

STRENGTH AND RATE OF FORCE DEVELOPMENT NEEDS FOR EFFECTIVE COMBAT
CASUALTY EVACUATIONS

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Strength and Rate of Force Development Needs for Effective Combat
Casualty Evacuations

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ABSTRACT

The purpose was to examine the necessary strength and rate of force development to complete a modified fireman's carry in unweighted and weighted conditions. Eighteen male participants from North Dakota State Universities Army Reserve Officers Training Corp (ROTC) participated in this study. An isometric deadlift was performed on an AcuPower force plate to determine maximum peak force and rate of force development. The unweighted trial used a 75kg dummy, and the 50m course. The weighted trial added 9.09kg weight vests onto the dummy and the participant. Participants (n=13) that completed the fireman's carry for both weighted and unweighted conditions had significantly ($p < 0.05$) greater peak force (145 ± 17 kg) compared to participants (n=15) that could not complete both trials (109 ± 26 kg). Peak force significantly correlated to lean muscle mass ($R = .51$, $p < 0.05$) Peak force is a positive predictor to determine soldier's capability for combat casualty evacuation task.

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DEDICATION

I would like to dedicate this work to my family; my husband's unwavering support and my mom and dad's constant encouragement even when the times got tough.

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CHAPTER 1. INTRODUCTION

The recent conflicts in Afghanistan and Iraq started as a direct result of the terrorist attack in New York City, New York on September 11, 2001 when suicide bombers struck the Twin Towers. President George W. Bush signed S.J.Res. 23, “Authorization for Use of Military Force,” on September 18, 2001. This was enacted when Afghanistan refused to turn over Osama bin Laden and all al Qaeda members in the terrorist training camps. The United States deployed troops on October 7, 2001, starting Operation Enduring Freedom that lasted thirteen years until December 28, 2014. In 2002 the United States also deployed troops to Kuwait and Iraq for the War on Terror (Torreon, 2015; Smithsonian, 2016). The total death toll of US soldiers in the Gulf War was 1,948 soldiers as last reported on December 22, 2014 (DeBruyne and Leland, 2015). This number encompasses both Operation Desert Storm and Operation Desert Shield. In comparison, Operation Enduring Freedom and Operation Iraqi Freedom have a combined total of 6,764 dead US soldiers (DeBruyne and Leland, 2015).

Like the current unrest in the rough terrains of Afghanistan and the Middle East required the implementation of new and improved training protocols, many of the conflicts throughout history have also required the military to develop new training protocols. Changing wartime environments necessitate that soldiers adapt to specific, demanding unit and personal requirements. More specifically, soldiers need to be in peak physical condition so they can perform their duties efficiently and respond quickly to emergency situations, such as casualty evacuations. Indeed, every war the United States military has been involved in has had unique environmental, athletic, and training challenges. For example, World War II was fought in several different theaters from the Pacific Asian Theater to the Western Front Theater.

These famous WWII theaters are only a few of the many that the United States military has been forced to adapt to during our short, yet powerful life as a country. For example, the Gulf War in Kuwait was one of our shortest conflict engagements. It lasted from August of 1990 and to April of 1991 when Iraq accepted the cease-fire agreement (Torreon, 2015). Although this war was relatively short, it is important because it began our foray into an environmentally unique theater. Kuwait is a dessert climate with temperatures that reach into the 100's during the day in the summer months. Our most recent engagements in Afghanistan and Iraq have very similar climates to the dessert temperatures that were first presented to United States Troops in the Gulf War. For the past two decades the United States troops have had to acclimate to exceedingly hot and dry environments.

One common denominator across history, terrain, and climate is the fact that one soldier must be able to evacuate a wounded brother, while at the same time carrying his own gear and successfully navigating difficult and dangerous terrain. This requires not only mental and strategic training, but also sheer physical strength. It is for this reason that soldiers are referred to as tactical athletes (Kraemer and Szivak, 2012; Scofield and Kardouni, 2015). The military's goal of training every soldier as thoroughly as an Olympian athlete is not only appropriate, but also laudable. Although the military's efforts to improve training protocols are ongoing, in many instances this standard remains a goal. Furthermore, the detrimental consequences from inadequate training in the military world range from missed duty time to death. While missed duty time may seem insignificant in comparison to death, limited on-duty men due to missed duty times during missions can and do lead to increased casualties.

The established military training protocols follow guidelines for general physical fitness as opposed to task specific fitness. However, in today's military world soldiers need to be strong

and explosive; this requires specifically designed training protocols. Current civilian research has focused on improving these training protocols (Bergeron et al., 2011; Kraemer et al., 2004; Heinrich et al., 2012). The literature agrees that improvements need to be made; however, the methods that are presented are spread across the spectrum, ranging from safe and practical, such as periodization and concurrent, to drastic and experimental, such as extreme conditioning programs like CrossFit (Bergeron et al., 2011). Enhancement to load carriage has been in the forefront of the safe and practical training applications. The types of loads and methods of load carrying have been repeatedly revamped in an attempt to expand soldier's capacity and overall well-being during deployment (Knapik et al., 2004). Unfortunately, improvements on load carriage alone have shown little success in maintaining strength and power. However, the recently introduced training methods such as functional training, periodization (Kraemer et al., 2004), and extreme conditioning programs (Bergeron et al., 2011) have shown success in some areas.

Summary of the study

The current study is devised to test the strength and rate of force development necessary to complete a Fireman's Carry casualty evacuation. A total of 18 male volunteers from North Dakota State University's Army Reserve Officers Training Corp (ROTC) will be asked to complete a self-reporting health history and the study test protocol for the Fireman's Carry. Once the intake process is completed, the participants will complete a Fireman's Carry in accordance with the United States Military's *Casualty Evacuation* Publication (USAF, 2015). Participant pass-fail rates will be determined by participant completion time for the Fireman's Carry. Environmental stressors, such as gunfire, as well as physiological stressors, such as adrenaline, cannot be replicated in a controlled civilian study.

Research questions

1. How does external loading influence casualty evacuation task performance?
2. Can strength and rate of force development thresholds for combat troops be identified to predict success in casualty evacuation task?

Significance of study

The significance of this study is that it will begin to quantify the necessary strength and rate of force development outputs for today's combat soldiers need in order to successfully execute a casualty evacuation. There is limited literature regarding the required physicality for proper casualty evacuations in today's military. There is also minimal research in this area that focuses solely on males. This study will serve to fill a small portion of this gap in literature.

Organization

This paper is organized into four chapters. Chapter One is the Introduction. Chapter Two is the Review of the Literature, followed by Chapter Three, which details the methods of the study. Chapter Four will be in article format with an introduction, methods, results, and discussion. Chapter Five will provide a summary, a discussion, and some concluding observations.

Limitations

In the current study there are several limitations that cannot be addressed by civilian researchers. The most significant limitation will be the inability to accurately replicate a combat setting. Because the study will be conducted in a research lab at a university, the researchers will be unable to replicate the adrenaline caused by enemy gunfire or the stress of returning gunfire. In addition to environmental limitations, there are also equipment limitations. The type of weight carried by the volunteers will be strictly limited because, due to the strict fire arm restrictions on

a university campus, participants will neither carry exact army weaponry nor have access to Army issued Kevlar body armor.

Definition of terms

- Army Physical Fitness Test (APFT): The fitness test that designed to test the muscular strength, endurance, and cardiovascular respiratory fitness of soldiers in the Army.
- Army Physical Readiness Training (APRT): Army specific training defined as the ability to meet the physical demands of any combat or duty position, accomplish the mission, and continue to fight and win.
- Extreme Conditioning Programs (ECP): ECP's are high repetition, vigorous training workouts that incorporate challenging exercises performed in sequences with short rest period between sets.
- High Intensity Interval Training HIIT: Organized cardiorespiratory activities with short bouts of high intensity exercise followed by periods of lighter activity for an active rest phase.
- Military Occupational Specialty (MOS): A unique coding system to differentiate specific jobs within the military.
- Musculoskeletal Injuries (MSK): Injuries that affect the muscles, tendons, ligaments, and bones that affect human movements.
- Physical Readiness Training (PRT): Training defined as the ability to meet the physical demands of any combat or duty position, accomplish the mission, and continue to fight and win.

CHAPTER 2. REVIEW OF LITERATURE

Introduction

Throughout history changing wartime environments have necessitated that soldiers adapt to demanding personal and unit requirements. More specifically, soldiers need to be in peak physical condition so they can perform their duties efficiently and respond to emergency situations quickly, such as casualty evacuations. Indeed, every war the United States military has been involved in has had unique challenges: environmental, athletic, and/or training. For example, World War II was fought in several different theaters from the Pacific Asian Theater to the Western Front Theater. Because of these varied and changing demands, in today's military, soldiers are referred to as tactical athletes, (Kraemer and Szivak, 2012; Scofield and Kardouni, 2015). The military's goal of training every soldier as thoroughly as an Olympian athlete is therefore not only appropriate, but also laudable. These efforts are recognized and are applauded. However, this in many instances remains a goal. Current research has focused on improving these training protocols. Although the literature agrees that improvements need to be made, the methods that are presented range from safe and practical to drastic and experimental. Exercise training for the enhancement of load carriage (i.e., the amount of mass a soldier carries or could be required to carry) has also been in the forefront numerous times. The types of loads and methods of load carrying have been improved upon in an attempt to expand soldier's capacity and overall well-being during deployment. Improvements on load carriage alone have shown little success in maintaining strength and power. However, new exercise training methods have been introduced with particular success such as functional training, periodization, and extreme conditioning programs. The purpose of this literature review is to provide a well-

rounded background for the study of strength and power needs for casualty evacuations, a type of load carriage, during combat scenarios.

Currently, the established exercise training protocols follow proper training guidelines for general fitness as opposed to task specific fitness. Nevertheless, in today's military world the soldiers need to be strong and explosive, while maintaining their aerobic endurance. Current training protocols are called Army Physical Readiness Training (APRT). The improved APRT came out in the early 2000's. The protocol consisted of "six different types of exercise: calisthenics, dumbbell drills, movement drills, interval training, long distance running, and flexibility training" (Showman and Henson, 2014). All of these are designed to create a physical fit individual ready to meet and defeat the enemies of the United States in close combat. The Army Physical Fitness Test (APFT) consists of timed push-ups for strength, timed sit-ups to test range of motion, and a 2-mile run for maximal heart rate (Heinrich, Spencer, Fehl, Poston, 2012).

In order to gain strength and rate of force development while maintaining aerobic endurance the training program must be adapted. The exercise training program must have the appropriate duration, volume, and type of exercise, which is the essence of periodization that is used to train elite athletes (Kraemer et al., 2004). This appears to be lacking in the current exercise training and testing protocols of the Army. Although there is minimal crossover between the exercise science world and military world there has been several studies that introduce the ideas of aerobic and anaerobic training concurrently as well as extreme conditioning programs (e.g. Crossfit). By melding the exercise science and the military worlds the incidence of battle related injuries, such as musculoskeletal injuries, could be drastically reduced.

Load carriage: background and context

The Military Medicine Journal published an article in 2004 that showed the evolution of load carriage with historical, physiological, and biomechanical significance (Knapik, Reynolds, and Harman, 2004). Research can use related occupations, such as firemen, to draw parallels and increase the information that is available to future studies.

Historical perspective

Overall, load carriage has changed over the past century. At the turn of the 18th century many militaries were moving away from motor pool transports and requiring their soldiers to pack much of their necessities around with them. Fortunately, in 1987 the U.S. Army proposed 5 new ways to improve the load that soldiers carry on a daily basis. These proposed methods included development of components lighter in weight, soldier load-planning models, specialized load-carrying equipment, re-evaluation of current doctrines, and the development of physical training programs to condition soldiers effectively for load carriage. Only one of the five approaches was feasible, physical training programs for load carriage, and is shown in today's military by their emphasis on physical fitness and physical training. Jumping forward to the twenty-first century, United States soldiers still carry considerable weight with their necessary equipment as well as supplies. While their packs are removable, a soldier's mobility and explosiveness is drastically reduced while carrying upwards of 130 pounds on their back. This can lead to increased casualties and injuries amongst our service members (Knapik et al., 2004).

Related occupation: firemen

Although there is limited research on casualty evacuations in military soldiers, there is considerably more research done for casualty evacuations and person carries in firefighters. Several firefighting studies have created testing protocols for casualty evacuations, commonly

known as rescue operations in firefighting literature; however, these studies prefer to use a dragging method versus a single or double person carry (von Heimburg, 2007; Michaelides, 2011; Gledhill, 1992; Rhea, 2004). Nevertheless, there are several other useful correlations between firefighters and military personnel, such as weighted gear and musculoskeletal injury prevalence. Firefighters wear up to 48.4 pounds of protective turn out gear during every fire call (Gledhill and Jamnik, 1992) likewise; military personnel wear upwards of 130 pounds on their backs when on duty while deployed (Knapik et al., 2004). Gledhill and Jamnik's job related performance tests simulated the firefighters gear weight with the use of soft ankle weights as well as a weight vest. This option helps simulate the weight firefighters carry in a safer, less cumbersome manner. While carrying these large amounts of weight, both firefighters and military soldiers increase the risk of musculoskeletal injuries (Rhea, Alvar, and Gray, 2004), creating missed work time as well as increased risk to squad members (AFHS, 2012).

One readily apparent discrepancy between firefighters and military soldiers are the reported stricter screening protocols for firefighters as opposed to military personnel. Although the information available to civilians on the full screening process for military personnel is minimal, for firefighters Gledhill and Jamnik (1992) clearly define the medical evaluation that firefighter applicants must pass: cardiovascular function, pulmonary function, visual acuity, peripheral vision, depth perception, color vision, audiometer, and orthopedic status. Although there is minimal information regarding military entrance evaluations, the research community can draw parallels from related occupations, such as firemen, to help create stricter entrance guidelines and physical fitness evaluations for military personnel.

Biomechanical aspects of load carriage

Although research has not been able to significantly reduce the weight that United States troops carry, studies have been able to look at the biomechanics of load carriage and can determine how the load should be carried to cause the least amount of stress on the soldier. Clearly, load carriage was a major stressor for troops in the past, and it remains a major consideration for today's military. While there have been considerable efforts to address this concern made through the use of lighter components and specialized equipment (Knapik et al., 2004) to reduce the loads that soldiers carry, it is equally important to look at proper application of load distribution. Also the physical toll that different methods take on a soldier should be evaluated. The main three factors that the *Military Medicine Journal* evaluated were distribution of weight across the body, the use of combat load carts, and physical training. The best distribution technique for heavy load carriage is to have soldiers carry the weight at a high position on the back. According to Knapik et al. (2004) writing in the *Military Medicine Journal*, this provides a lower energy cost as well as a dynamic movement increase of 40%, which would greatly aid in the ability to defend ones self as well as perform effective casualty evacuations. Combat load carts are not appropriate in many environmental settings because they are not reliable on rugged terrain (Knapik et al., 2004). The last approach and the common theme of many research articles today, is physical fitness. Currently, the major issue with physical fitness and load carriage is injuries during the physical fitness. There are many different approaches to load carriage and physical fitness, however one must look at the current deployment needs to know how one can make effective changes that will help save lives of our deployed service members (Knapik et al., 2004).

Functional training and physiological readiness

Several studies have looked at the reliability of functional circuit training and the testing needed to determine physical readiness in combat troops. Functional circuit training mimics everyday activities for soldiers to ensure proper muscle activation and usage in combat situations. Mission Essential Fitness looked at the use of functional circuit training versus the Army's predesigned (APRT). The results indicated that the functional training group did significantly better than the APRT group. There were no reported injuries with this new training protocol. This suggests, "Progressive and scaled workouts are safe" (Heinrich et al., 2012). As this study shows, there are many ways to achieve functional strength necessary for physical readiness, however the testing protocols have remained the same in the 1970's and 1980's (Crowder, Ferrara, Levinbook 2013). Both facets of physical readiness need to be updated simultaneously in order to make the change measurable and applicable to today's soldier's needs. The Army is currently using the original test that was created almost forty years ago, a time when the test was "nothing more than a baseline fitness test administered and graded for the privilege to wear the uniform" (Crowder et al., 2013). One study looked at the test retest reliability of military relevant task tests and showed that their testing protocols were very reliable and showed overall fitness after several interventions (Spiering et al., 2012). U.S. Army Rangers are the elite soldiers in the Army and it has been shown that special emphasis on high levels of strength and power are needed to help them accomplish their missions (Nindl et al., 2007). Functional training would be extremely beneficial to this sector of the Army because they can train their muscles for tasks specific to their missions. The summation of these studies shows that there are feasible and reliable ideas that can be used and implemented in today's military to help determine physical readiness for combat troops.

Deployment physical fitness requirements

There are gaps in the literature in regard to body armor and its restriction of mobility during combat activities. Looking at the restrictive nature of body armor can show the military where their soldiers are vulnerable. If these soldiers are unable to adequately move and maneuver around their body armor they will not be able to properly perform casualty evacuations. Currently, this study does not have access to body armor and cannot properly assess the restrictions in mobility caused by body armor. However, there are many other topics that have been more widely researched, such as aerobic and anaerobic needs, load carriage, and environmental factors.

Aerobic training

Although today's battlefields are becoming primarily anaerobic (Kraemer and Szivak, 2012) it has been shown that increased or maintained aerobic endurance can significantly decrease medical resource utilization (Warr, Heumann, Dodd, Swan, and Alvar, 2012). This means soldiers need to keep up their cardiorespiratory fitness levels during deployments to help maintain a fit and properly functioning body. In a 9-month deployment study 70% of returning soldiers reported that they had a decrease in aerobic exercise frequency during their deployment (Sharp et al., 2008). While the literature proves that aerobic fitness is a key component to overall deployment well-being, it is one of the first physical attributes to decline. Not only does the aerobic capacity of soldier's decrease during deployment, a portion of deployed soldiers also come back with a higher percentage of fat mass versus their pre-deployment fat mass percentage (Sharp et al., 2008).

Anaerobic training

In a recent study, two groups of soldiers were given two different types of training to illustrate how aerobic and anaerobic, or resistance training, can be executed together to achieve physical fitness for today's warfighters. The results showed that the two groups, concurrent training as well as independent training, showed gains in physical fitness. While the concurrent group showed greater transferability to military relevant tasks (Kraemer et al., 2004). The effects of load carriage on explosive tasks have little research behind it, however it has been show that using high intensity interval training (HIIT) methods can significantly improve anaerobic capacity (Treloar and Billing, 2011). Unfortunately, improper training during high intensity interval methods can lead to overtraining and overuse injuries (Nindl et al., 2013).

Extreme conditioning programs

Extreme conditioning programs (ECP's) have become increasingly popular in both civilian and military circles. These programs are considered extreme because many times quantity versus quality is the mantra and form is lacking in many strength and power exercises. One example of an ECP would be the ever-popular Crossfit program. The literature is split on ECP's and their benefit in military performance.

Within current literature the cons are more prevalent than the pros. Conversely, the ECP's do employ functional movements that help improve the necessary muscle activations for the strength and power needed while deployed (Bergeron et al., 2011). Functional training has been proven effective within the military in previous studies.

Physicians and health care providers are concerned with the increased risk for musculoskeletal injuries associated with extreme conditioning programs (Nindl et al., 2013; Bergeron et al., 2011). Previous literature has shown that musculoskeletal injuries are a common

injury in deployed troops due to the stress of increased load carriage and physical demands. Adding in a conditioning program that also increases the risk of musculoskeletal injuries could be detrimental to the well-being and physical readiness of soldiers. Along with musculoskeletal injuries ECP's also impact cardiovascular health and increased incidences of heat exhaustion (Bergeron et al., 2011). Regrettably, the overall safety, physiological, and functional outcomes will need more investigation in order to fully understand their short and long-term consequences and benefits (Nindl et al., 2013).

Physical fitness correlations to injuries and illness

Due to these declines in physical fitness the incident of injuries and illness increase during deployments. Excluding battle related injuries; the top causes for injuries and illness are musculoskeletal injuries, gastrointestinal illnesses, and respiratory issues (Nindl et al., 2013).

Environmental factors

Along with the increase risk of injuries and illness due to declines in aerobic fitness, soldiers are exposed to a variety of environmental changes during deployments. The biggest of them being altitude changes and temperature changes (Nindl et al., 2013). In the current deployment arena, soldiers are going into extremely hot and dry environments that they may or may not be accustomed to. Soldiers must be able to adapt to these changes in environment quickly to maintain their physical readiness for missions.

Evacuations

Combat evacuations encompass both casualty evacuations as and medical evacuations, with medical evacuations accounting for the largest portion. Casualty evacuation procedures and practices are underrepresented in the literature. Many articles do not broach the subject and if they do, it is very minimally, such as in Spiering et al., 2012 while they were testing reliability for

readiness in United States troops with the use of military relevant tests. The United States Army has one publication specifically for proper form and technique for casualty evacuations, Casualty Evacuations, Army Techniques Publications 4-25.13. This publication describes single person carries, two person carries, and proper procedures to execute casualty evacuations. However, very few civilian research studies have looked into casualty evacuations and even less have looked at the strength and rate of force development needed to properly perform a casualty evacuation during combat. Combat evacuations have a myriad of causations; such as battle wounds, musculoskeletal injuries, and mental disorders (Nindl et al., 2013).

Evacuation prevalence and type

Evacuations happen for copious reasons in the battlefield. While battle related injuries are the largest singular reason for casualty evacuations it only makes up a small portion of the total medical evacuations. There have been several studies that show the breakdown of combat evacuations during several operations in the Middle East (AFHS, 2003-2011). The top medical evacuation causes during Operation Iraqi Freedom and Operation New Dawn were, battle injuries 17.7%, musculoskeletal injuries 16.3%, non-battle injury and poisoning 14.9%, and mental disorders 11.6% (AFHS, 2012). A second study, (Nindl et al., 2013) showed that gastrointestinal injuries were also a notable cause for evacuations. There are many other categories for medical evacuations and all of those combined far outweigh the number that is caused by battle injuries. This is a good statistic for our armed forces and their families because it means more deployed soldiers will return home safely. However, the musculoskeletal injuries occur from overuse and overtraining and account for the largest portion of medical evacuations even with external variables changing, such as location, troop surges, and the theater of operation (Nindl et al., 2013).

Casualty evacuation technique for battle injuries

Proper form is dependent on what type of evacuation is occurring. There are two main categories for battle injury evacuations that are relevant to this literature review: single carries and two-person carries. According to the United States's *Army Casualty Evacuation Manual*, a proper carry is defined as:

Carries, when performed correctly...provide the casualty more protection from further injury than drags...and are used to move a casualty a greater distance (from 50 to 300 meters depending on the carry). (USAF, 2015)

The focus of this study is on single person carries. The Army supports and teaches five different carries: 1) the Fireman's Carry, 2) a supporting carry, 3) an arms carry, 4) a saddle back carry, and 5) a pack strap carry. Many of these carries are similar to those seen on sports fields and everyday life, such as the supporting carry. The supporting carry aids those who are capable of moving one or both of their lower extremities. The injured soldier uses the bearer as a crutch with which to move (USAF, 2015). Other carries are more technical, such as the Fireman's Carry. This carry involves lifting the person from the ground up onto the bearer's shoulders. According to the published *Army Casualty Evacuation Manual*, the proper carry form for the Fireman's Carry is described as:

- After rolling the casualty onto his abdomen, straddle him. Extend your hands under his chest and lock them together.
- Lift the patient to his knees as you move backward.
- Continue to move backward, thus straightening the casualty's legs and locking his knees.

- Walk forward, bringing the casualty to a standing position; tilt him slightly backward to prevent his knees from buckling.
- As you maintain constant support of the casualty with one arm, free your other arm and quickly grasp his wrist, and raise his arm high. Instantly pass your head under his raised arm, releasing it as you pass under it.
- Move swiftly to face the casualty and secure your arms around his waist. Immediately place your foot between his feet and spread them apart (approximately 6 to 8 inches).
- Grasp the casualty's wrist and raise his arm high over your head.
- Bend down and pull the casualty's arm over and down on your shoulder, bringing his body across your shoulders. At the same time, pass your arm between his legs.
- Grasp the casualty's wrist with one hand and place your other hand on your knee for support.
- Rise with the casualty positioned correctly. Your free hand may be used to grasp your weapon. (USAF, 2015)

These techniques are taught to all United States Military. However, these lifts require not only strength and power, but also endurance, in order to successfully complete a subsequent move across unknown distances with an injured soldier. Yet, the literature on the strength, power, and endurance needed to execute these lifts is scarce.

Conclusion

There are gaps in the literature that need to be filled. Indeed, this complete literature review demonstrates that improved training protocols need to be developed in order to build and maintain the strength and power for all combat soldiers while maintaining their aerobic fitness levels. There are no studies comparable to this study that test the strength and rate of force development necessary to complete a casualty evacuation during combat. Nonetheless, the literature provided this study with an excellent starting point.

CHAPTER 3. METHODS

Overview of the study

The current study was devised to test the strength and power, via rate of force development, necessary to complete a Fireman's Carry casualty evacuation. The testing was conducted in a laboratory due to the restrictive nature of testing in a combat situation. A total of 18 men volunteered from North Dakota State Universities Army Reserve Officers Training Corp (ROTC) to participate in this study. The participants were asked to complete a self-reporting health history and the Par-Q questionnaires as an assessment of lower body strength and power, and then participated in the test protocol for the Fireman's Carry in unweighted and weighted conditions. These activities took approximately 1 hour per participant. The questionnaires were designed by the researcher to determine each participant's current physical fitness and activity levels. These levels were then compared to the participants' levels testing protocol pass-fail rates. Once the intake process was completed, the participants completed a Fireman's Carry in accordance with the United States Military's Casualty Evacuation Publication (USAF, 2015). The study's total time to complete data collection was approximately 40 hours. Participant pass-fail rates were determined by participant completion time for the Fireman's Carry as well as their ability to lift and compete both unweighted and weighted. This study was limited by the use of a laboratory setting as environmental stressors, such as gunfire, as well as physiological stressors, such as adrenaline, cannot be replicated in a controlled civilian study.

Research questions

1. How does external loading influence casualty evacuation task performance?
2. Can strength and rate of force development thresholds for combat troops be identified to predict success in casualty evacuation task?

Participants

The participants were volunteers from the North Dakota State University ROTC. Of the enrolled cadets, 18 volunteered to participate in the study the other cadets had prior engagements. This resulted in a convenience sample of Army ROTC male cadets (17-30 years of age).

Procedure

Groups of two to four participants were requested to arrive in one-hour intervals in order to create a systematic circuit system. Upon arrival, the participants were asked to complete the demographic questionnaire, the Par-Q health assessment, and the Health History questionnaire. Along with the paperwork, the participants also completed intake anthropometric data, such as height using stadiometer (Seca 213, Chino, CA), and weight using a standard digital scale, taken prior to beginning the warm up physical activity.

Warm up

In order to maintain a similarity to a real combat situation, the warm up was designed to be minimal, yet appropriate, in order to avoid the risk of injuries in the ROTC cadets. The warm up lasted 5 minutes and consisted of dynamic stretching and warm up repetitions of the deadlift exercise. The first stretch was walking knee to chest followed by a hip stretch with a twist. For the last dynamic stretch, the participants were asked to complete jump squats, in order to warm up the lower body prior to a set of deadlifts. The warm-up deadlift set consisted of 10 repetitions with an empty bar weighing 45 pounds.

Deadlift strength and rate of force development assessment

To determine a baseline strength and power for each participant, the study used an isometric deadlift utilizing an Acupower force plate (Advanced Mechanical Technology

Incorporated (AMTI) to obtain the data. The proper deadlift form was explained and the participants had the opportunity to practice with an un-weighted bar prior to the isometric deadlift protocol.

In order to obtain an accurate isometric deadlift, the bar was weighted with more weight than an individual could lift. This created the isometric hold portion of the lift since the bar was not be capable of leaving the ground. While the participants executed the deadlift, the force plate registered the force that their body exerted on the ground in accordance to Newton's Third Law. From this value, we could infer the rate of force development they exerted during the deadlift. This value was used to predict whether an individual would either pass or fail the Fireman's Carry test protocol. It was hypothesized that the higher the strength and rate of force development value from the isometric deadlift, the more probable that the participant would pass the Fireman's Carry test protocol.

Peak force and rate of force development testing

Peak force was determined by two to three averaged isometric deadlift outputs using the AcuPower force plate. If the first two maximal trials were within 5% of each other, the individual was done with that portion of the testing. Those who had drastically different maximal trial times were asked to do a third lift to obtain a better average. The rate of force development was determined by taking the time and maximal isometric force outputs and calculating the RFD using the formula, $RFD = (\text{force at 40\% MIF} - \text{force at 10\% MIF}) / (\text{corresponding time interval})$ Spiering, (2012).

Familiarizations walk through

A walk through was used to familiarize the participant to the environment and the route the Fireman's Carry test protocol followed. The walk-through was un-timed and helped

eliminate confusion during the testing protocol. By eliminating confusion, the data collected during the testing protocol was a more accurate representation of the true abilities of the participants.

Unweighted trial

An un-weighted trial was then completed, where neither the participant nor the test dummy had any additional mass added. This was a timed trial.

Weighted trial

The weighted trial was also preceded by a familiarization exercise. However, it was familiarizing the participants with the Fireman's Carry test protocol start to finish. The participants were fitted with a weight vest equaling twenty pounds to carry, in addition to the 165-pound test dummy they were carrying. The dummy was also fitted with a twenty-pound weight vest to simulate the weight of a fallen soldier's minimal gear. First, the participants were asked to execute the proper lift form for a Fireman's Carry. Once the participants were familiar and comfortable with the Fireman's carry lift, they were then asked to carry the dummy for 5-10 meters of the testing route. After a proper rest period of 2 minutes, the participants then began the actual testing protocol.

Fireman's carry testing protocol

The Fireman's Carry has been taught to the military for years as an effective casualty evacuation technique. This technique requires only one bearer to help their fallen brother to safety. Per the Army, the proper execution of a Fireman's Carry is defined as: "...one of the easiest ways for one individual to carry another. After an unconscious or disabled casualty has been properly positioned, they are raised from the ground, then supported and placed in the

carrying position. When possible, the bearer should transport the casualty so that the bearer's dominant (firing) hand is free." (See introduction for full description.)

Each participant began at that starting point with the simulation dummy at his feet. Upon hearing the whistle, the participant lifted the dummy onto his shoulders per the military's Fireman's Carry guidelines and carried the dummy 50 meters. After walking 25 meters, the participant performed a turn of their choice and headed back to the starting line to complete the full 50 meters. Once they crossed the starting line, the timer was stopped. The time values were recorded and later entered the statistical software. The participants were given a pass or fail designation based on criterion as indicated in Figure 1.

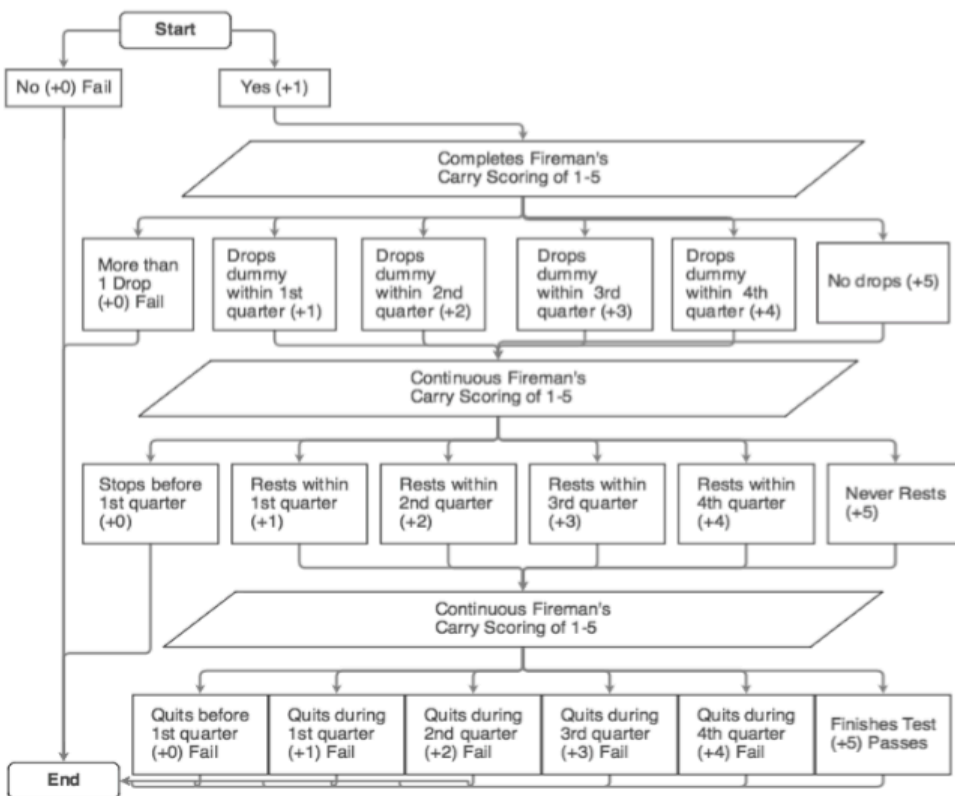


Figure 1. Fireman's Carry Score Chart

Dependent variables

The dependent variables in this research study are the participant's individual fitness levels and their timed scores for the Fireman's Carry. Although the cadet's do the same PT, they have a choice in their activity levels outside of the ROTC program and this can create a stronger or weaker individual. This will also have an impact on their ability to successfully carry out the timed Fireman's Carry test protocol.

Analysis

All data from the questionnaires was manually entered into an Excel spreadsheet. The data from the force plate was gathered and exported into an Excel spreadsheet. The remaining data was collected manually during the testing protocol and was entered into Excel prior to being transferred to SPSS for statistical analysis.

Means and standard deviations were calculated for each variable, as well as, bivariate correlations between all variables. Multiple regression was used to investigate each variables contribution to predicting the time it took for a individual to complete a trial. Additionally, independent sample t-tests were conducted to determine if there were significant differences between the individuals who passed and those who failed the weighted trial on any of the predictor variables.

CHAPTER 4: ARTICLE

Abstract

The purpose of the current study was to examine the necessary strength and rate of force development to complete a modified fireman's carry in unweighted and weighted conditions. Eighteen male participants from North Dakota State University's Army Reserve Officers Training Corp (ROTC) volunteered to participate in this study. An isometric deadlift was performed on an AcuPower force plate to determine maximum peak force and rate of force development. Two trials were then to be completed with a weighted and unweighted simulation dummy. The unweighted trial consisted of carrying a dummy that was 75kg, and the participants were timed on their completion a 50m course. The weighted trial added 9kg weight vests onto both the dummy and the participant and again the participants were asked to complete the course. Participants ($n = 13$) that completed the modified fireman's carry for both weighted and unweighted conditions had significantly greater peak force, greater lean muscle mass, higher weight, as well as significantly faster unweighted trial times when compared to participants ($n = 5$) that could not have completed both trials. Peak force was found to be significantly correlated to lean muscle mass ($r = .51, p < 0.05$). This indicated that isometric peak deadlift force is a positive predictor for determining soldiers' capability for completing combat casualty evacuation.

Introduction

Soldiers need to be in peak physical condition so they can perform their duties efficiently and respond quickly to emergency situations, such as casualty evacuations. It is for this reason that soldiers are referred to as tactical athletes (Kraemer and Szivak, 2012; Scofield and Kardouni, 2015). Current civilian research has focused on improving emergency training

protocols (Bergeron et al., 2011; Kraemer et al., 2004; Heinrich et al., 2012). Many researchers agree that improvements need to be made; however, the methods that are presented are spread across the spectrum, ranging from safe and practical, such as periodization and concurrent, to drastic and experimental, such as conditioning programs like CrossFit (Bergeron et al., 2011). Soldier's jobs are not limited to firearms and combat training. Per the Army MEDCOM Task Assessment publication, soldiers must be able to complete a myriad of tasks such as combat casualty evacuations, carrying large quantities of gear, and even rebuilding schools and hospitals that have been destroyed by the conflicts (Foulis, 2015). These tasks require the soldiers to maintain their physical strength and power throughout the duration of the deployment. The weight that is required of the men to carry can be extremely high depending on their MOS. Having such physical demands as simply moving items to and from places can put inadequately trained soldiers at risk should they have to perform or respond quickly to an unexpected situation such as an insurgent attack. The purpose of this study was to examine the strength and rate of force development necessary to complete a modified Fireman's Carry casualty evacuation.

Methods

The testing was conducted in a laboratory due to the restrictive nature of testing in a combat situation. A total of 18 men volunteered from North Dakota State University's Army Reserve Officers Training Corp (ROTC) to participate in this study (Table 1). The participants were asked to complete a self-reporting health history along with the Par-Q questionnaire as an assessment of lower body strength and rate of force development, and the study test protocol for a modified Fireman's Carry in unweighted and weighted conditions. These activities took approximately 1 hour per group of participants. Each group of participants consisted of two students and/or faculty members from the military sciences department and one group was tested

per day for a total of 9 days of testing. A questionnaire was designed in house to determine participant's current physical fitness and activity levels. Once the proper paperwork was completed, the participants worked through the testing combine, ending with the Fireman's Carry in accordance with the United States Military's Casualty Evacuation Publication (USAF, 2015).

Descriptive measures

The research team, using the available laboratory equipment at NDSU, obtained anthropometric data prior to beginning testing. Height was measured using a stadiometer (Seca 213, Chino, CA), weight was measured using a Tanita biometrical impedance digital scale, which also gave the research team the individual's body composition.

Peak force and rate of force development testing

Peak force was determined by two to three averaged isometric deadlift outputs using the AcuPower force plate. If the first two maximal trials were within 5% of each other, the individual was done with that portion of the testing. Those who had drastically different maximal trial times were asked to do a third lift to obtain a better average. The rate of force development was determined by taking the time and maximal isometric force outputs and calculating the RFD using the formula, $RFD = (\text{force at 40\% MIF} - \text{force at 10\% MIF}) / (\text{corresponding time interval})$ Spiering, (2012).

Fireman's carry

Each participant began at that starting point with the simulation dummy on an athletic training table. Upon hearing the whistle, the participant demonstrated the proper technique to lift the dummy off the table in a safe and controlled manner and proceeded to carry the dummy 50 meters. The 50-meter distance was broken in half and the participant executed a turn at the 25-

meter mark and head back to the starting line. Once they crossed the starting line, the timer was stopped. Both the unweighted and weighted trials followed this procedure. The dummy originally weighed 75kg for the unweighted trial, whereas the weighted trial began after the addition of a 9kg weight vest to both the participant and the dummy.

Statistical analysis

The data was analyzed using SPSS software, version 24. After the data were manually and digitally entered, a series of statistical tests were conducted to determine significance. Descriptive statistics were run and bivariate correlations were conducted to determine if there were any correlations between any of the study variables. Linear regressions were conducted to determine which, if any, of the variables significantly predicted the times of the unweighted trials and weighted trials. Lastly, independent sample t-tests were used to determine if there were significant differences between the participants who passed and those who failed the unweighted trial based on their times and abilities to make it to the finish line.

Results

Descriptive statistics for each variable are presented in Table 1. As 5 participants were not able to lift the dummy on the weighted trial, only the 13 participants who completed the weighted trial were included in the descriptive statistics for the weighted trial. Participant pass-fail rates were determined by participant completion time for the weighted Fireman's Carry, those who did not complete the weighted trial were excluded from the data analysis.

Table 1

Descriptive statistics

Variable	N	Mean	SD
Age (yrs)	18	23.39	6.02
Height (cm)	18	179.40	4.14
Weight (kg)	18	82.91	8.57
Fat Mass (%)	18	13.14	5.11
Lean Mass (%)	18	71.72	5.55
Peak Force (kg)	18	135.38	25.01
RFD (kg/s)	18	32.30	6.70
Unweighted Time (s)	18	34.40	.46
Weighted Time (s)	13	33.22	10.78

Bivariate correlations were used to look at the associations among the variables (Table 2). Higher body weight was significantly correlated with higher percentage fat, higher percentage lean mass, greater peak force, as well as being positively related to passing the weighted trial. Additionally, higher body weight was significantly associated with faster times on both the unweighted and weighted trials.

Table 2

Bivariate correlations

	1	2	3	4	5	6	7	8	9
1. Age (yrs)	-								
2. Height (cm)	.06	-							
3. Weight (kg)	.34	.11	-						
4. Fat Mass (%)	.48*	-.35	.70**	-					
5. Lean Mass (%)	.07	.45	.81**	.15	-				
6. Peak Force (kg)	.14	.11	.51*	.24	.51*	-			
7. RFD (kg/s)	.31	.30	.33	.08	.40	.69**	-		
8. Unweighted Time (s)	-.05	-.14	-.65**	-.30	-.67**	-.64**	-.31	-	
9. Weighted Time (s)	-.42	-.15	-.71**	-.38	-.71**	-.46	.73**	-	-
10. Pass/Fail	-.21	.29	.47*	-.09	.73**	.65**	.30	-.73**	-

* $p < .05$. ** $p < .01$. *** $p < .001$.

Larger percentage lean mass was significantly correlated to greater peak force (see Figure 1), faster times on both trials, and was positively related to passing the weighted trial. Peak force was positively correlated with rate of force development, negatively correlated to times on both trials, and positively correlated to passing the weighted trial. Faster times on the unweighted trials were significantly related to faster times on the weighted trials as well as passing the weighted trial.

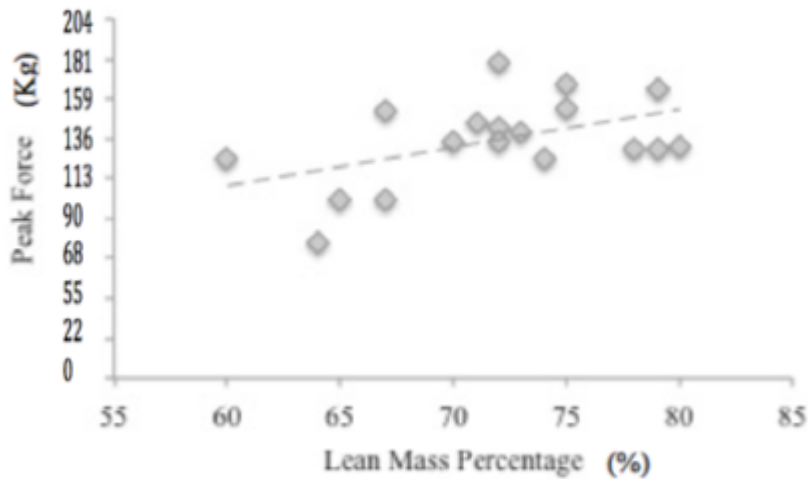


Figure 2. Depiction of Significant Correlation between Peak Force and Lean Mass Percentage

Inferential Analyses

In order to understand how individual differences, influence the amount of time it took each participant to complete the initial unweighted trial a linear regression was conducted. The unweighted time was entered as the dependent variables while age, height, weight, percentage body fat, percentage lean mass, peak force, and rate of force development were entered as the independent variables. The results of the analysis are displayed in Table 3. Unfortunately, none of the predictors showed significance and even with an R^2 of .63, the model did not significantly predict the variance for the unweighted trial time. Peak force approached significance with higher force predicting faster times, but the p-value was 0.11. Perhaps with a larger sample size the predictor could show significance towards higher force.

Table 3

Regression predicting unweighted trial time

	R^2	β	t
	.63		
Age (yrs)		.01	.05
Height (cm)		.02	.09
Weight (kg)		1.83	.41
Fat Mass (%)		-1.21	-.45
Lean Mass (%)		-1.80	-.55
Peak Force (kg)		-.53	-1.72
RFD (kg/s)		.25	.83

* $p < .05$. ** $p < .01$. *** $p < .001$.

An additional regression analyses was conducted to explore the impact of each of the predictor variables on the weighted trial time. As not everyone completed the weighted trial, only those who had a number for the variable were included in the analyses. The results for the analysis can be seen in Table 4. As with the previous model, the model did not predict a significant amount of the variance, $R^2 = .34$. Similar to the unweighted trial regression, none of the variables proved to significantly predict how long it took an individual to complete the weighted trial.

Table 4

Regression predicting weighted trial time

	R^2	β	t
	.34		
Age (yrs)		.10	.23
Height (cm)		.12	.23
Weight (kg)		7.67	.76
Fat Mass (%)		-5.42	-.75
Lean Mass (%)		-5.73	-.80
Peak Force (kg)		-.39	-.64
RFD (kg/s)		.47	.83

* $p < .05$. ** $p < .01$. *** $p < .001$.

As has been previously acknowledged, not all participants completed the weighted trial of the experiment. In fact, all participants who could lift the weighted dummy could complete the trial. However, five individuals were not able to safely lift the weighted body and therefore, did not complete the weighted trial. To understand what contributed to which individuals could pass the trial and those who failed, a set of independent sample t-tests was conducted. Whether an individual passed or failed the weighted trial was entered as the grouping variable, while age, height, weight, percentage body fat, percentage lean mass, peak force, rate of force development, and unweighted trial time were entered as the dependent variables in each of the separate t-tests. The results for the t-tests can be seen in Table 5. There were no significant differences between those who passed and failed in age, height, percentage body fat, or rate of force development. Those individuals who passed the weighted trial had significantly higher body weight ($M =$

85.34, SD = 6.18) than those who failed (M = 76.60, SD = 11.34), $t(16) = -2.13, p < .05$.

Participants who passed the weighted trial had significantly higher percentage lean mass (M = 74.18, SD = 3.89) than those who failed (M = 65.34, SD = 3.89), $t(16) = -4.31, p < .001$, (Figure 2). There was a similar pattern found with peak force, such that those who passed had significantly higher peak force (M = 145.14, SD = 16.9 kg) than those who failed (M = 110.00, SD = 26.19 kg), $t(16) = -3.40, p < .01$. (Figure 3) Additionally, those who had passed had significantly faster times on the unweighted trial (M = 30.34, SD = 4.41) than those who failed to initiate the trial (M = 44.92, SD = 10.65), $t(16) = 2.97, p < .05$.

Table 5

T-tests analyzing mean differences between weighted trial passing and failing

	<i>t</i>	Trial		Mean	SD
		Success	N		
Age (yrs)	.56	Pass	13	22.62	2.99
		Fail	5	25.40	10.97
Height (cm)	-1.83	Pass	13	180.11	4.67
		Fail	5	177.52	1.27
Weight (kg)	-2.13*	Pass	13	85.34	6.18
		Fail	5	76.60	11.34
Fat Mass (%)	.35	Pass	13	12.88	4.34
		Fail	5	13.84	7.34
Lean Mass (%)	-4.31***	Pass	13	74.18	3.89
		Fail	5	65.34	3.89
Peak Force (kg)	-3.40**	Pass	13	145.14	16.9
		Fail	5	110.00	26.19
RFD (kg/s)	-1.261	Pass	13	33.50	5.85
		Fail	5	29.13	8.41
Unweighted Trial Time (s)	2.97*	Pass	13	30.34	4.41
		Fail	5	44.92	10.65

* $p < .05$. ** $p < .01$. *** $p < .001$.

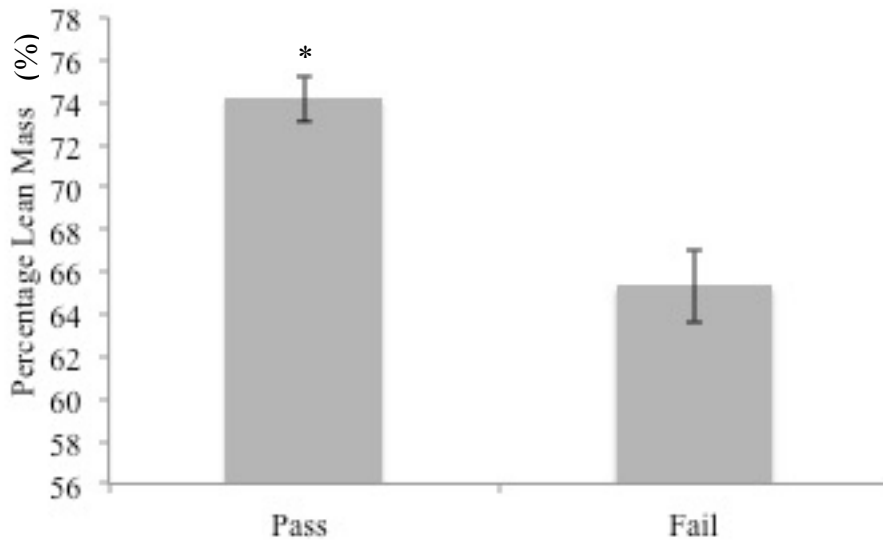


Figure 3. Depiction of Significant Difference on Percentage Lean Mass between Those Who Passed and Failed *P < 0.05

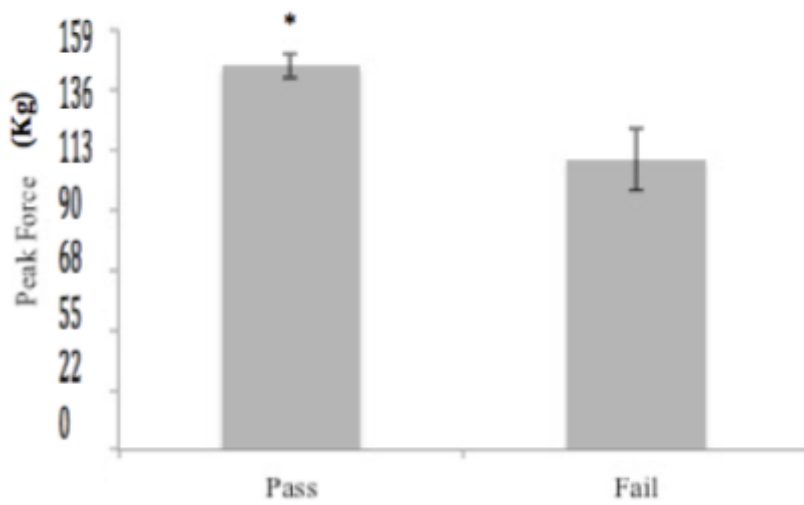


Figure 4. Depiction of Significant Difference on Peak Force between Those Who Passed and Failed *P < 0.05

Discussion

The purpose of this study was to examine the strength and rate of force development necessary to complete a modified Fireman's Carry casualty evacuation. This test protocol was modified from a traditional Fireman's Carry to fit within the constraints of a laboratory setting. Between the two test trials, the only variable that changed was the weight of the dummy and the participant. During the unweighted trial the cadet was unweighted and the dummy was also unweighted at its original weight of 75kg. Once the unweighted trial was successfully completed the cadets who passed moved on to the weighted trial where they were required to wear a weight vest weighing 9kg and the second 9kg weight vest was placed on the dummy. These vests simulated the addition of a backpack or other necessities.

Peak force and rate of force development

Peak force was positively correlated with the rate of force development, which was tested by doing isometric deadlifts on a force plate, as well as the individuals' ability to achieve a finishing time on the weighted trial. Per our data, a cadet who can reach the average peak force of 319lbs during the isometric deadlift could complete both timed trials with the simulation dummy. This supports the hypothesis that peak force is a positive predictor, or benchmark, to test soldiers for readiness for casualty evacuations. The military is beginning to use deadlifts as a testing protocol to maintain physical fitness standard, although this protocol is in its infancy, the deadlift used in is study helps support the validity and relevance of using a deadlift as a physical fitness test.

Lean mass significance

These data support the idea that lean mass is beneficial for soldiers in their daily activities and that it is a positive predictor for completing the Fireman's Carry. Currently the Army uses

waist circumference to determine adequate body composition. Unfortunately, this does not account for lean mass versus fat mass; therefore, soldiers who are in excellent condition can fail the APFT and those who are not strong can pass. Those individuals with more lean muscle mass are perceived to be in better physical shape in today's civilian society. However, these data support that not only are they better equipped for everyday life, they are also better equipped for the arduous tasks that the military requires. Higher lean mass percentages relative to body fat mass suggest a stronger, faster, and better equipped soldier defending our country.

Predict weight times

These statistics support that some (n=5) ROTC cadets are currently unable to adequately performing the duties necessary to be deployed into a combat theater and that with more training they will be better equipped to help fellow soldier in combat. Conversely they show that the remainder of the cadets (n=15) would be capable of carrying the test weight as well as some of the physical tasks asked of them. During the testing the average time for the unweighted trial was 34.39 seconds, which is slower than the weighted time average at 31.84 seconds. The slower time for the easier trial can be attributed to the individuals that struggled with the unweighted trial their longer times increased the average time it took to do the unweighted trial. The faster time for weighted trial could be because the participants were more familiar with protocol and the testing route. However, given the participants were able to practice with the dummy prior to the unweighted trial this prior experience probably has minimal impact on the faster weighted time. The positive outcome shows that many of the men defending our country can do the minimum asked of them in a combat theater.

Limitations of the study

There were several limitations to this study that need to be taken into consideration. Limitations such as environmental stressors, which include live gunfire, as well as physiological stressors, such as adrenaline could not be feasibly replicated in a controlled civilian study. Also, the small sample size (n=18) of ROTC cadets did limit the information the data was able to provide but this initial study has shown promise for further evaluation of isometric deadlift peak force as a predictor for combat casualty evacuation readiness.

Conclusion

The data that was collected during the research shows promising support of the research questions; “How does external loading influence casualty evacuation task performance?” and “Can strength and rate of force development thresholds for combat troops be identified to predict success in casualty evacuation task?” As seen in these data, those individuals who can achieve a deadlift of 319lbs or higher could complete the modified Fireman’s Carry test protocol. This gives a very strong and definite cut point for the military to use to determine if a soldier is strong enough to complete this basic task. Those who were not able to complete the weighted trial would not be able to carry the weight required of soldiers in a combat theater. Along with supporting data for external loading, we have supporting data for the force of development thresholds that can be used to identify successful combat casualty evacuations. Further research studies will be needed to officially conclude these results due to our small sample size.

CHAPTER 5: SUMMARY AND CONCLUSIONS

It was apparent beforehand that a higher pass rate would be the most favorable outcome for this research study. The methodology of this study was formulated to simulate a casualty combat evacuation as closely as possible in a controlled, educational environment. The study was devised to verify whether the current physical fitness standards are strict enough in order to ease the minds of family members who support troops stateside. Early in the process many factors came into light to determine what needed to be incorporated in order to make the study a valid representation. For this research study, isometric deadlifts, on an AcuPower force plate, were utilized to determine peak force and rate of force development to understand the participant's ability to generate force and ultimately the power necessary for lifting a person. The study also used a simulation dummy, weight vests, and an indoor 50m course to simulate the combat evacuation.

With the data collected from this study, the research team can conclude that the standards appear to be in good standing; however, more in depth studies will be needed to provided significant results that could be brought to the military. Currently the military is starting to introduce a new testing protocol using a deadlift. This study will help to provide evidence that a deadlift test protocol is a useful tool in determining combat readiness.

Further research needs to done on the topic of combat casualty evacuations. There are many avenues that one could take when looking at this research study and developing a secondary or more in-depth study. This study had to modify the Fireman's Carry by having the participants lifting the dummy off a table, a reasonable next step would be to conduct a full Fireman's Carry study that has the participants lifting the dummy from the floor or a shorter, more difficult starting point. In addition, the length of the carry could be increased since 50m

was the shortest distance proposed. Although this study shows practical significance, the research team would like to see a larger sample size in future studies to gain a better perspective and potentially statistically significant results.

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APPENDIX A. IRB APPROVAL LETTER



March 28, 2016

Dr. Kyle Hackney
Department of Health, Nutrition & Exercise Sciences
24 Bentson Bunker Fieldhouse

IRB Approval of Protocol #HE16227, "Strength and Rate of Force Development Necessary for Effective Combat Casualty Evacuations"
Co-investigator(s) and research team: Whitney Poser

Approval period: 3/28/2016 to 3/27/2017
Continuing Review Report Due: 2/1/2017

Research site(s): NDSU Funding Agency: n/a
Review Type: Expedited category # 4
IRB approval is based on the original protocol submission, with revised: consent form (received 3/25/2016).

Additional approval is required:

- o prior to implementation of any changes to the protocol (Protocol Amendment Request Form).
- o for continuation of the project beyond the approval period (Continuing Review/Completion Report Form). A reminder is typically sent 4-6 weeks prior to the expiration date; timely submission of the report is your responsibility. To avoid a lapse in approval, suspension of recruitment, and/or data collection, a report must be received, and the protocol reviewed and approved prior to the expiration date.

A report is required for:

- o any research-related injuries, adverse events, or other unanticipated problems involving risks to participants or others within 72 hours of known occurrence (Report of Unanticipated Problem or Serious Adverse Event Form).
- o any significant new findings that may affect risks to participants.
- o closure of the project (Continuing Review/Completion Report Form).

Research records are subject to random or directed audits at any time to verify compliance with IRB regulations and NDSU policies.

Thank you for cooperating with NDSU IRB procedures, and best wishes for a successful study.

Sincerely,

A handwritten signature in black ink that reads "Kristy Shirley".

Digitally signed by Kristy Shirley
DN: cn=Kristy Shirley, o=NDSU,
ou=Institutional Review Board,
email=kristy.shirley@ndsu.edu,
c=US
Date: 2016.03.28 10:30:54 -0500

Kristy Shirley, CIP, Research Compliance Administrator

For more information regarding IRB Office submissions and guidelines, please consult www.ndsu.edu/irb. This Institution has an approved FederalWide Assurance with the Department of Health and Human Services: FWA00002439.

APPENDIX B. INFORMED CONSENT

NDSU North Dakota State University

Health, Nutrition, and Exercise Sciences

Department # 2620, PO Box 6050

Fargo, ND 58108-6050

701-231-6706

Title of Research Study: Strength and Rate of Force Development Necessary for Effective Combat Casualty Evacuations

This study is being conducted by: Dr. Kyle J. Hackney 701-231-6706 and Co-Investigator, Whitney Poser 406-595-0385, whitney.poser@ndsu.edu.

Why am I being asked to take part in this research study? Up to 25, male participants in North Dakota State University's Army ROTC program are being asked to participate in this research study. The study will be looking at strength and rate of force development capabilities of male Army ROTC cadets and their ability to carry a fallen soldier (simulated with a rescue dummy) to safety using the Fireman's Carry.

What is the reason for doing the study? The purpose of this research study is to find out how strong a person needs to be in order to carry a fellow soldier to safety. This will help show if the current physical fitness activities are making Army cadets strong enough to properly perform their mandatory tasks. On a larger scale, this study will provide more information for other researchers to work with in this field of study.

What will I be asked to do? Volunteers will be asked to fill out health questionnaires when they arrive at the lab. This will help determine if the volunteer is healthy enough to be in the study. Once the paper work is done, the volunteers will be measured for their height, weight, and body

fat composition. Next we will use a force plate to measure strength using a deadlift exercise. The researchers will then explain the test and walk the volunteers through each step:

- Warm-up
- Unweighted trial walk through
- Unweighted Fireman's carry test protocol for a score
- Weighted Fireman's carry test protocol for a score.

The unweighted fireman's carry test will consist of lifting a rescue dummy that weights (165 lbs) and moving with it across the laboratory for up to 165 feet. The weighted fireman's carry test will consist of lifting a rescue dummy that is also wearing 20 lbs of additional mass via a vest (185 lbs). This simulates added gear worn by the solider. You will also be wearing 20 lbs of additional weight to simulate added gear. We will record the time it takes to perform the task and if it is completed successfully. Once the weighted fireman's carry is complete the participants will be done with the study.

Where is the study going to take place, and how long will it take? The study will be taking place in the Human Performance Lab located in the Bentson Bunker Field House room 15 at North Dakota State University. The total time needed for each volunteer will be roughly one hour.

What are the risks and discomforts? This research opportunity holds little risk to the participants considering the population is performing exercise training and practicing similar tasks. The risk of fatigue is the largest concern for the individuals that volunteer. However, the participants can rest or stop the testing at any time if they feel too tired. The researchers will also

be watching the test and will step in if the need arises. Other risks included with exercise or lifting objects include:

- General muscle soreness and tenderness after the deadlift exercise and unweighted and weighted suit sessions. This is typical response from overloading the muscular system with additional weight (moderate to high probability of risk occurring).
- There is a risk of mild skin irritation from the weighted vest and the synthetic dummy rubbing against the skin. If these are noticed during a session bandaids, tape, or padding will be used to help reduce the irritation (moderate probability of risk occurring).
- Muscle, tendon, ligament, bone strain/tears or breaks or cardiovascular irregularities.

Within any exercise or lifting task there are some potential risks. This will be minimized by having 1-2 spotters with the participant at all times to minimize a potential fall. We will also make sure that there are no previous injuries to sensitive areas (example- lower back, spine, neck, and knees) prior to initiating the study. You are also participating in general exercise conditioning to potentially perform similar tasks as part of your military training, which lowers the potential risk of injury. Further, those with a current medical profile with ROTC or those that are not allowed to participate in current ROTC exercise training will be excluded from this study for health reasons (low probability of risk occurring).

What are the benefits to other people? This study will help understand the fitness required for some of the more demanding soldier performance tasks.

Do I have to take part in the study? Your participation in this research is your choice. If you decide to participate in the study, you may change your mind and stop participating at any time without penalty or loss of benefits to which you are already entitled.

What will it cost me to participate? There will be no cost to the individual to participate in this research study. It will take roughly one hour of their time.

What are the alternatives to being in this research study? Instead of being in this research study, you can choose not to participate.

Who will see the information that I give? We will keep all of your information confidential and secure. We will create a 2 digit code that links your information with your name. The code will be used in spreadsheets and in equipment software instead of your name. The link file between the participant number and name will be kept in an encrypted excel file behind a password protected computer. Once data collection is completed the link file will be destroyed. All hard copies of paper documentation will be kept in a lock file behind locked doors to ensure confidentiality and privacy. All digital copies of paper documentation or digital documentation will be kept on an encrypted flashdrive within the locked file cabinet and/or on NDSU secured shared drives. These will only be accessed by the principle investigator, co-investigators, and members of the research team.

Can my taking part in the study end early? The study will take place for a period of one to two weeks with scheduled time frames. It will require one hour of the volunteer's time. Failure to show up could remove the individual from the study, but more than likely it can be rescheduled.

What happens if I am injured because of this research?

If you receive an injury in the course of taking part in the research, you should contact Dr. Hackney at the following phone number 701-231-6706. Minor treatments for the injuries will be available including first aid. However, if further treatments are required payment for this treatment must be provided by you and your third party payer (such as health insurance). This

does not mean that you are releasing or waiving any legal right you might have against the researcher or NDSU as a result of your participation in this research.

What if I have questions?

Before you decide whether to accept this invitation to take part in the research study, please ask any questions that might come to mind now. Later, if you have any questions about the study, you can contact the researcher, Dr. Kyle Hackney at this phone number 701-231-6706 or by email at kyle.hackney@ndsu.edu. Also, you may contact Whitney Poser 406-595-0385, whitney.poser@ndsu.edu for questions.

What are my rights as a research participant?

You have rights as a participant in research. If you have questions about your rights, or complaints about this research you may talk to the researcher or contact the NDSU Human Research Protection Program by:

- Telephone: 701.231.8995 or toll-free 1-855-800-6717
- Email: ndsu.irb@ndsu.edu
- Mail: NDSU HRPP Office, NDSU Dept. 4000, PO Box 6050, Fargo, ND 58108-6050.

The role of the Human Research Protection Program is to see that your rights are protected in this research; more information about your rights can be found at: www.ndsu.edu/irb .

Documentation of Informed Consent:

You are freely making a decision whether to be in this research study. Signing this form means that

1. you have read and understood this consent form
2. you have had your questions answered, and

3. you have decided to be in the study.

You will be given a copy of this consent form to keep.

Your signature

Date

Your printed name

Signature of researcher explaining study

Date

Printed name of researcher explaining study