

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 3- Prepare Fighting Position

Bag Number	**Fill** Sandbags (min:sec)
1	:
2	:
3	:
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26	:

Bag Number	**Carry** Sandbags (min:sec)
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24	:
25	:
26	:

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 4a- Drag a Casualty to Immediate Safety

First Day Fighting Load Weight (lbs): _____

FIGHTING LOAD Weight (lbs)	*Time (Min:Sec)*	*RPE (0-10)*	*Pre HR (bpm)*	*Final HR (bpm)*	*Go/ No Go*	*Time of Day*
Weight with ± 3 lbs of first day Fighting Load	____ : ____					

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 4b- Remove a Casualty from a Wheeled Vehicle (mounted)

First Day Fighting Load minus Weapon Weight (lbs): _____

Two Soldier Team

Team (circle one): Male-Male / Male-Female **Teammate Subject ID: _____**

FIGHTING LOAD MINUS WEAPON *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go/ No Go*	*Time of Day*
Weight within ± 3 lbs of first day Fighting Load Minus Weapon	____ : ____			

Comments:

Individually

	Time to Finish (Min:Sec)	*RPE (0-10)*	*Go/ No Go*	*Time of Day*
	____ : ____			

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 5- Lift, Carry and Install the Barrel of a 25mm Gun

Team (circle one): Male-Male / Male-Female Teammate Subject ID: _____

First Day Fighting Load (lbs):_____

FIGHTING LOAD *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go/ No Go*	*Time of Day*
Weight within ± 3 lbs of first day Fighting Load	____ : ____			

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 6- Remove the Feeder Assembly of a 25mm Gun

First Day Body Weight (lbs): _____

39 LBS OF TASK SPECIFIC PPE *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go / No Go*	*Time of Day*
	____ : ____			

Task PPE = First Day Body Weight + 39lbs of Task Specific PPE
IOTVC with ESAPI and ESBI, CVC/ACH Helmet

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 7- Load 25mm H-EIT Tracer Ammunition Cans onto BFV

Oxycon Device Number: _____

Stopwatch Number:_____ Stopwatch Record #: _____

First Day Fighting Load minus Weapon Weight (lbs):_____

FIGHTING LOAD MINUS WEAPON *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (6-20)*	*Pre HR (bpm)*	*Final HR (bpm)*	*Go/No Go*	*Time of Day*
Weight within ± 3 lbs of first day Fighting Load minus Weapon	____ : ____					

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 7- Load 25mm H-EIT Tracer Ammunition Cans onto BFV

Ammo Can Number	Time (min:sec)
1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
9	:
10	:
11	:
12	:
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28	:
29	:
30	:

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 8- Load TOW Missile Launcher on Bradley Fighting Vehicle

First Day Fighting Load minus Weapon (lbs):_____

FIGHTING LOAD MINUS WEAPON *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go/No Go*	*Time of Day*
Weight within ± 3 lbs of first day Fighting Load minus Weapon	____ : ____			

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 9- Move Over, Through, or Around Obstacles

First Day Fighting Load (lbs):_____

FIGHTING LOAD *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go/No Go*	*Time of Day*
Weight within ± 3 lbs of first day Fighting Load	____ : ____			

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 10- Move Under Direct Fire

First Day Fighting Load Weight (lbs): _____

FIGHTING LOAD Weight (lbs)	*Time (Min:Sec)*	*RPE (6-20)*	*Pre HR (bpm)*	*Final HR (bpm)*	*Go/ No Go*	*Time of Day*
Weight with ± 3 lbs of first day Fighting Load	____ : ____					

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 10- Move Under Direct Fire

Split #	Time (min:sec)
1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
9	:
10	:
11	:
12	:
13	:
14	:
15	:

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 11- Prepare Dismounted TOW Firing Position

First Day Fighting Load minus Weapon (lbs):_____

FIGHTING LOAD MINUS WEAPON *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go/No Go*	*Time of Day*
Weight within ± 3 lbs of first day Fighting Load minus Weapon	____ : ____			

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 12- Lift and Carry M2 .50 Caliber Machine Gun

Team (circle one): Male-Male / Male-Female Teammate Subject ID: _____

First Day Fighting Load (lbs):_____

FIGHTING LOAD *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go/ No Go*	*Time of Day*
Weight within ± 3 lbs of first day Fighting Load	____ : ____			

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11B

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
STOPWATCH PRINTOUTS

Task 3 Fill & Emplace Sandbags	Task 7 Load Ammo Cans	

Test Administrator's Initials _____

11C

Subject ID: _____ **Date:** _____

USARIEM MOS Physical Performance Standards Study

Task 3- Prepare Fighting Position

Oxycon Device Number: _____

Stopwatch Number: _____ **Stopwatch Record #:** _____

First Day Fighting Load Minus Weapon: _____

Filling Sandbags

FIGHTING LOAD MINUS WEAPON *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (6-20)*	*Pre HR (bpm)*	*Post HR (bpm)*	*Go/No Go*	
Weight within ± 3 lbs of First Day Fighting Load minus Weapon	____ : ____					

Comments:

Carrying Sandbags

	Time to Finish (Min:Sec)	*RPE (6-20)*	*Pre HR (bpm)*	*Post HR (bpm)*	*Go/No Go*	*Time of Day*
	____ : ____					

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11C

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 3- Prepare Fighting Position

Bag Number	**Fill** Sandbags (min:sec)
1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
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10	:
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19	:
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22	:
23	:
24	:
25	:
26	:

Bag Number	**Carry** Sandbags (min:sec)
1	:
2	:
3	:
4	:
5	:
6	:
7	:
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24	:
25	:
26	:

Test Administrator's Initials _____

11C

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 4a- Drag a Casualty to Immediate Safety

First Day Fighting Load Weight (lbs): _____

FIGHTING LOAD Weight (lbs)	*Time (Min:Sec)*	*RPE (0-10)*	*Pre HR (bpm)*	*Final HR (bpm)*	*Go/ No Go*	*Time of Day*
Weight with ± 3 lbs of first day Fighting Load	____ : ____					

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11C

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 9- Move Over, Through, or Around Obstacles

First Day Fighting Load (lbs):_____

FIGHTING LOAD *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go/No Go*	*Time of Day*
Weight within ± 3 lbs of first day Fighting Load	____ : ____			

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11C

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 10- Move Under Direct Fire

First Day Fighting Load Weight (lbs): _____

FIGHTING LOAD Weight (lbs)	*Time (Min:Sec)*	*RPE (6-20)*	*Pre HR (bpm)*	*Final HR (bpm)*	*Go/ No Go*	*Time of Day*
Weight with ± 3 lbs of first day Fighting Load	____ : ____					

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11C

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 10- Move Under Direct Fire

Split #	Time (min:sec)
1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:
9	:
10	:
11	:
12	:
13	:
14	:
15	:

Test Administrator's Initials _____

11C

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study

Task 13- Lift and Emplace Base Plate for 120mm Mortar
Task 14- Lift Emplace Cannon for 120mm Mortar

First Day Fighting Load (lbs):_____

Task 13: Lift and Emplace Base Plate

Team (circle one): Male-Male / Male-Female Teammate Subject ID: _____

FIGHTING LOAD *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go/ No Go*	*Time of Day*
Weight within ± 3 lbs of first day Fighting Load	____ : ____			

Comments:

Task 14: Lift Emplace Cannon for 120mm Mortar

Team (circle one): Male-Male / Male-Female Teammate Subject ID: _____

	Time to Finish (Min:Sec)	*RPE (0-10)*	*Go/ No Go*	*Time of Day*
	____ : ____			

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11C

Subject ID: _____ **Date:** _____

USARIEM MOS Physical Performance Standards Study

Task 16- Fire a Mortar (Lift and Hold Round, Place in Tube)

First Day Body Weight (lbs): _____

46 LBS OF TASK SPECIFIC PPE *Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Go / No Go*	*Time of Day*
	____ : ____			

Task PPE = First Day Body Weight + 46lbs of Task Specific PPE

- *Body Armor w/ Neck/Groin Protector (Size Large)*
- *Enhanced Small Arms Protective Inserts (Size Large)*
- *Enhanced Side Ballistic Insert Set w/ Side Place Carrier*
- *100 oz Hydration System (w/ Water)*
- *Advanced Combat Helmet (ACH) w/ Night Vision Goggle Mounting Plate, and Helmet Cover w/ Band*
- *Ballistic Protection Goggles (ESS)*
- *Ballistic Knee and Elbow Pads*
- *Visual/Language Translator Card*
- *Casualty Feeder Report/Witness Statement*

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

11C

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
STOPWATCH PRINTOUTS

Task 3 Fill & Emplace Sandbags		

Test Administrator's Initials _____

APPENDIX I. TASK INSTRUCTIONS FROM STUDY 2

1. Conduct a Tactical Movement (Sustainment Load and Weapon)

The purpose of the test is to determine the reliability of a road march test. You will walk four miles as fast as possible without running or doing the airborne shuffle. To start you will insert your SPORTident stick into the start receptacle. As soon as it beeps, your time is running. Walk on the right side of the road out and back. At each ½ mile and mile mark, there will be a set of cones. Walk in-between the two cones on the right side of the road. You should hear a beep from your stick as you pass, but you don't need to do anything. As you walk through the cones marked mile 4, check your heart rate and remember the number.

When you get to the finish cones, punch out with your SPORTident stick. Upon completion of the task, you will be asked for your heart rate. Upon completion of the task, you will be asked for your heart rate. You will also be asked to rate your physical effort on a scale from 6-20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can. (show scale) Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

> 9 corresponds to "very light" exercise. For most healthy people it represents walking slowly at their own pace for several minutes.
>
> 13 corresponds to "somewhat hard" exertion, but it still feels OK to continue.
>
> 17 corresponds to "very hard" or difficult exercise. A healthy person can still go on but they really have to push themselves. It feels very strenuous and the person is very tired.
>
> 19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task.

Next we will ask you to point out the pain, soreness and discomfort you experienced during the march. Identify all regions in which you are currently feeling any discomfort and then rate that discomfort from 0 (No Discomfort) to 3 (Extreme Discomfort). If you are not experiencing any discomfort, you may skip that region.

To complete participation you will return the SPORTident stick at station 3, get weighed and return your weights at station 2, return your weapon to the truck, and return your heart watch and strap to station 1. Do you have any questions?

3. *Prepare a Fighting Position (Fill and Emplace Sandbags)*

The purpose of this task is to determine the reliability of carrying and emplacing 16 filled sandbags, as quickly as possible. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When I say go, you will carry a total of 16 sandbags 10 m where you will build a fighting position that is 4 sandbags wide, 2 sandbags deep, and two sandbags tall (Figure A). You may carry no more than 2 sandbags at a time, and you must properly place the sandbags you are carrying within the marked outline before returning for the next bag. Upon completion of the task, you will rate how hard you worked using the scale from 6-20 (show scale, read instructions). You should move as quickly as you can complete the task while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

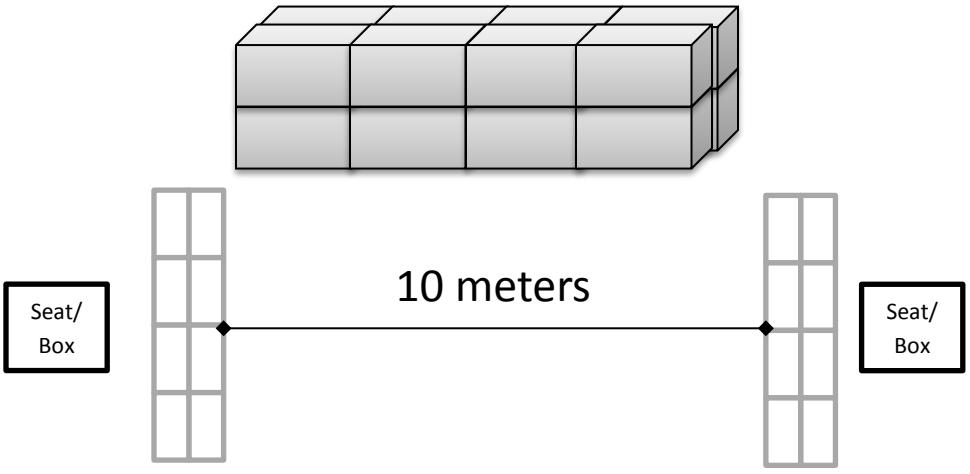


Figure A. Overhead layout.

4a. *Drag a Casualty to Immediate Safety (Dismounted)*

The purpose of this task is to determine reliability of quickly dragging a 271-lb casualty a distance of 15 m. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When told to begin, you will grasp the harness on the dummy with one or two hands and drag it as quickly as possible past the 2nd set of cones. The feet of the dummy must cross the line before you stop, so don't stop until I tell you to. You will have 30 seconds to complete this task and I will count down the last 5 seconds and say 'stop'. If you cross the finish line within 30s, I'll tell you when to stop (Figure A). If you do not cross the finish line when I count down and say 'stop', stop right where you are and wait until I tell you to release the dummy (Figure B). I will measure how far you dragged it. Upon completion of the task, we will record your heart rate and you will rate how hard you worked during the task on a scale from 0-10 (show scale, read instructions).

You should perform the task as quickly as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Before we start the test, you will drag the dummy a few feet to get a feel for the weight. Do you have any questions?

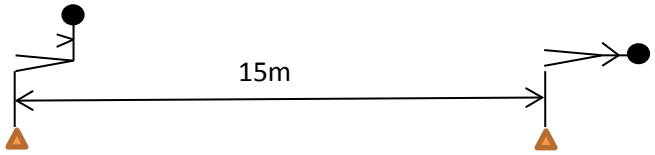


Figure A. If completed task (Record 15m & actual completion time)

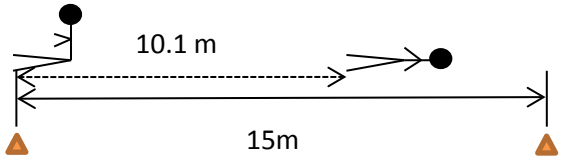


Figure B. If task not completed (Record 30 seconds & Distance to feet)

4b*. Remove a Casualty from a Vehicle (Mounted)*

The purpose of this test is to determine the reliability of a maximal heavy lift test designed to mimic removing a casualty from a vehicle turret. The weight of the bag will begin at 50 lb. You will squat, grasp the shoulder straps and pull the bag out through the hole simulating the commander's hatch. You must lift the bag up and place it beside the hatch (either upright or on its side) for it to be considered successful. Everyone will complete this weight so that we can ensure you are using the proper lifting technique. After everyone has completed the first weight, an additional 10 lb will be added to the bag, and we will cycle through everyone again. You may choose to skip up to 2 consecutive weight increments if you feel confident you can complete it; however, the tester may ask you to perform the weight anyway. The maximum lift for this test is 210 lb.

Make sure you are wearing gloves. Prior to starting we will review proper lifting technique using a set of kettlebells. You will be required to use good technique to protect your lower back. If you show poor lifting technique, we will stop you and you will not receive credit for that weight. If you feel any pain or discomfort, you should release the bag and stop performing the task.

Upon completion of each lift, you will be asked to rate how hard you worked during the task on a scale from 0-10 (show scale, review instructions before test begins). Your rating should reflect only your effort for that particular weight. Do you have any questions?

PROPER LIFTING TECHNIQUE: ***Demonstrate and check before testing***
Starting position:

- Place feet at edge of the opening, shoulder width apart
- Knees in line with toes
- Bend at the hips, sticking your butt back so that your *back is flat or slightly arched*
- Head up
- Grip the bag with arms fully extended.

Motion:

- Pull the bag straight up by extending the knees and hips at the same time. The bag should stay as close to your legs as possible.
- Arms should remain extended until knees and hips are fully extended.
- Extend your knees and hips fully before you use your arms to lift and tilt the bag out of the opening. Once upright, you are allowed to bend your knees again to finish the lift if necessary

If you do not use correct form, the test will be stopped. Poor form includes:

- Arching or rounding your back during the lift
- Holding your breath. You should exhale while lifting

10. *Move Under Direct Fire*

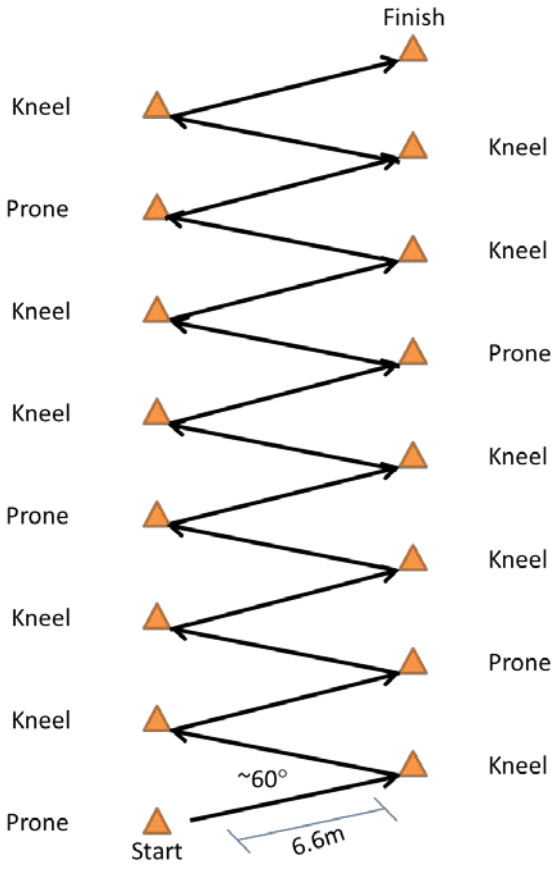
The purpose of this task is to determine the reliability of a test simulating moving 100 m under direct fire. Make sure the chest strap of your heart rate monitor is tight and your heart rate is displayed on the watch (check now). You will begin the test lying in an unsupported prone fighting position.

When told to begin, the first timing station will light up and beep. You will rise and sprint to the first marker, get right next to the marker, and assume a kneeling fighting position. The marker should be right in front of you so you can make sure the light turns off. It is OK to touch the light. After 5 seconds, the second marker will light up and beep. You will sprint, get right next to the marker, and assume a kneeling fighting position. Again, make sure the light on the marker turns off. You will continue sprinting between markers in a similar manner, cycling between 1 prone, and 2 kneeling positions, until you have completed the entire course (Figure A).

You should perform the task as quickly as possible while maintaining your safety, but choose a pace at which you can complete the task. Once you start the test, do not stop unless it is an emergency. You should continue even if you stumble, as you may not be allowed to restart. Upon completion of the task, you will be asked for your heart rate. You will also be asked to rate your physical effort on a scale from 6-20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can. (show scale) Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

> 9 corresponds to "very light" exercise. For most healthy people it represents walking slowly at their own pace for several minutes.
>
> 13 corresponds to "somewhat hard" exertion, but it still feels OK to continue.
>
> 17 corresponds to "very hard" or difficult exercise. A healthy person can still go on but they really have to push themselves. It feels very strenuous and the person is very tired.
>
> 19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?


Finish
Kneel
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Prone
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~60°
Prone
Start
6.6m

APPENDIX J. QUESTIONNAIRES AND SURVEYS FROM STUDY 2

Physical Performance Standards Study

Demographics Sheet

Subject ID_____

Sex _____

Age _____

Date of Birth: _____

(To be filled out by investigator)
Height (in)
_____
ACU Unloaded (lbs)
_____
Fighting Load minus Weapon (lbs)
_____
Fighting Load (lbs)
_____
Approach March Load (lbs)
_____

Race (circle one):

Caucasian African American Hispanic Asian

MOS _____ Rank _____

Last Army Physical Fitness Test Score (total) _____

Push-ups (reps) _____

Sit-ups (reps) _____

2-Mile Run Time (min:sec) _____

Subject ID: _____ Date/Time: _____

USARIEM MOS Physical Performance Standards Study
Reliability Phase

Sandbag Carry

Test Repetition Number: **1** **2** **3** **4**
(Circle one)

Soldier Weight
***Fighting Load NO WEAPON* (lbs):** _____

Stopwatch Number: _____ **Stopwatch Record #:** _____

Time to Finish (Min:Sec)	*RPE (6-20)*	*Pre HR (bpm)*	*Post HR (bpm)*
____ : ____			

Bag Number	*Time (min:sec)*
1	:
2	:
3	:
4	:
5	:
6	:
7	:
8	:

Bag Number	*Time (min:sec)*
9	:
10	:
11	:
12	:
13	:
14	:
15	:
16	:

Comments:

Test Administrator's Initials _____

Subject ID: _____ Date/Time: _____

USARIEM MOS Physical Performance Standards Study
Reliability Phase

Casualty Drag

Test Repetition Number: **1** **2** **3** **4**
(Circle one)

Soldier Weight
***Fighting Load WITH WEAPON* (lbs):** _____

Distance (m)	*Time (sec)*	*Velocity (m/s)*

RPE (0-10)	*Pre HR (bpm)*	*Final HR (bpm)*

Comments:

Test Administrator's Initials _____

Subject ID: _____ **Date/Time:** _____

USARIEM MOS Physical Performance Standards Study
Reliability Phase

Casualty Extraction

Test Repetition Number: **1** **2** **3** **4**
(Circle one)

Soldier Weight
***Fighting Load NO WEAPON* (lbs):** _____

Rep	*Bag Weight (lbs)*	*Completed (Y/N)*	*RPE (0-10)*
1			
2			
3			
4			
5			
6			
7			

Comments:

Test Administrator's Initials _____

Subject ID: _____ Date: 12/____/ 2014 Time: _____

Investigators Last Name (Printed): _____

USARIEM MOS Physical Demands Study
Reliability Phase

Move Under Direct Fire

Test Repetition Number: 1 2 3 4
(Circle one)

Soldier Weight *Fighting Load With WEAPON* (lbs): _____

Stopwatch Number: _____ Stopwatch Record #: _____

	Time to Finish (Min:Sec)	*RPE (6-20)*	*HR (bpm)*
Baseline			
Finish	:		

STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY ISSUES WITH PRINTOUT BELOW.

Comments:

Date: _____ Data Collector: _____

Test Repetition Number: 1 2 3 4

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Start Data Sheet

Subject #	Start Time	HR
	:	
	:	
	:	
	:	
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Page ___ of ___

Date: _____ Data Collector: _____

Test Repetition Number: 1 2 3 4

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Finish Data Sheet

Subject #	Finish Time	RPE	HR
	:		
	:		
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Page ___ of ___

Date: _____ Data Collector: _____

Test Repetition Number: 1 2 3 4

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Checkpoint Data Sheet

Subject #	Check-in Time	RPE	HR
	:		
	:		
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Page ___ of ___

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Start Discomfort Scale

Date: _____ **Data Collector:** _____

Test Repetition Number: 1 2 3 4

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Finish Discomfort Scale

Date: _____ **Data Collector:** _____

Test Repetition Number: 1 2 3 4

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

APPENDIX K. TASK INSTRUCTIONS FROM STUDY 3

Conduct a Tactical Movement

The purpose of the test is to determine the ability for simple tests to predict performance on a 4-mile road march. You will walk four miles as fast as possible without running or doing the airborne shuffle. Your weapon should be held at the ready in front of you at all times. To start you will insert your SPORTident stick into the clear and test receptacles. You will report your heart rate, then insert your Sportident into the start receptacle. As soon as it beeps, your time is running. Walk on the right side of the road out and back. At each ½ mile and mile mark, there will be a set of cones. Walk in-between the two cones on the right side of the road. You should hear a beep from your stick as you pass, but you don't need to do anything. Do NOT stop to rest at the cones because your stick will keep recording times. Move at least 25 feet away before you stop. As you walk through the cones marked mile 4, check your heart rate and remember the number.

When you get to the finish cones, punch out with your SPORTident stick. Upon completion of the task, you will report your heart rate. You will also rate your physical effort on a scale from 6-20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task.

Next we will ask you to point out the pain, soreness and discomfort you experienced during the march. Identify all regions in which you are currently feeling any discomfort and then rate that discomfort from 0 (No Discomfort) to 3 (Extreme Discomfort). If you are not experiencing any discomfort, you may skip that region.

To complete participation you will return the SPORTident stick, return your weapon to the supply closet, return your weights, and return your heart watch and strap to station 1. Do you have any questions?

Prepare a Fighting Position (Sandbag Carry and Emplace)

The purpose of this task is to determine the relationship between performance of carrying and emplacing 16 filled sandbags and simple predictor tasks. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When I say go, you will carry a total of 16 sandbags 10 m where you will build a fighting position that is 4 sandbags wide, 2 sandbags deep, and two sandbags tall (Figure A). You may carry no more than 2 sandbags at a time, and you must properly place the sandbags you are carrying within the marked outline before returning for the next bag.

Upon completion of the task, you will be asked for your heart rate. You will also rate your physical effort on a scale from 6-20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?

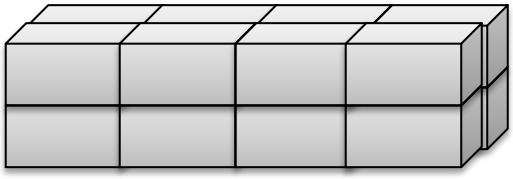
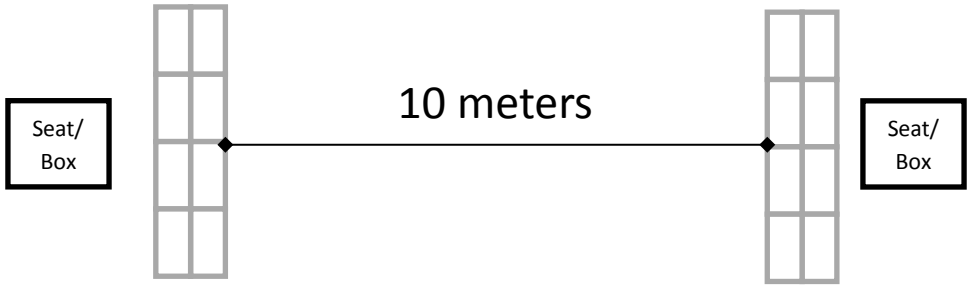


Figure A. Design of fighting position.



Casualty Drag

The purpose of this task is to determine the relationship between performance of dragging a 270-lb casualty a distance of 15 m and simple predictor tasks. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When told to begin, you will grasp the harness on the dummy with one or two hands and drag it as quickly as possible past the 2nd set of cones. The feet of the dummy must cross the line before you stop, so don't stop until I tell you to. You will have 60 seconds to complete this task and I will count down the last 5 seconds and say 'stop'. If you cross the finish line within 60 seconds, I'll tell you when to stop (Figure A). If you do not cross the finish line when I count down and say 'stop', stop right where you are and wait until I tell you to release the dummy (Figure B). I will measure how far you dragged it.

Upon completion of the task, you will rate your physical effort on a scale from 0-10. This rating should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people (show scale). Look at this rating scale: 0 means "no exertion at all," and 10 means "Extremely Hard."

You should perform the task as quickly as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Before we start the test, you will drag the dummy a few feet to get a feel for the weight. Do you have any questions?

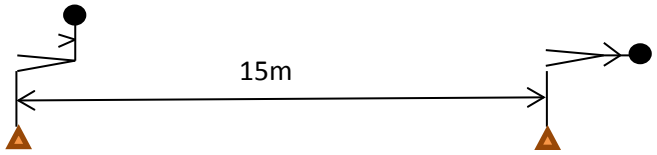


Figure A. If completed task (Record 15m and actual completion time)

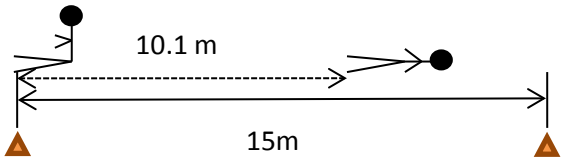


Figure B. If task not completed (Record 30 seconds and Distance to feet)

Casualty Evacuation

The purpose of this task is to determine the relationship between performance of a maximal heavy lift test designed to mimic removing a casualty from a vehicle turret, and simple predictive tests. You will squat, grasp the shoulder straps and pull the bag out through the hole simulating the commander's hatch. You must lift the bag up and place it beside the hatch (either upright or on its side) for it to be considered successful.

Make sure you are wearing gloves. Prior to starting we will review proper lifting technique using a set of 25-lb kettlebells. You will be required to use good technique on every lift to protect your lower back. If you show poor lifting technique, we will stop you and you will not receive credit for that weight. If you feel any pain or discomfort, you should release the weight and stop performing the task.

After everyone has completed the 50-lb, we will cycle through everyone again. You may choose add 10, 20, or 30 lb to the bag after each successful lift; however, the tester may ask you to perform a lower weight if it is deemed appropriate. The maximum lift for this test is 210 lb. You may be skipped during some cycles in order to minimize the time we spend adjusting the bag.

Upon completion of each lift, you will rate your physical effort on a scale from 0-10. This rating should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people (show scale). Look at this rating scale: 0 means "no exertion at all," and 10 means "Extremely Hard."

Your rating should reflect only your effort for that particular weight, and not be solely based on whether or not you lifted the bag. Do you have any questions?

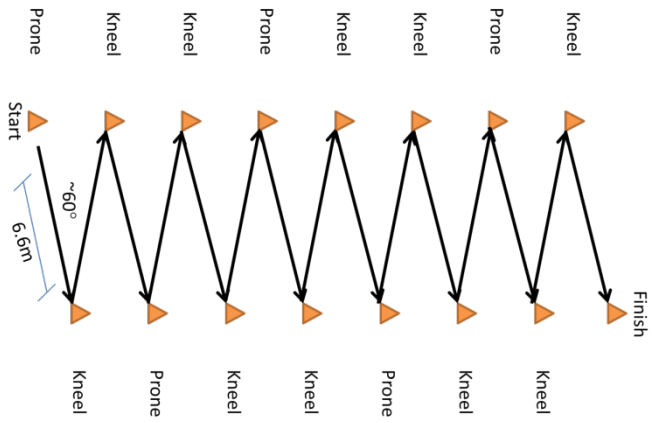
Move Under Direct Fire

The purpose of this task is to determine the relationship between performance of a test designed to simulate moving 100 m under direct fire and simple predictor tests. Make sure the chest strap of your heart rate monitor is tight and your heart rate is displayed on the watch (check now). You will begin the test lying in an unsupported prone fighting position.

When told to begin, you will rise and sprint to the first marker. Get right next to the marker and assume a kneeling fighting position. After 5 seconds, we will cue you to run to the next marker. You will sprint, get right next to the 2nd marker, and again assume a kneeling fighting position. You will continue sprinting between markers in a similar manner, cycling between 1 prone, and 2 kneeling positions, until you have completed the entire course. The signs next to each cone will instruct you whether to kneel or get prone. When getting up, you may not use the barrel of the gun for support. On the final sprint, run straight through the finish line.

You should perform the task as quickly as possible while maintaining your safety, but choose a pace at which you can complete the task. Once you start the test, do not stop unless it is an emergency. You should continue even if you stumble, as you may not be allowed to restart. Upon completion of the task, you will be asked for your heart rate. You will also be asked to rate your physical effort on a scale from 6-20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?



Beep Test

The purpose of this task is to determine the ability of the beep test to predict performance of the physically demanding tasks of an 11B and 11C. You will jog, run, and then sprint continuously between the two lines 20 m apart in time to recorded beeps. This test will require that you push yourself to your maximal ability and you should be winded at the end of the test. The audio recording will tell you when to begin. The test start begins with a slow warmup. The beeps will increase in speed every level, which is about every minute. This will be indicated on the audio recording with a different sound. Each shuttle within a level is at the same speed.

You must cross the opposite line before the beep occurs and you cannot leave the line until the beep sounds. If you do not make it to the line before the beep, I will call out your ID number and give you a warning (Example: "352 Warning #1"; "352 Warning #2"). When you miss 3 beeps *in a row*, you will be informed by the investigator that the test is over ("352 you're done!"). At any point, you may choose to stop on your own if you do not feel like you can continue.

After completing, an investigator will ask you to read your heart rate off of your heart rate monitor. Do you have any questions?

Standing Long Jump

The purpose of this task is to determine the ability of the standing long jump to predict performance of the physically demanding tasks of an 11B and 11C. You will stand behind the line with your feet slightly apart. You will jump as far as possible with a two foot take-off and landing. You are allowed to swing your arms and bend your knees to provide forward push. If you fall, we will ask you to repeat the attempt. You will be given two practice jumps and then you will perform three maximal effort jumps that will be recorded. Do you have any questions?

Upright Pull at 38 cm

The purpose of this task is to determine the ability of an upright pull to predict performance of the physically demanding tasks of an 11B and 11C. You will stand with your feet about 50 cm apart, and squat down flexing at the knees and hips. You will grasp the handles with the palms facing in opposite direction approximately equidistant from the center of the handle. Then place your buttocks against the wall to the rear, and straighten your back and look straight ahead. I will give you a "ready-three-two-one-pull," without jerking build up to your maximal force in about 2 seconds, maximally pull for about 3 more seconds and then relax. You will perform the test three times, if you improperly performed the test you will be asked to take a short rest and repeat the attempt. Do you have any questions?

Isometric Biceps Curl

The purpose of this task is to determine the ability of an isometric biceps curl to predict performance of the physically demanding tasks of an 11B and 11C. You will stand holding onto a bar with palms facing up, elbows at right angle and forearms parallel to the floor. I will adjust the instrument to fit you. You will stand with your feet hip width apart without bending your knees or hips. I will give you a "ready-three-two-one-pull," without jerking or leaning back, build up to your maximal force in about 2 seconds, pull for about 3 more seconds and then relax. You will perform the test three times, if you improperly performed the test you will be asked to take a short rest and repeat the attempt. Do you have any questions?

Arm Ergometer

The purpose of this task is to determine the ability of an arm ergometer test to predict performance of the physically demanding tasks of an 11B and 11C. The test involves cranking an Arm Ergometer, as fast as possible, for two minutes. You will kneel in front of the arm ergometer and I will adjust the handles to fit you. After, you will perform ten revolutions to familiarize yourself with the test and to provide a warm up. When you are ready I will say "ready-three-two-one-GO," you will then have two minutes to perform as many revolutions as possible. We will inform you when you are half way, and when you have 30 and 15 seconds left. We will record the number of revolutions at 2 minutes. Do you have any questions?

Handgrip

The purpose of this task is to determine the ability of handgrip strength to predict performance of the physically demanding tasks of an 11B and 11C. The base of the handle will be set so it rests on the heel of the palm and the handle will rest on the middle of the four fingers. You will then hold it so that your elbow is flexed to 90 degrees, the device is oriented up and down, and your shoulder and wrist are in a relaxed position. When I say go, you will squeeze your hand as tight as possible, while avoiding use of any other part of the body. If I see that you are using other muscles, you will be asked to repeat the measure. You repeat this 3 times in each hand, alternating hands. Do you have any questions?

1-Minute Sit-Ups

The purpose of this task is to determine the ability of using a 1-minute sit-up score to predict performance of the physically demanding tasks of an 11B and 11C. You will begin by lying down in the proper sit-up position. You should be lying on your back with your knees bent at a 90-degree angle. Place your feet under the tables at the end of the mat. During the test, your fingers must be interlocked behind your head and the backs of your hands must touch the ground. On the command "go" you should begin raising your upper body forward to the vertical position. After reaching the vertical position, you should lower body until the bottom of your shoulder blades touch the ground. You must use proper sit-up technique for the repetition to count. If you need to

rest, you may do so only in the up position without resting your arms on your legs to hold yourself up. You may not rest in the down position. You will have 1 minute to complete as many as possible.

You should perform the task as long as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

1-Minute Push-Ups

The purpose of this task is to determine the ability of using a 1-minute push-up score to predict performance of the physically demanding tasks of an 11B and 11C. You will begin by assuming a front-leaning rest position by placing your hands shoulder-width apart, with your feet together or up to 12 inches apart. When I say "Go", you should begin the push-up by bending your elbows and lowering your entire body as a single unit until your upper arms are at least parallel to the ground. Then, you should return to the starting position by raising your entire body until your arms are fully extended. At the end of each repetition, the scorer will state the number of push-ups correctly performed. Push -ups in which the arms are not parallel to the ground or the elbows are not fully locked at the end of a repetition will not be scored. You may rest at any time, however during rest breaks your hands and feet must not break contact with the ground. You will have 1 minute to complete as many as possible.

You should perform the task as long as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Illinois Agility Test

The purpose of this test is to assess the ability of the Illinois agility test to predict performance of the physically demanding tasks of an 11B and 11C. During this test, you will run through a series of cones. (*Show Soldiers Figure A below, and point out the course as you explain the next section*). You will start the test lying on your stomach with your hands in a push-up position and facing the first far cone. I will give you a "three-two-one-go" and you will sprint the far cone, then sprint back to this middle cone (point to it). Do a zig-zag up and back in the center cones. Sprint to the far cone (point to it) and then sprint back through the finish line (point to it). During the test, run through the course as fast as you can, while maintaining safety and without knocking over the cones. If at any point you feel you are unable to continue, the test will be terminated. If you make a mistake during the test we will ask you to stop and repeat the attempt. Do you have any questions? If you wouldn't mind following me, I will walk you through the course before we begin.

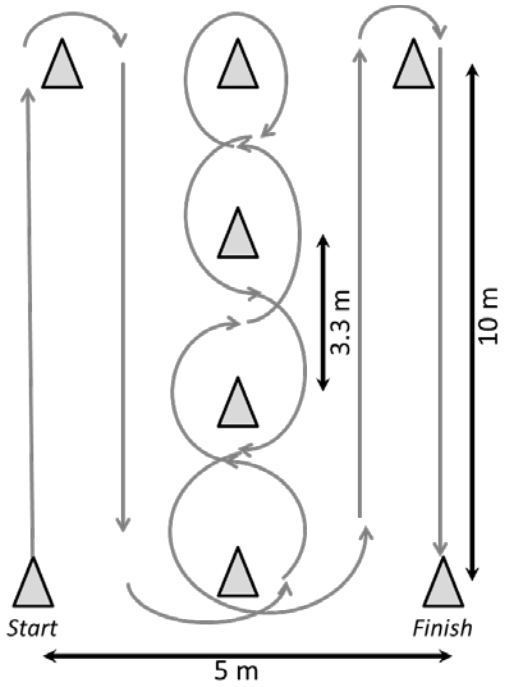


Figure A. Illinois Agility Course Outline

300 m Sprint

The purpose of this test is to assess the ability of the 300 m sprint test to predict performance of the physically demanding tasks of an 11B and 11C. You will start the test with the toes of one foot on the starting line, and the other foot either even with or behind the line. When I say "go", you will run 300 m. The test is complete when you cross the finish line. Run the 300 m as fast as you can, while maintaining safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Resistance Pull (with sled)

The purpose of this test is to assess the ability of the resistance pull test to predict performance of the physically demanding tasks of an 11B and 11C. You will be asked to run backwards 20 m while holding a 24-kg kettlebell attached to a sled providing resistance.

You will begin with your back facing the direction you will be running. When ready, you will pick up the kettlebell with two hands side by side, and I will give you a "3, 2, 1, go" countdown. On the "go" command, run backwards as fast as you can while maintaining your safety. I will let you know when you cross the finish line. Time stops when the sled crosses the line, not your body. If you don't cross the line in 90 seconds, I will give you a "5, 4, 3, 2, 1, stop" countdown. On the "stop" command, stop where you are, and I will measure how far you ran. If you fall during the test, attempt to get up and

keep going. If at any point you feel you are unable to continue, the test can be terminated. Do you have any questions?

Powerball Throw

The purpose of this test is to assess the ability of the powerball throw test to predict performance of the physically demanding tasks of an 11B and 11C. During the test, you will be standing with your back facing the direction you will be throwing. Your feet should be shoulder width apart with your heels on the "zero"/ start line.

(Demonstrate while describing motion) You will begin the throw with the ball in both hands, held over your head. While keeping your arms extended, swing the ball down between your legs while flexing your knees, hips and trunk. After you have reached a squatting position, thrust your hips forward, extend your knees and trunk, flex your shoulders, while in one motion, throw the ball back overhead.

You will be given two practice throws. After the practice throws you will be asked to complete three throws for record. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Squat Lift

The purpose of this task is to determine the ability of a dumbbell squat test to predict performance of the physically demanding tasks of an 11B and 11C. Beginning with a pair of 25-lb dumbbells, you will squat, grasp handles, and complete a set of 3 to 5 squat lifts.

Prior to testing, make sure you are wearing gloves. (Demonstrate while explaining) You will begin by placing feet between the dumbbells about shoulder width apart. Make sure your knees are in line with toes. On the "set" command, bend at the hips and knees, sticking your butt back so that your back is flat or slightly arched. Keep your head up, and grip the dumbbells at your sides with your arms fully extended. When given the "lift" command, lift the dumbbells straight up by extending your knees and hips at the same time. Keep your head angled up. The dumbbells should stay as close to your legs as possible, and your arms should remain extended. When you are standing with your hips and knees fully straight, the test administrator will say "good" and you will squat back down and release the weights in their stands in a safe and controlled manner. If you show poor lifting technique or you drop the weights, we will stop you and you will not receive credit for that lift.

After you have completed the first weight, you will be given a short rest and then you'll be asked to lift a pair of dumbbells 10 lb heavier. The maximum lift for this test is a pair of 110-lb dumbbells for a total load of 220 lb. If you fail to lift a load, you may try one more time after a brief rest.

Don’t overexert yourself trying to lift a weight that is too heavy. If you feel any pain or discomfort, you should put the dumbbell down and stop performing the task. Do you have any questions?

Medicine Ball Throw

The purpose of this test is to assess the ability of the medicine ball throw test to predict performance of the physically demanding tasks of an 11B and 11C. During the test, you will sit in the chair with your back against the back rest and both feet on the ground. During throw and follow through your back must stay in contact with the chair. You will hold the medicine ball with both hands. When I say “go”, you will touch the medicine ball to your chest and then push/throw it as far forward as possible. It is recommended that you throw it up at a 45° angle to get maximum distance. The distance between the front of the chair and the landing point of the medicine ball will be measured. You will be given two practice throws. After the practice throws you will be asked to complete three throws for record. While throwing the medicine ball, you must keep your back against the chair. If you fail to maintain contact with the back of the chair you will be asked to repeat the throw. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

APPENDIX L. QUESTIONNAIRES AND SURVEYS FROM STUDY 3

Demographics, Training and Experience

11B/11C

Physical Performance Standards Study

Ft Carson, CO April 2015

Demographics Sheet

Subject ID_____

Sex _____

Age _____ **Date of Birth:** _____

Race *(Circle one or more)*

Caucasian African American Hispanic Asian Other:

_____

MOS _____ **Rank** _____

Date of Last Army Physical Fitness Test_____

APFT Total Score _____

Push-ups (#) _____

Sit-ups (#) _____

2-Mile Run Time (min:sec) _____

11B/11C

Physical Performance Standards Study 3

Demographics Sheet

Testing Site: Ft. Stewart (MAY/JUN 15) Ft. Riley (JUN 15)

Subject ID_____

Sex _____

Age _____ Date of Birth: _____

Race (circle one):

Caucasian African American Hispanic Asian

MOS _____ Rank _____

Date of Last Army Physical Fitness Test_____

APFT Total Score _____

Push-ups (reps) _____

Sit-ups (reps) _____

2-Mile Run Time (min:sec) _____

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
11B 11C 19D Carson APRIL 2015
Criterion Tasks

Sandbag Carry

Stopwatch Number: _____ **Stopwatch Record #:** _____

Time to Finish (Min:Sec)	*RPE (6-20)*	*Pre HR (bpm)*	*Post HR (bpm)*
____ : ____			

STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY ISSUES WITH PRINTOUT BELOW.

Comments:

Move Under Direct Fire

Stopwatch Number: _____ **Stopwatch Record #:** _____

	Time to Finish (min:sec)	*RPE (6-20)*	*HR (bpm)*
Baseline			
Finish	:		

Comments:

Last Revised 17AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
11B 11C 19D Carson APRIL 2015
Criterion Tasks

Casualty Extraction from BFV

Rep	*Bag Weight (lbs)*	*Completed (Y/N)*	*RPE (0-10)*
1			
2			
3			
4			
5			
6			
7			

Comments:

Casualty Drag

	Distance (m)	*Time to Finish (sec, up to 60)*	*RPE (0-10)*	*HR (bpm)*
Baseline				
Finish		:		

Comments:

Last Revised 17AUG2015

Date: _____ Data Collector: _____

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Start Data Sheet

Subject #	Start Time	HR
	:	
	:	
	:	
	:	
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	:	
	:	
	:	
	:	

Page ____ of ____

Date: _____ Data Collector: _____

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Finish Data Sheet

Subject #	Finish Time	RPE	HR
	:		
	:		
	:		
	:		
	:		
	:		
	:		
	:		
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Page ____ of ____

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Finish Discomfort Scale

Date: _____ **Data Collector:** _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Start Discomfort Scale

Date: _____ **Data Collector:** _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
Predictive Tests

Beep Test

Check as Shuttle Completed

Level #	Shuttle # 1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													

Beep Test	*Level #*	*Shuttle #*	*Heart Rate (bpm)*
Baseline			
Finish			

Comments:

Last Revised 17AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
Predictive Tests

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Medicine Ball Put (cm)					
Illinois Agility (min:sec)	:				

Comments:

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Upright Pull (lbs)					
Isometric Bicep Curl (lbs)					

Comments:

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Standing Broad Jump (m)					
One Minute Push Ups (#)					

Comments:

Resistance Pull Test	*Time* (min:sec)	*Distance (m)* *(if not completed)*	*Heart Rate (bpm)*
Baseline			
Finish *(up to 20m or 90 sec)*			

Comments:

Last Revised 17AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
Predictive Tests

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Power Ball Throw (cm)					
One Minute Sit-Ups (#)					

Comments:

Arm Endurance	*Revolutions (#)*	*Heart Rate (bpm)*
Baseline		
Minute 1 (Halfway)		
Minute 2 (Finish)		

				If Necessary	
	Left 1	*Left 2*	*Left 3*	*Left 4*	*Left 5*
Handgrip (kg)					
	Right 1	*Right 2*	*Right 3*	*Right 4*	*Right 5*

Comments:

	Time (min:sec)
300 Meter Run (min:sec)	:

Comments:

Last Revised 17AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
Predictive Tests

Squat Lift (lbs)	*Completed (Y/N)*	*RPE (0-10)*
50		
60		
80		
100		
120		
140		
160		
180		
200		
220		

Comments:

Last Revised 17AUG2015

APPENDIX M. SME RECORDING SHEETS OF SOLDIER PERFORMANCE ON CRITERION TASKS FROM STUDY 3

SME Task Rating – TACTICAL MOVEMENT

Rate the soldier on his/her pace to complete the 4-Mile Tactical Movement and the likelihood that the Soldier will reach the objective on time with enough physical reserve to conduct the mission. Use the definitions for Certain, Very Likely, Likely, Unlikely, and Very Unlikely listed on the rating form.

Volunteer Number	Certain Pace was much faster than needed to reach objective on time and with ample physical reserve to conduct the mission [Top 10% soldiers]	Very Likely Pace was faster than needed to reach objective on time and with more than adequate physical reserve to conduct the mission	Likely Pace was adequate to reach objective on time with adequate physical reserve to conduct the mission [Mid-level soldiers]	Unlikely Pace was slower than needed to reach objective on time and with less than adequate physical reserve to conduct the mission	Very Unlikely Pace was inadequate to reach objective on time and with no physical reserve to conduct the mission; mission failed [Bottom 5% of soldiers]

SME Task Rating - SANDBAG CARRY

INSTRUCTIONS: Record the helmet number in the section titled "Volunteer Number" then rate the Soldier based on his or her performance by checking your level of agreement for the following statement:

Pace: This Soldier is performing this task at a pace that is likely to allow for completion of an emplacement in the time allotted for preparation for protection from and engagement with the enemy.

Ability: This Soldier is performing this task with technique that will create effective bunker and does not risk injury to themselves.

	Pace					Ability				
Volunteer Number	Certain Pace was much faster than needed and emplacement would be completed far ahead of schedule [Top 10% soldiers]	Very Likely Pace was faster than needed and emplacement would be completed ahead of schedule	Likely Pace was adequate to complete emplacement and emplacement would be completed on schedule [Mid-level soldiers]	Unlikely Pace was slower than needed and emplacement would be completed behind schedule	Very Unlikely Pace was inadequate and assistance would be needed to complete emplacement [Bottom 5% of soldiers]	Maintained proper technique to create bunker to standard and mitigate injury throughout all of the task	Maintained proper technique most of the time to create bunker to standard and mitigate injury during the task	Maintained proper technique half of the time to create bunker to standard and mitigate injury during the task	Occasionally maintained proper technique to create effective bunker and mitigate injury during the task	Rarely maintained proper technique to create effective bunker and mitigate injury during the task

SME Task Rating – Move Under Fire

INSTRUCTIONS: Record the helmet number in the section titled "Volunteer Number" then rate the Soldier based on his or her performance by checking your level of agreement for the following statement:

Pace: This Soldier is performing this task at a pace that is likely to provide them adequate protection from enemy fire and still maintain adequate physical reserve to engage the enemy.

Ability: This Soldier is performing this task with technique that does not risk injury to themselves.

	Pace						Ability				
Volunteer Number	Certain Pace was much faster than needed and soldier would be at much reduced risk of being shot/killed [Top 10% soldiers]	Very Likely Pace was faster than needed and soldier be at reduced risk of being shot/killed	Likely Pace was adequate and Soldier would be at average risk of being shot/killed [Midlevel soldiers]	Unlikely Pace was slower than needed and Soldier would be at somewhat higher risk of being shot/killed	Very Unlikely Pace was inadequate and soldier would be at very high risk of being shot/killed [Bottom 5% of soldiers]	Maintained proper technique to mitigate injury throughout all of the task	Maintained proper technique most of the time to mitigate injury during the task	Maintained proper technique half of the time to mitigate injury during the task	Occasionally maintained proper technique to mitigate injury during the task	Rarely maintained proper technique to mitigate injury during the task

SME Task Rating – Evacuate a Casualty from a Vehicle Turret

INSTRUCTIONS: Record the helmet number in the section titled "Volunteer Number" then rate the Soldier based on his or her performance by checking your level of agreement for the following statement:

Ability: This Soldier is performing this task with technique that does not risk injury to themselves and would result in removal of the casualty.

	Ability					
Volunteer Number	Maintained proper technique to mitigate injury to self and casualty throughout all of the task	Maintained proper technique most of the time to mitigate injury to self and casualty during the task	Maintained proper technique half of the time to mitigate injury to self and casualty during the task	Maintained minimally acceptable technique to mitigate injury to self and casualty less than half the time	Technique would likely result in injury to self and inability to remove casualty

SME Task rating - CASUALTY DRAG

INSTRUCTIONS:

Record the helmet number in the section titled "Volunteer Number." Rate the soldier on his/her pace to complete the casualty drag under fire and the likelihood that the victim and Soldier will survive. Use the definitions for Certain, Very Likely, Likely, Unlikely, and Very Unlikely listed on the rating form.

	Pace					Ability				
Volunteer Number	Certain Pace was much faster than needed to rescue the victim [Top 10% soldiers]	Very Likely Pace was faster than needed to rescue the victim	Likely Pace was adequate to rescue the victim [Mid-level soldiers]	Unlikely Pace was slower than needed to rescue victim under fire, but adequate not under fire	Very Unlikely Pace was inadequate to rescue victim [Bottom 5% of soldiers]	Maintained proper technique to rescue the victim and mitigate injury throughout all of the task	Maintained proper technique most of the time to rescue the victim and mitigate injury during the task	Maintained proper technique half of the time to rescue the victim and mitigate injury during the task	Occasionally maintained proper technique to rescue the victim and mitigate injury during the task	Rarely maintained proper technique to rescue the victim and mitigate injury during the task

APPENDIX N. ADDITIONAL STATISTICAL TABLES FROM STUDY 3

11B Predictor Tests among other Predictor Tests

		Beep Test (#)	Med Ball Put (cm)	Illinois Agility (min)	Upright Pull (lb)	Biceps Curl (lb)	SLJ[1] (cm)	Push-ups (#)
Beep	r	—	0.43**	-0.63**	0.43**	0.39**	0.67**	0.60**
Test (#)	N	—	190	190	190	190	190	190
Med Ball	r	0.43**	—	-0.43**	0.87**	0.85**	0.65**	0.70**
Put (cm)	N	190	—	190	190	190	190	190
Illinois	r	-0.63**	-0.43**	—	-0.47**	-0.38**	-0.73**	-0.54**
Agility (min)	N	196	196	—	190	190	190	190
Upright	r	0.43**	0.87**	-0.47**	—	0.87**	0.68**	0.69**
Pull (lb)	N	190	190	190	—	190	190	190
Biceps	r	0.39**	0.85**	-0.38**	0.87**	—	0.60**	0.70**
Curl (lb)	N	190	190	190	190	—	190	190
SLJ[1]	r	0.67**	0.65**	-0.73**	0.68**	0.60**	—	0.67**
(cm)	N	190	190	190	190	190	—	190
Push-Ups	r	0.60**	0.70**	-0.54**	0.69**	0.70**	0.67**	—
(#)	N	190	190	190	190	190	190	—
Resist Pull	r	0.44**	0.87**	-0.42*	0.84**	0.82**	0.62**	0.57**
(m/sec)	N	190	190	190	190	190	190	190
Powerball	r	0.44**	0.85**	-0.49**	0.84**	0.82**	0.67**	0.63**
(cm)	N	190	190	190	190	190	190	190
Sit-Ups	r	0.40**	0.03	-0.33**	0.09	0.01	0.33**	0.37**
(#)	N	190	190	190	190	190	190	190
ArmErg	r	0.56**	0.71**	-0.52**	0.70**	0.69**	0.59**	0.62**
(RP2m)	N	190	190	190	190	190	190	190
Handgrip	r	0.36**	0.86**	-0.40**	0.87**	0.85**	0.61**	0.64**
(lb)	N	190	190	190	190	190	190	190
300m	r	-0.76**	-0.57**	0.71**	-0.55**	-0.48**	-0.78**	-0.65**
Sprint (min)	N	190	190	190	190	190	190	190
Squat	r	0.42**	0.74**	-0.45**	0.74**	0.67**	0.57**	0.52**
Lift (lb)	N	190	190	190	190	190	190	190

**p<0.01; *p<0.05

[1] Standing Long Jump

11B Predictor Tests among other Predictor Tests (cont.)

		Resist. Pull (m/sec)	Powerball Throw (cm)	Sit-ups (#)	ArmErg (RP2m)	Handgrip (lb)	300m Sprint (min)	Squat Lift (lb)
Beep Test (#)	r	0.44**	0.44**	0.40**	0.56**	0.36**	-0.76**	0.42**
	N	190	190	190	190	190	190	190
Med Ball Put (cm)	r	0.87**	0.85**	0.03	0.71**	0.86**	-0.57**	0.74**
	N	190	190	190	190	190	190	190
Illinois Agility (min)	r	-0.42**	-0.49**	-0.33**	-0.52**	-0.40**	0.71**	-0.45**
	N	190	190	190	190	190	190	190
Upright Pull (lb)	r	0.84**	0.84**	0.09	0.70**	0.87**	-0.55**	0.74**
	N	190	190	190	190	190	190	190
Biceps Curl (lb)	r	0.82**	0.82**	0.02	0.69**	0.85**	-0.48**	0.67**
	N	190	190	190	190	190	190	190
SLJ[1] (cm)	r	0.62**	0.67**	0.33**	0.59**	0.61**	-0.78**	0.57**
	N	190	190	190	190	190	190	190
Push-Ups (#)	r	0.57**	0.63**	0.37**	0.61**	0.64**	-0.65**	0.52**
	N	190	190	190	190	190	190	190
Resist Pull (m/sec)	r	—	0.86**	-0.02	0.74**	0.82**	-0.54**	0.72**
	N	—	190	190	190	190	190	190
Powerball (cm)	r	0.86**	—	0.07	0.72**	0.82**	-0.57**	0.70**
	N	190	—	190	190	190	190	190
Sit-Ups (#)	r	-0.02	0.07	—	0.10	-0.04	-0.32**	-0.04
	N	190	190	—	190	190	190	190
ArmErg (RP2m)	r	0.74**	0.72**	0.10	—	0.70**	-0.58**	0.67**
	N	190	190	190	—	190	190	190
Handgrip (lb)	r	0.82**	0.82**	-0.04	0.70**	—	-0.49**	0.71**
	N	190	190	190	190	—	190	190
300m Sprint (min)	r	-0.54**	-0.57**	-0.32**	-0.58**	-0.49**	—	-0.52**
	N	190	190	190	190	190	—	190
Squat Lift (lb)	r	0.72**	0.70**	0.04	0.66**	0.71**	-0.52**	—
	N	190	190	190	190	190	190	—

**p<0.01; *p<0.05

[1] Standing Long Jump

11C Predictor Tests among other Predictor Tests

		Beep Test (#)	Med Ball Put (cm)	Illinois Agility (min)	Upright Pull (lb)	Biceps Curl (lb)	SLJ[1] (cm)	Push-ups (#)
Beep Test (#)	r	—	0.55**	-0.63**	0.50**	0.49**	0.63**	0.64**
	N	—	182	182	182	182	182	182
Med Ball Put (cm)	r	0.55**	—	-0.62**	0.89**	0.88**	0.75**	0.72**
	N	182	—	182	182	182	182	182
Illinois Agility (min)	r	-0.63**	-0.62**	—	-0.59**	-0.59**	-0.72**	-0.57**
	N	182	182	—	182	182	182	182
Upright Pull (lb)	r	0.50**	0.89**	-0.59**	—	0.89**	0.69**	0.66**
	N	182	182	182	—	182	182	182
Biceps Curl (lb)	r	0.49**	0.88**	-0.59**	0.89**	—	0.66**	0.71**
	N	182	182	182	182	—	182	182
SLJ[1] (cm)	r	0.63**	0.75**	-0.72**	0.69**	0.66**	—	0.63**
	N	182	182	182	182	182	—	182
Push-Ups (#)	r	0.64**	0.72**	-0.57**	0.66**	0.71**	0.63**	—
	N	182	182	182	182	182	182	—
Resist Pull (m/sec)	r	0.46**	0.84**	-0.62*	0.82**	0.83**	0.67**	0.59**
	N	182	182	182	182	182	182	182
Powerball (cm)	r	0.51**	0.83**	-0.65**	0.81**	0.83**	0.69**	0.63**
	N	182	182	182	182	182	182	182
Sit-Ups (#)	r	0.15*	0.03	-0.14	0.06	-0.00	0.16*	0.14
	N	182	182	182	182	182	182	182
ArmErg (RP2m)	r	0.57**	0.75**	-0.66**	0.73**	0.76**	0.59**	0.69**
	N	182	182	182	182	182	182	182
Handgrip (lb)	r	0.49**	0.84**	-0.61**	0.85**	0.84**	0.68**	0.67**
	N	182	182	182	182	182	182	182
300m Sprint (min)	r	-0.74**	-0.65**	0.68**	-0.59**	-0.60**	-0.75**	-0.66**
	N	182	182	182	182	182	182	182
Squat Lift (lb)	r	0.42**	0.72**	-0.52**	0.74**	0.68**	0.56**	0.52**
	N	182	182	182	182	182	182	182

**p<0.01; *p<0.05

[1] Standing Long Jump

11C Predictor Tests among other Predictor Tests (cont.)

		Resist. Pull (m/sec)	Powerball Throw (cm)	Sit-ups (#)	ArmErg (RP2m)	Handgrip (lb)	300m Sprint (min)	Squat Lift (lb)
Beep	r	0.46**	0.51**	0.01*	0.57**	0.49**	-0.74**	0.42**
Test (#)	N	182	182	182	182	182	182	182
Med Ball	r	0.84**	0.83**	0.03	0.75**	0.84**	-0.68**	0.72**
Put (cm)	N	182	182	182	182	182	182	182
Illinois	r	-0.62**	-0.65**	-0.14	-0.66**	-0.61**	0.68**	-0.52**
Agility (min)	N	182	182	182	182	182	182	182
Upright	r	0.82**	0.81**	0.06	0.73**	0.85**	-0.59**	0.52**
Pull (lb)	N	182	182	182	182	182	182	182
Biceps	r	0.83**	0.83**	-0.00	0.76**	0.84**	-0.60**	0.74**
Curl (lb)	N	182	182	182	182	182	182	182
SLJ[1]	r	0.67**	0.69**	0.16*	0.59**	0.68**	-0.75**	0.68**
(cm)	N	182	182	182	182	182	182	182
Push-Ups	r	0.59**	0.63**	0.14	0.69**	0.67**	-0.66**	0.56**
(#)	N	182	182	182	182	182	182	182
Resist Pull	r	---	0.89**	-0.02	0.73**	0.78**	-0.58**	0.52**
(m/sec)	N	---	182	182	182	182	182	182
Powerball	r	0.89**	---	-0.04	0.73**	0.82**	-0.61**	0.70**
(cm)	N	182	---	182	182	182	182	182
Sit-Ups	r	-0.02	-0.04	---	0.03	0.01	-0.06	-0.09
(#)	N	182	182	---	182	182	182	182
ArmErg	r	0.73**	0.73**	0.03	---	0.76**	-0.58**	0.61**
(RP2m)	N	182	182	182	---	182	182	182
Handgrip	r	0.78**	0.82**	0.01	0.76**	---	-0.59**	0.71**
(lb)	N	182	182	182	182	---	182	182
300m	r	-0.58**	-0.61**	-0.06	-0.58**	-0.59**	---	-0.52**
Sprint (min)	N	182	182	182	182	182	---	182
Squat	r	0.70**	0.70**	-0.09	0.61**	0.71**	-0.52**	---
Lift (lb)	N	182	182	182	182	182	182	---

**p<0.01; *p<0.05

[1] Standing Long Jump

11B Criterion Tasks among other Criterion Tasks

		Foot March (min)	Sandbag (min)	Move Under Fire (min)	Cas Evac (lb)	Cas Drag (m/sec)
Foot March (min)	r	—	0.61**	0.53**	-0.62**	-0.61**
	N	—	197	190	190	190
Sandbag (min)	r	0.61**	—	0.62**	-0.75**	-0.63**
	N	190	—	190	190	190
Move Under Fire (min)	r	0.53**	0.62**	—	-0.63**	-0.52**
	N	190	190	—	190	190
Cas Evac (lb)	r	-0.62**	-0.75**	-0.63**	—	0.75**
	N	190	190	190	—	190
Cas Drag (m/sec)	r	-0.61**	-0.63**	-0.52**	0.76**	—
	N	190	190	190	190	—

**p<0.01; *p<0.05

11C Criterion Tasks among other Criterion Tasks

		Foot March (min)	Sandbag (min)	Move Under Fire (min)	Cas Evac (lb)	Cas Drag (m/sec)
Foot March (min)	r	—	0.64**	0.51**	-0.63**	-0.61**
	N	—	182	182	182	182
Sandbag (min)	r	0.64**	—	0.60**	-0.74**	-0.65**
	N	182	—	182	182	182
Move Under Fire (min)	r	0.51**	0.60**	—	-0.61**	-0.52**
	N	182	182	—	182	182
Cas Evac (lb)	r	-0.63**	-0.74**	-0.61**	—	0.76**
	N	182	182	182	—	182
Cas Drag (m/sec)	r	-0.61**	-0.65**	-0.52**	0.76**	—
	N	182	182	182	182	—

**p<0.01; *p<0.05