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Perceived exertion and the increase in risk of injury in ROTC cadets

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PERCEIVED EXERTION AND THE INCREASE IN RISK OF INJURY IN ROTC CADETS

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APPROVAL OF THESIS

We, the faculty supervising the work of Courtney Dawn Chiaramonte, affirm that the thesis, *Perceived Exertion and the Increase in Risk of Injury in ROTC Cadets*, meets the high academic standards for original scholarship and creative work established by the Exercise Science with a Concentration in Athletic Training and the Masters of Science and the College of Health Profession. This work also conforms to the editorial standards of our discipline and the Graduate College of Marshall University. With our signatures, we approve the manuscript for publication.

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ABSTRACT

Context: Musculoskeletal injury in military personnel creates problems due to economic losses, and decreased training. The repetitive motions associated with military training and the daily physical training sessions can lead to the development of fatigue. Fatigue has been shown to contribute to 18% - 26% of musculoskeletal injuries. [7] Several studies have explored fatigue as a risk of injury during occupation. Fatigue has been shown to increase the perceived effort during physical exercise. The purpose of this study was to characterize the perception of effort during physical training sessions and injury rates in ROTC cadets throughout an academic year.

Methods: The design of this study is a retrospective records review. The participants in the study are ROTC cadets from a collegiate institution. ROTC cadets participated in physical training five days a week for 65 to 90 minutes. A modified Borg perceived exertion scale was used to determine the Cadet's perception of their effort (RPE) during regular physical training sessions. The Borg scale is a 1 point scale (0 = no effort, ten = very, very strong), 64 ROTC provided ratings of perceived exertion. Cadets completed the survey following all physical training sessions. Cadets excluded from results reported RPE ratings at six or below. Twelve (12) cadets reported an injury to the Athletic Training staff. The mean RPE, acute and chronic workloads, mean RPE during the week the cadet reports an injury and mean RPE during the four weeks before the reported injury respectfully followed the acute to chronic workload ratio. The University IRB approved this investigation.

Results:

A total of 1,426 RPEs during the 23 weeks completed data collection. With RPE ratings at six or below, seventeen cadets did not contribute to the study. The average RPE rating was a six (6) on the Borg Scale. Twelve (12) injuries reported by 11 cadets (6 males and five females); of these

injuries, six were acute, and six were chronic. An injured cadet having an RPE score at six or below did not contribute to data collection. The ten injured cadets reported 419 RPEs with their mean RPE 5.2 ± .5 on the Borg scale. The cadets not reporting injuries mean RPE was 5.8 ± 1.8. The injured acute workload was 5.3 ± 1.9 for the injured cadets and 5.2 ± .8 for the non-injured cadets. The injured cadets' chronic workload was 5.0 ± 1.0 for the injured cadets and 5.3 ± .3 for the non-injured cadets. The injured cadets' workload ratio was 1.06 ± .4 for the injured cadets and .96 ± .1 for the non-injured cadets. None of these differences reached statistical significance.
Conclusion: Ratings of perceived exertion and workload ratios did not differ between ROTC cadets that reported or did not report a musculoskeletal injury.

CHAPTER 1

INTRODUCTION

Musculoskeletal injury in military personnel creates problems due to economic losses, lack of labor source, and a decrease in training. [1] These injuries occur within the military personnel result mainly from overuse or “chronic” mechanisms rather than acute injury. The repetitive motions associated with military training and the daily physical training sessions can lead to the development of fatigue. One study found that fatigue did associate with an increased risk of injury due to the workloads of physical training. [2] However, within military personnel, thorough investigation between the association between fatigue and injury is limited within research.

Increased knowledge on the mechanisms leading to development of injuries of military personnel could lead an improvement in injury reduction strategies, which accomplishes our goal of preventing injuries through researching perceived exertion and the risk of injury.

Fatigue is multifaceted and complex, leaving the effects of fatigue to overlap areas of performance, cognition, and emotion. Fatigue is also reported as a lack of energy, consistently feeling run down, lack of motivation, or decline in the ability of a muscle to generate force or function of body weakens. [3, 4] The two types of general fatigue are peripheral (physical) and central (mental). [5] These types of fatigue can be broken down into exercise fatigue, localized muscle fatigue, systemic fatigue (CFS), systemic exertion intolerance disease (SEID), central nervous system fatigue, central fatigue, and burnout. Built-up fatigue is different from “feeling tired” after a workout; instead it involves extreme fatigue or tiredness that makes one feel that their body has to work harder to perform. [6] By improving the understanding of fatigue and the breakdown in the body that occurs to create injury, reduction of injury development could occur by recognizing fatigue early.

Injury due to fatigue has been shown as being responsible for up to 18% of bodily injuries and as much as 26% of overuse injuries. [7] Studies that have researched injuries in physical training showed that the overall incidence of all injuries during the 9-week training period was 31.9% and the risk factors of lower extremity injury in ROTC were reported that 21% of the cadets sustained a lower extremity injury which took 120.15 ± 85.69 days on average to recover. [8, 9]

Perceived exertion is a subjective feeling of how difficult a given task or physical activity is after completing that given task or physical activity. [10-12] The ratings of perceived exertion scale (RPE) was founded by Gunnar Borg in 1973 and since then has developed and changed based on further research. [13] The RPE scale is a subjective measure allowing an individual to reflect on the intensity of the physical training. The RPE scale has been shown to reflect increased muscle contraction intensity, heart rate, and respiration. [14] RPE has also been shown to increase with increased fatigue level resulting from repetitive motion and physical activity. [11, 15] Although Borg and perceived exertion have been significantly researched, connecting perceived exertion and injury is limited in research, especially in the military.

Several studies have explored fatigue as a risk of injury during occupation. [3, 4, 16] A relationship between an increase in fatigue and frequency of occupational injuries was reported. [3, 4, 16] As fatigue develops within the body a decline in the ability of a muscle to generate force or function of body decreases. [3, 4] The literature supports the relationship between fatigue and the risk of injury; however, limited research supports the link between the RPE and injury rate specifically in a military population.

By examining the correlation between these two concepts, an injury could be prevented by intervening when the perceived exertion levels continue to grow rather than increase and decrease based on the workouts. The current gaps within the research are not only the correlation between these two concepts but also the military population has not been researched.

Purpose

The purpose of this study was to characterize the RPE during workout/physical training sessions and injury rates in ROTC cadets throughout an academic year. The results of this study will provide and improve information on perceived exertion and its effects on injury. With these results, identification could be made for exposed individuals so intervention could occur before injury.

Statement of the Problem

The rate of musculoskeletal injury in a military population presents economic and readiness problems to the armed forces. Many of the injuries experienced by military personnel are classified as chronic injuries. The relationship between repeated exercise, RPE, and the occurrence of musculoskeletal injury has not been explored in a military population.

Research Question

Can ratings of RPE predict the occurrence of musculoskeletal injury in an ROTC cadet population?

Null Hypothesis

H_o: RPE ratings will have no association with musculoskeletal injury occurrence in an ROTC cadet.

Alternative Hypothesis

H_1: Higher the RPE will be associated with an increased occurrence of musculoskeletal injury in an ROTC cadet.

Operational Definitions

Borg Rating of Perceived Exertion (RPE)- A subjective method of measuring physical activity intensity, how hard you feel like your body is working based on psychological factors (cognition, memory, previous experience, understanding of task) and situational factors experienced during activity. [11]

Perceived Exertion- Exertion is a subjective feeling of how difficult a given task or physical activity is after completing that given task or physical activity. [11]

Borg's 0-10 scale- An 11-point scale used to measure (0=nothing to 10=very, very heavy). [17]

Fatigue (modified) - A lack of energy, consistently feeling run down, lack of motivation or decline in the ability of a muscle to generate force or function of the body weakens. [3, 4]

Injury- Occurrence of harm, damage, or impairment resulting from physical conditioning during training that is severe enough to prevent return to normal activities or modification to normal activities for at least one day. [8]

Injury risk- The probability of injury per individual or proportion of a closed population who may become harmed, impaired or damaged within a given period. [18]

Athletic Trainer(s) - Are highly qualified, multi-skilled health care professionals who collaborate with physicians to provide preventative services, emergency care, clinical diagnosis, therapeutic intervention and rehabilitation of injuries and medical conditions. [19]

ROTC cadet(s) - A college or university-based student in training programs to become a commissioned officer in the United States Armed Forces. [20]

Workload - the cumulative amount of stress placed on an individual from multiple training sessions over some time. [21]

Limitations

The limitations of this study include:

1. Physical activity outside of the Cadets' ROTC activities were not controlled (ex: lifting, swimming, running, recreational leisure).
2. The time between physical training activities was not consistent.
3. Interpretations of instructions for rating perceived exertion.
4. The investigators were not blinded to the RPE reporting procedures.
5. Sample population from a single collegiate institution.

Delimitations

The delimitations of this study include:

1. The sample size.
2. The participation pool being male dominate.
3. The participation pool containing males and females aged 18-27.
4. Generalization being to the military population only, specifically ROTC.

Assumptions

The assumptions for this study include:

1. The Marshall University ROTC cadets will be representative of ROTC cadets or general military population.
2. Participants read the question and complied with all instructions.
3. Participants understood the rating of perceived exertion scale and answered truthfully.
4. Participants reported all injuries to the Certified Athletic Trainers on staff.
5. Participants will not seek treatment from other health care professionals until after investigation

from the Certified Athletic Trainers on staff.

CHAPTER 2

LITERATURE REVIEW

Introduction

The purpose of this study is to characterize the ratings of perceived exertion during workout/physical training sessions and injury rates in ROTC cadets throughout an academic year. The results of this study will provide and improve information on perceived exertion and its effects on injury. With these results, identification can be made for exposed individuals so intervention could occur before injury. The rate of injury in a military population presents economic and readiness problems to the armed forces. Many of the injuries experienced by military personnel are classified as chronic injuries. The relationship between repeated exercise, ratings of perceived exertion, and the rate of injury have not been explored in a military population. Military members including ROTC cadets experience overuse injury and injury from fatigue due to the physical demands required during daily physical training sessions, outside physical training, and the difficult repetitive movements that occur. [8, 9, 22] This review will be comprised of the available literature on perceived exertion ratings, injury rates from fatigue, Army injury, and cost of treatment.

Musculoskeletal injuries result in over one million medical encounters, and ten million limited duty days per year for over 70% of the medically non-deployed population. [23] This high rate of limited duty days poses a threat to the combat readiness to troops and is also a high financial cost to the United States. Jordaan and Schwellnus reported the incidence of injuries over the 9-week training period of 31.9% in military recruits during basic training. [8] These injuries are conditions of fractures, wounds, sprains, strains, dislocations, concussions, compressions, and chronic injury that occur from prolonged exposure. [24] Injury can also be described as a characterized impairment and dysfunction that is either painful or debilitating to the body. [18] Injury in the military is important for clinicians to understand and recognize because of the consequences that follow.

Cost and Loss of Training Days

Musculoskeletal injuries are common at all US military training sites. [25] Musculoskeletal injuries incur a substantial cost, interrupt training, and prompt medical discharges. [25] The US Department of Defense has approximately 1.6 million musculoskeletal injuries occur annually. [26] These musculoskeletal injuries account for 2.4 million medical visits and $548 million in direct patient cost. [26] Musculoskeletal injuries translates into 25 million limited-duty days and 900,000 plus service members affected each year. Military duties are hazardous; however, the leading cause of musculoskeletal injuries is non-combat related and often related to participation in recreational sports and physical training. The vast majority of injuries (82%) between 2001 and 2003 in Iraq and Afghanistan were classified as overuse, and 31% to 34% of medical evacuations were non-battle musculoskeletal injuries. [26]

According to the Army Public Health Center, musculoskeletal injuries and related conditions average 37 limited duty days per injury. [27] These types of conditions translates to 2 million medical encounters across the Army annually and an estimated 10 million lost training days due to limited duty. [27] Seventy percent of these limited duty profiles are for musculoskeletal injuries, which occur more often with greater amounts of training. [27] These greater amounts of training result in more injuries; however, physical training is necessary to maintain fitness for military missions but is also known to cause injury.

In a study of a 9-week basic military training period, injuries were responsible for the loss of 2,631 training days. Of these injuries, overuse injuries were responsible for 2,301 training days, equaling 2 days per military recruit. [8] Overall the injuries in the study population over the training period was 31.9% (367 injuries), the mean weekly incidence of injuries was 3.63/100 recruits/week, and the incidence of all injuries per 1,000 training hours was 1.8/1,000/training hours. [8] Of all injuries 317 (86.4%) were classified as overuse, and 50 (13.6 %) were classified as acute traumatic injuries. Out of the 9-week training period the highest incidence of injuries was recorded in the 9th week of training followed by the first and second weeks. These injuries were defined as an occurrence resulting from physical conditioning during basic activities for at least one day after medical consultation. [8] Training included physical training sessions for 60- 90 minutes 3-5 times a week, rucking, combat swimming training, field training consisting of route marches and battle tactics training. Reserve Officer Training Corps (ROTC) cadets must meet the same physical standards as active duty and undergo organized physical training. [28] Therefore, cadets are at risk for training related musculoskeletal injuries.

Fatigue

Fatigue is a common complaint when an individual partakes in physical activity. Fatigue is the outcome of an individual's ability to meet the demands of an activity through aerobic means.[29] If an individual cannot meet the demands of an activity, fatigue increases. Although fatigue increases the likelihood of injury, the presence of some fatigue is essential to increasing fitness level. Elevated fatigue levels, both physically and mentally, for a prolonged period of time can significantly increase the risk of injury due to the compromising of muscle strength, coordination, mental attentiveness, and concentration.

Fatigue is broken down into different types, such as exercise-induced fatigue, localized muscle fatigue, chronic fatigue syndrome (CFS), systemic exertion intolerance disease (SEID), central nervous system fatigue, central fatigue, or burnout. Fatigue is noted as a lack of energy, consistently feeling run down, lack of motivation or decline in the ability of a muscle to generate force or function of localized area or body weakens. [3, 4] During this research process fatigue is defined as a lack of energy, consistently feeling run down, lack of motivation or decline in the ability of a muscle to generate force or function; this can be the whole body or localized. The subjective limit of fatigue typically occurs around RPE 19 (extremely hard) on the Borg 6-20 scale which would be nine on the Borg 0-10 scale. [17]

Exercise-induced fatigue can also be defined as muscle fatigue. Muscle fatigue is a decrease in maximal force or power in response to activity. This type of fatigue originates at different levels of motor pathways and is divided into central and peripheral components. Peripheral fatigue is caused by changes at the distal neuromuscular junction, and central fatigue originates at the central nervous system (CNS) which decreases neural drive. [30, 31] Muscle fatigue is usually experienced during physical training, performance, prolonged activity, and strenuous activity.

Localized muscle fatigue (LMF) is defined as "a loss of maximal force-generating capacity" [32] or "failure to maintain the required or expected force." [33] LMF is a complex multifactorial phenomenon that is used as an indicator of physiological processes, since this type of fatigue leads to a decline in desired performance and muscle force production. [34] Localized muscle fatigue usually occurs during diverse activities such as occupation and athletic performances, which involve voluntary muscle generation.[34-36] LMF systems are both subjective as well as objective changes, which include increased perceived exertion, diminished neuromuscular control, and reduced strength.

Fatigue accumulation, unresolved, leads to overwork, chronic fatigue syndrome (CFS) also known as systemic exertion intolerance disease (SEID). Chronic fatigue and systemic exertion intolerance are defined as a persistent tiredness lasting months that is not ameliorated by rest.[32, 37] CFS and SEID is a disease that is characterized by profound fatigue, pain, disturbed sleep patterns, all of which are increased with exertion.

Jones et al. [2] investigated the relationship between injury and illness and longitudinal training load and fatigue markers in the sporting population. In this study, it was found that athletes are at an increased risk of injury/illness at key stages of training and competition, including periods of training load increase. Fatigue can result in overtraining, which has a significant impact on performance. These findings suggest that when adequate recovery time between training and competition is not taken, fatigue accumulates, and comprises key aspects of performance which results in increased risk of injury or illness.

Fatigue initiates a decline in maximal muscle contraction and muscle strength requiring alternate muscles and techniques to occur in order to continue activity. [29, 38] Fatigue can also induce many biomechanical and muscular alterations as a result of an athlete adjusting their movement in order to continue to play at their best. [2, 29] These adjustments and lack of contraction may increase the likelihood of injury due to the recruitment of alternate muscles and techniques.

Perceived Exertion

The study of perceived exertion is an area of extensive research within the exercise and sports performance, as physical performance emanates the interaction of perceptual, cognitive, and metabolic process. [17, 39] During recent decades, researchers have become more interested in how individuals feel what pain or aches they have, and how difficult they perceive their work to be. [40] Perceived exertion is a measurement of how hard one personally feels like their body is working. The rating of perceived exertion (RPE) is a recognized marker of intensity and the disturbance of homeostatic during exercise. [40] Rating of perceived exertion is a quantitative subjective measurement and allows an individual to reflect on the intensity of the physical training, based on sensations like increased heart rate, increased respiration, and fatigue levels. [11] The body perceives exertion through heart rate, respiration, fatigue, workload, and stress. Each individual has perceptional highs and lows based on the process of recognizing and interpreting these sensory stimuli. The RPE has remarkable value as a psychophysiological integrator that can be used in diverse ways to predict exercise capacity and explain changes in pace. [39]

In 1962 Borg devised a simple rating method in which physical work is subjectively evaluated. [15] The rating of perceived exertion (RPE) can be done using the Borg scale 6-20, modified Borg Scale 0-10, and Borg CR10 Scale 2010 model. In both Borg 6-20 and 0-10 the lowest number on the scale being 6 or 0 equals no exertion at all and gradually increases to the maximal number being 20 or 10 equal to maximal exertion. [40] CR10 Scale is best used when there is an overriding sensation from a specific body part such as breathlessness, chest pain, angina, dyspnea, and musculoskeletal pain. It is important to note that the comparison of the RPE values from 6-20 scale with those from CR-10 scale, RPE 19 equates to 10 and RPE 20 equates to 12 on the CR-10 scale.[39]

Exercise intensity is reflected in the response of oxygen consumption, blood pressure, blood lactate levels, and heart rate. The most common Borg Scale 6-20 was constructed to correspond with normal heart rate for healthy individuals. Several studies by Borg have confirmed 1:10 ratio of RPE to exercise heart rate in adults. Gillach et al.[41] found correlations between heart rate and RPE based on the mean of individual correlations across powers (0.92 children and 0.94 adults); extremely high correlations in all groups indicated strong association between heart rate and RPE (0.94 children and 0.95 adults), and lastly correlations between heart rate and RPE based on the entire group, all correlations significant at $p<0.001$ of 193 children and 188 adults. [41] Bjorn Ekbolm and Alberto Goldbarg performed a study with 19 healthy male subjects in which bicycling, arm work, running and swimming occur. [15] In all experiments, maximal workloads were chosen to exhaust subjects in 3 to 6 minutes, were preceded by a 2 to 3 min “warm-up” with a load of about 40 to 50 percent of an individual’s maximal oxygen uptake. [15] This study reported a correlation between heart rate (HR) and ratings of perceived exertion with smaller muscle groups (arm work) as well as larger muscle groups (bicycling, running, and swimming). Also, RPE is linearly related to heart rate during bicycling ergometer, arm ergometer, walking, and running. [42] RPE scales are extremely valuable when HR measures exercise intensity; this is due to the scales’ ability to capture perceived exertion from central cardiovascular, respiratory, and central nervous system function. [17]

Perceived exertion is rated differently for each individual and the activity they participated in. As for individuals with chronic fatigue syndrome (CFS) the perception of exertion varies from individuals without CFS. Gibson et al. [43] examined the role of delay in recovery of peripheral muscle function following exercise in the fatigue experienced by patients with CFS. By assessing muscle function at rest, during recovery, and during maximum voluntary contractions, it was found that patients with CFS show normal muscle physiology before and after exercise; however, raised perceived exertion scores were shown during exercise. The raised RPE values during exercise suggests that the central factors are limiting exercise capacity in these patients resulting in higher RPE. [43] Knowing if a disorder or disease can affect RPE is important when taking into consideration the risk of injury, prevention of injury, recovery time, recognition of disease, and RPE.

Skeletal muscle force production depends on contractile mechanisms and failure at any site upstream of the cross-bridge and can contribute to muscle fatigue development. [31, 44] Muscle fatigue has multiple metabolic reactant factors such as hydrogen ions, lactate, inorganic phosphate, reactive oxygen species, heat shock proton, and orosomucoid. [31] The neural contribution plays an important role during whole-body exercise and fatigue, especially 5- HT, DA, and NA. [31] The CNS produces various excitatory and inhibitory inputs on the spinal motoneurons, activating motor units (MU) to achieve force output, via a central neurotransmitter. Motor units usually fire 5-8 Hz when first recruited, 50-60 Hz during non- fatiguing voluntary contractions. Motor units are recruited and un-recruited in an order based on motoneuron size and the muscle tissue being activated. [31, 45] Slowing or loss of MU firing creates the loss of force that marks fatigue; during fatiguing motoneuron firing rate decreases because of repetitive activation, excitatory drive from the motor cortex, the firing of group muscle afferent is increased, the sensory receptors are decreased, therefore decreasing motoneuron firing and finally slowing the muscle itself. [31, 46-48]

When the body fatigues and these contractile mechanisms decrease, the body has to work harder to perform the activity or compensation in the movement and mechanisms. RPE values increase with fatigue because of the factors and sensations that are associated with both RPE and fatigue that the subject is experiencing. As one’s heart rate, respiration, breathing, muscle contraction, muscle fatigue and sweating increases one’s perceived exertion or effort will be rated greater during that task. [38] Participants are asked to rate their exertion on the scale during activity, combining all sensations and feels of physical stress and fatigue. [38] By assessing all of these sensations the body then increases its risk for injury.

Training Load

Training load or workload is textual feedback on the strenuousness of a single training session; this is based on the consumption of critical energy sources during exercise or known as the stress placed on the body during the performed activity. [15] Training load is made up of internal and external workload; internal workload quantifies the physical loading experience, and external workload describes the measurement of the external work to the individual.[2] To achieve optimal performance, the body must be trained and developed, which, irrespective of the training load levels used, may also induce further level of fatigue. [2]

From statements made above, it has been reported that fatigue also increases injury rate, therefore, suggesting a relationship between training load and injury. Given the relationship between training load and injury, measures of controlling and reducing the risk factors of injury are critical for injury prevention. [2] By using the rating of perceived exertion scale which is valid for monitoring, prescribing, and regulating exercise intensity and assessing training load, individuals would be able to measure if a cadet is at an optimal level for injury. [39, 42]

Injury

Physical training-related injury and prevention is the top priority for the U.S. Military, specifically the army. During basic combat training (BCT), injures of new trainees are of special interest. [49] One quarter of male trainees and half of female trainees are estimated to experience an outpatient musculoskeletal injury during an 8-week training period.[50] The most common training-related injuries are overuse injuries, sprains, strains, and stress fractures occurring in the lower extremity. [23, 49] Injuries occur across a wide range of body parts; the majority of injuries occurring in the military population occur in the lower extremity; these injuries account for 37% to 85% of all injuries. [9]

Repetitive motion injuries have been reported to be among the most common injuries in the United States. Repetitive motion injuries make up over 50% of all athletic-related injuries seen by physicians. Repetitive injuries occur when the body is unable to repair the tears in tissue as fast as they are being made. Repetitive strain can affect muscle, nerve, tendons, and ligaments which can be caused by improper techniques, fatigue, compensation, and repetitive movement.

When observing the incidence of overuse injuries in military recruits during basic military training of these injuries, 86.4% were classified as overuse injuries, and the injuries were responsible for a loss of 3.6% or 2.631 training days. [8] This high rate of injury poses a threat to labor source, training readiness, and a costly treatment plan. Delivering medical care to 703 active-duty soldiers over 12 months cost the United States a reported $1,337,000.00 in 2018. [26] These costs can also be associated with lost days or days out of training due to injury, which increases the cost to $1,514,998.000. [25]

A similar study examined the injury epidemiology of the U.S. Army Special Operations Force. [22] This study utilized self-reported injury histories of 106 SOF for one year, filtered for injury type, activity, and mechanism. [22] Musculoskeletal injuries impede optimal physical readiness/tactical training. Musculoskeletal injuries were 24.5 injuries per 100 subjects per year for total injuries, and of those injuries 76.9% of total injuries could have been prevented. [22] During this study, the most reported activity for total and preventable injuries was during physical training sessions.

Due to the need and desire to achieve optimal performance and fitness, physical training sessions are 60-90 minutes 3-5 times a week; because of this injury can occur due to training load. Ekbolm and Goldbarg reviewed the relationship between training load and musculoskeletal injury as a systematic review. [15] Twenty-four additional articles examined injury-load relationship in athletes; twenty of the reporting articles reported significant findings for a relationship between training load and musculoskeletal injury. [15] Overall these studies contributed meaningful literature, which strengthens the emerging evidence to established evidence for a relationship between training load and injury. These results demonstrate that training load does affect injury and the relationship appears to depend on the type and timeframe of load measure.

Identification of risk factors for basic combat training-related injuries allows changes to be made to reduce injury risk. [50] These risk factors include acute: chronic training load and fatigue which can be monitored by ratings of perceived exertion. The assessment of perceived exertion and its correlation with injury could help prevent injuries within the military and ROTC program as well as save the United States money and loss of training days.

Acute: Chronic Workload Ratio

Acute: chronic workload ratios (ACWRs) are common calculations within sport. [49] Calculations of acute: chronic workload ratios (ACWR) can either be coupled or uncoupled formulas. Coupled calculations are the ratio between the most recent week of work with the average of the most recent four weeks. [51] Uncoupled calculations are the ratio of the most recent week of work with the average of the three preceding weeks.[51] In both coupled and uncoupled calculations, whether recent workloads are increasing or decreasing compared with prior workloads, ACWR>1 is increasing, and ACWR<1 is decreasing. The optimal load is where acute and chronic load is equal, and the ratio is 1.0. Higher ACWR is associated with increased injury likelihood for both coupled and uncoupled ACWR. [49]

When an acute: chronic load ratio ≤1.0 it indicates that the individual is in a well-prepared state, acute load is low therefore experiencing minimal fatigue and chronic load is high showing signs for developed fitness. [51] According to Dr. Gabbett the risk of injury is reduced when the ratio is within the "sweet spot" of 0.8-1.3, >1.5 is a danger zone with more risk of injury, and >1.8 is a danger zone with further increased risk of injury. [51, 52] Suddenly increasing training load has been associated with an increase of injuries. [52] Monitoring the acute: chronic workload can ensure increases in training load are introduced safely and without exposing a greater risk of injury.

Athletic Trainers

Athletic Trainers have been working with the military population for decades; however, jobs for Certified Athletic Trainers have been increasing rapidly by various Armed Forces over the last few years. [53] Athletic Trainers are to assist in the health and welfare of active-duty soldiers. [54] The NATA conducted a national survey of industrial companies that found that 100% reported an Athletic Trainer provides a favorable return of investment (ROID), 30% percent indicated that the ROI was at least $7/employee per $1 invested, 83% indicated that the ROI was more than $3/employee per $1 invested. [55] On top of the return of investment cost, 46% of the companies that provided on-site rehabilitation indicated that healthcare costs had decreased by more than 50%.[55] Based on the industrial surveys implementing Athletic Trainers into all branches of Armed Forces could result in a decrease of days lost and money spent. Lt. Col. Todd Burkhardt stated, "Our tactical athletes need to be physically ready for the rigors of their profession and Athletic Trainers are an essential component of facilitating this." [55]

Conclusion

Repeated physical activity is associated with injury risk. Musculoskeletal injuries result in over one million medical encounters, and ten million limited duty days per year for over 70% of the medically non-deployed population. [23] As both RPE and acute: chronic training loads increase so does the risk of injury. Previous research has been focused on perceived exertion and injury in the athletic population; however, limited research has been conducted on the rating of perceived exertion and risk of injury in the military population.

CHAPTER 3

METHODS

Purpose

The purpose of this study was to characterize the relationship between the ratings of perceived exertion during a workout/physical training session and injury occurrence in ROTC cadets throughout an academic year. The results of this study will provide and improve information on perceived exertion and its effects on injury. With these results, identification can be made for exposed individuals so intervention could occur before injury.

Research Question

Can ratings of perceived exertion predict the risk of injury in an ROTC cadet population?

Null Hypothesis

H_0: An increase in perceived exertion ratings will have no effect on injury risk in an ROTC cadet.

Alternative Hypothesis

H_1: An increase in perceived exertion ratings will increase the risk of injury in an ROTC cadet.

Research Design

The design of this study was a retrospective records review. With the independent variable being ratings of perceived exertion and the dependent variable being injury rate.

Participants & Setting

The participants in the study are ROTC cadets from a collegiate institution. ROTC cadets participated in physical training 3-5 days a week for 65 to 90 minutes. The survey was completed by 64 ROTC cadets and included male and female. Cadets were excluded if they did not report six or more RPE ratings. Twelve cadets reported an injury to the Athletic Trainers on staff;

however, one cadet was excluded due to having six or less reported RPE. The survey was given after each physical training session, which occurred either on the recreational field or around Marshall's campus.

Inclusion Criteria

Participants were 1) ROTC cadets at Marshall University, 2) between the ages of 18 and 30, 3) exposed to ROTC physical training sessions, and 4) more than 6 RPEs reported.

Exclusion Criteria

1) Individuals who were not ROTC cadets at Marshall University, 2) individuals who were under the age of 18 years old, 3) individuals who were over the age of 30 years old.

IRB Approval

IRB #1488742-1 approval attached in Appendix A. All participants affiliated with the Marshall ROTC program at the time of the records review provided written informed consent (Appendix B) before the records review. The Marshall University IRB approved a consent waiver for records belonging to Cadets no longer affiliated with the Marshall ROTC program. The privacy of each cadet will be made by using the last seven digits of the student ID number. This number is unique to each student but gives no personal information away.

Instrumentation

A modified Borg perceived exertion scale was used in this study. [19] The scale contains 0 = nothing at all and 10 = very, very strong (Figure 1). The scale was given after each physical training session on a Samsung or iPad tablet, which is password protected, and individualized for the certified athletic trainers on staff. The scale is on Office Forms made specifically for the perceived exertion scale and the cadets' student ID numbers.

Figure 1. Borg Perceived Exertion Scale. The scale used by participants to report ratings of perceived exertion.

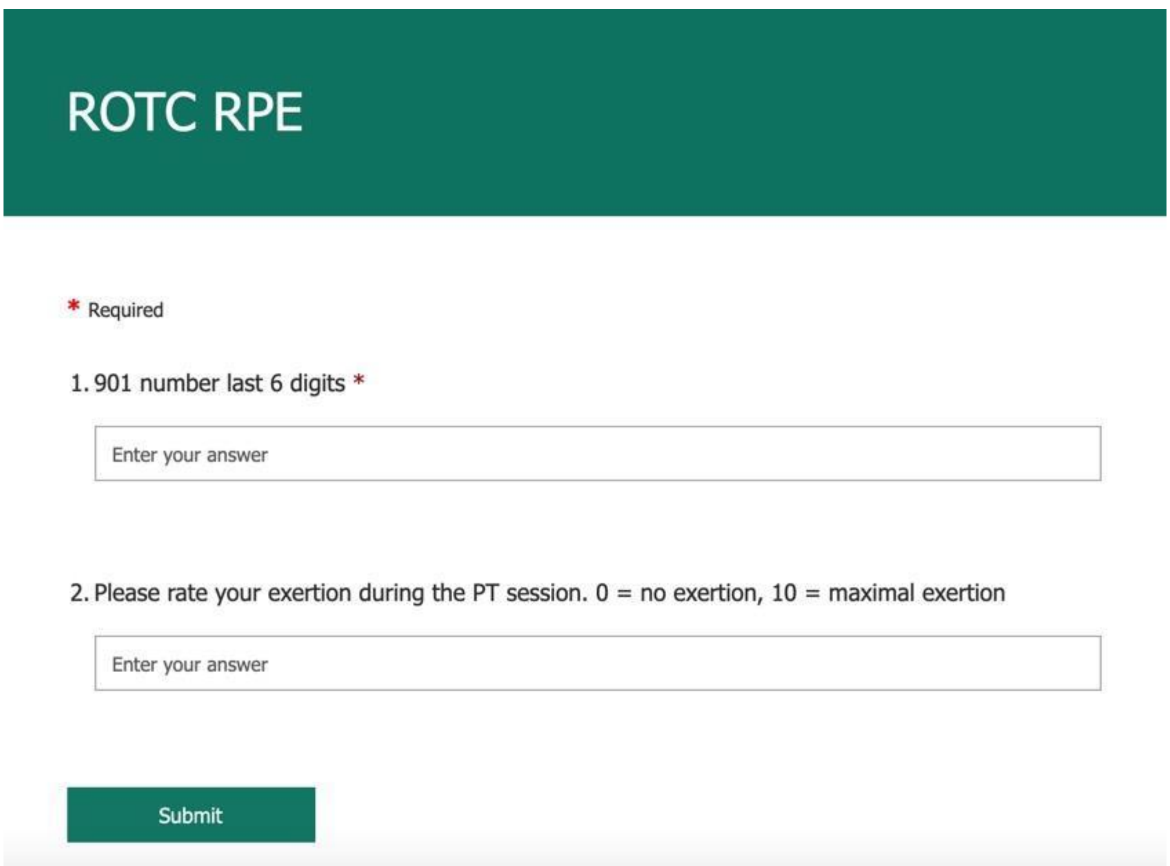
0	No Exertion
1	Extremely Easy
2	
3	Easy
4	
5	Somewhat Hard
6	
7	Hard
8	
9	Very Hard
10	Maximal Exertion

The current study was a retrospective chart review of de-identified patient data compiled via a web-based electronic medical records (EMR) system. The CORE-AT EMR is managed through the Athletic Training Practice Based Research Network (AT-PBRN) and housed at A.T. Still University. The AT-PBRN is an Agency for Healthcare Research and Quality affiliated practice-based research network. Information was entered by four newly certified graduate assistant Athletic Trainers. This information includes demographics, evaluation, treatment, treatment time, referral, patient-reported outcomes, and discharge forms. Before using Core-AT, ATs were required to complete a two-hour training session to ensure the quality of the data. This electronic medical health record is monitored by the athletic trainers on staff.

Procedure

Reserve Officer Training Corps (ROTC) cadets were informed of the study through an announcement in the first week of physical training session. No incentives to participate were given. The survey was administrated following each physical training session by a certified athletic trainer on an iPad or Samsung tablet using Office Forms (Figure 2). All ROTC cadets are between the ages of 18 and 27 and participated in the study voluntarily. Perceived exertion data was collected every physical training session for one academic year. Data was saved and protected by the students' MU ID numbers, username, and password which only the researcher can access. Data extracted occurred from September 2018 to May 2019. RPE data were extracted by a single individual. Cadets were excluded if they reported < 6 RPE values. Along with perceived exertion, injury data was collected in a medical documentation system.

Figure 2. RPE Data Collection Form. A screenshot of the RPE office form given to cadets directly following physical training.



ROTC RPE

* Required

1. 901 number last 6 digits *

Enter your answer

2. Please rate your exertion during the PT session. 0 = no exertion, 10 = maximal exertion

Enter your answer

Submit

Injuries were documented when an ROTC cadet saw the certified Athletic Trainer and received treatment of any kind (evaluation, therapeutic exercise, modalities, etc.). The information extracted from AT-Core was the date of injury, injured area, gender, and how long they were treated. This information of injured cadets was extracted by a single Certified Athletic Trainer. The injury was classified into four different levels (Table 1) level zero no contact, level one involved contacting the athletic trainer for a complaint and two or fewer treatment days, level two involved receiving two or more treatments, and level three involved an alter in activity or referral.

Table 1. Injury Classification. Classifications used by the researcher to determine level of injury for each participant.

Level of Injury	Description
0	No injury reported
1	Contacting the athletic trainer for a complaint and two or fewer treatment days
2	Receiving two or more treatments
3	An alter in activity or referral

The incidence of injury was calculated individually, as well as the overall injury rate during the study period. Each injured individual was placed into categories based on the ACWR calculation, categories are <0.80, 0.80-1.30, and >1.50. By analyzing the injury data, the ratings of perceived exertion are then pulled from the data for observation, to see if the RPE for that individual rose before injury.

Delimitations

A single college institution is used in this study due to the convenient sample pool. The participants were males and females from the ages of at least 18 to ensure an adult population to the maximum age of 30. The sample size was on the smaller scale, with less than 100 participants, and the participant's gender was male dominate. This study is generalized to the military population, specifically an ROTC program.

Limitations

A college institution is used in this study; therefore, there were multiple scheduled breaks throughout the year, such as Thanksgiving, winter, and spring breaks. Subjects' participation varied throughout the study, some more than others.

Data Processing & Analysis

Data were collected from the electronic medical recorded Core-AT. Data processing and analyzation consist of examining both the ratings of perceived exertion and injuries in the ROTC cadets, both of which are coded information. For data to be analyzed on an injured cadet there must be an injury reported to the Certified Athletic Trainer, meaning classification level one or above. The date of injury was recorded, and the RPE scale was observed for a rise in ratings for that specific individual. From there a coupling equation (equation 1) was used to determine the RPE level.

Equation 1: $\frac{A}{0.25*(A+W2+W3+W4)}$

CHAPTER 4

RESULTS

A total of 1,426 ratings of perceived exertion were reported over 23 weeks. These RPEs were reported by 43± 18 cadets who were primarily male participants. The ROTC demographic was 27% female and 73%, male. Seventeen cadets reported six or fewer RPE ratings; therefore, they were excluded from the study. The average of the RPE ratings was a six on the Borg Scale. There was a total of 12 injuries reported by six men and five women. Out of these injuries six were acute, and six were chronic. The ten injured cadets reported 419 RPEs with their mean RPE 5.2 ± .5 on the Borg scale (Figure 3). The cadets not reporting injuries mean RPE was 5.8 ± 1.8. The injured acute workload was 5.3 ± 1.9 for the injured cadets and 5.2 ± .8 for the non-injured cadets (Table 2). The injured cadets' chronic workload was 5.0 ± 1.0 for the injured cadets and 5.3 ± .3 for the non-injured cadets (Table 2). The injured cadets' workload ratio was 1.06 ± .4 for the injured cadets and .96 ± .1 for the non-injured cadets (Table 2).

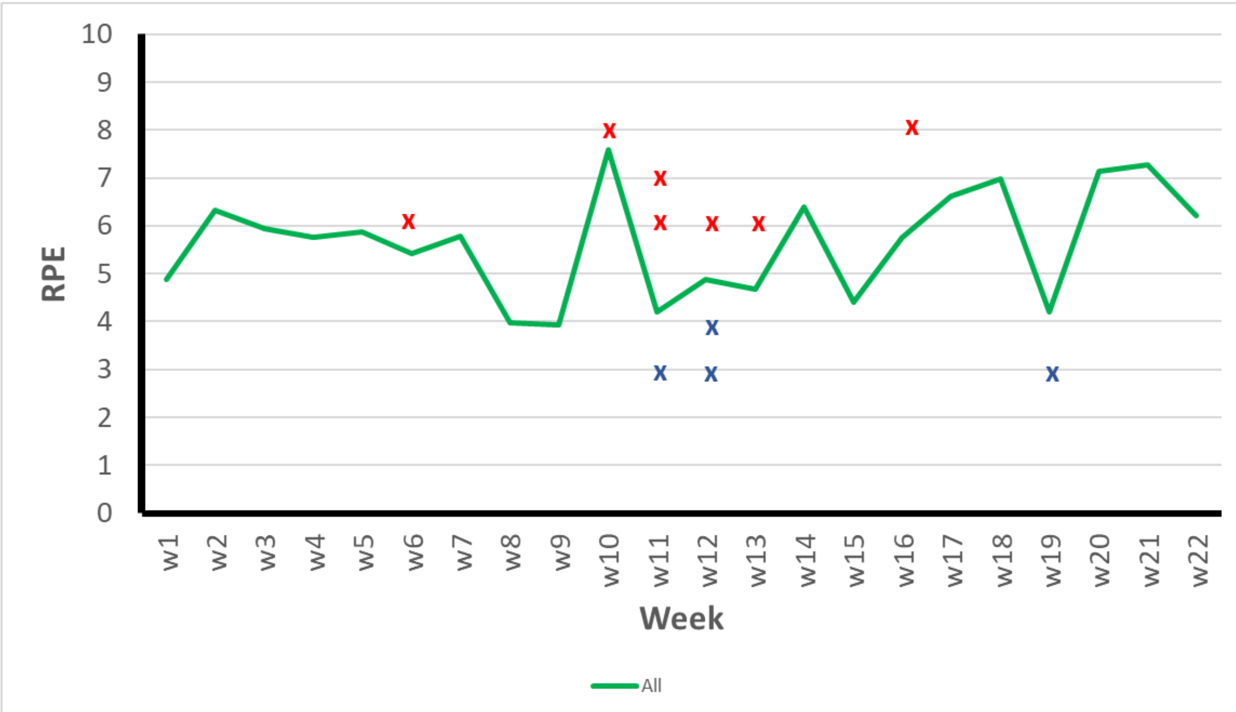
The injury diagnosis in prevalence included: upper extremity sprain/strain (3/11), lower extremity sprain/strain (2/11), tendonitis (2/11), low back pain (2/11), hip pain (1/11), and contusion (1/11). Based on these categories of injuries, the average treatment days include 7.66 treatment for upper extremity, 7.5 treatments for upper-lower extremity, 9 treatments for tendonitis, 4 treatments for low back pain, 19 treatments for hip pain and, 2 treatments for a contusion. Radzak et al. [28] found similar findings between frequency and types of injuries found in ROTC cadets and other initial-entry training routes.

The acute: chronic workload ratio of each participant and the level of injury that occurred for that individual, three patients reported >1.3 which increases the risk of injury (Table 1). One patient reported a 1.3, which would be at the top end of the increased risk of injury; a 1.51 was reported, which falls within the moderate risk of injury, and lastly a 1.8, which falls within the danger zone for injury. Based on these results and level of injury it shows that two patients who reported higher rates of exertion received more than two treatments or received a referral or alteration in activity. None of these differences reached statistical significance. From these results, we can conclude that the alternative hypothesis can be accepted in part.

Table 2. Injured Cadet Demographic. Cadet, injured area, level of injury, ACWR ratios.

Cadet	Body Part	Acute or Chronic	Level	ACWR for Injured Cadets	ACWR for non-injured same week as injured cadet
1	Upper	Acute	1	1.3	1.17
2	Upper	Chronic	2	1.8	0.86
3	Lower	Acute	3	0.9	0.88
4	Lower	Acute	1	1.04	0.88
5	Lower	Acute	1	0.93	1.04
5	Upper	Chronic	3	0.9	1.03
6	Lower	Acute	1	1	0.96
7	Lower	Chronic	2	0.8	0.90
8	Lower	Chronic	2	0.6	0.89
9	Lower	Chronic	3	1.51	1.05
10	Trunk	Chronic	2	0.9	0.98

Figure 3. Average Weekly RPE. The red and blue x's are the RPE that the injured cadet reported the week injury was reported. Red is above the average, and blue is below the average.



CHAPTER 5

DISCUSSION

The purpose of this study was to characterize the ratings of perceived exertion during workout/physical training sessions and injury rates in ROTC cadets throughout an academic year. The alternative hypothesis was an increase in perceived exertion ratings will increase the risk of injury in an ROTC cadet. The alternative hypothesis was supported, in part. The risk of injury in the participants increased as the ratings of perceived exertion increased. The participants' risk of injury was developed during physical training due to the increase of fatigue occurring because of training load. As training load increases, a rating in perceived exertion increases.

To the knowledge of the investigator, the current study is the first to investigate the ratings or perceived exertion and risk of injury in ROTC cadets. The current study used the Borg scale to quantify the perception by ROTC cadets of the difficulty of daily physical training and make comparison between the RPE provided by ROTC cadets that experienced musculoskeletal injury and those that did not. The ten injured cadets reported 419 RPEs with their mean RPE 5.2 ± .5 on the Borg scale. The cadets not reporting injuries mean RPE was 5.8 ± 1.8. Individual RPE values may not reflect the risk of injury. Instead the risk of injury is likely related to the accumulation of effort not the effort of an individual workout. The injured acute workload was 5.3 ± 1.9 for the injured cadets and 5.2 ± .8 for the non-injured cadets. The injured cadets' chronic workload was 5.0 ± 1.0 for the injured cadets and 5.3 ± .3 for the non-injured cadets. The injured cadets' workload ratio was 1.06 ± .4 for the injured cadets and .96 ± .1 for the non-injured cadets. None of these differences reached statistical significance; however, three injured cadets did report an ACWR >1.3, which categorizes them into the minimal to danger risk of injury. During each physical training session, all cadets performed the same workout. Since all cadets did the same workout then the differences in perceived exertion would explain the differences in the reported RPEs. RPE increases with fatigue therefore those who were experiencing fatigue reported higher RPEs. Based on the results on average the cadets reporting injury reported a higher RPE compared to the ROTC group as a whole.

Using the workload ratio equation injury risk can be categorized into <0.80 undertraining, 0.80-1.30 “sweet spot” or optimal workload, and >1.50 the danger zone/highest relative injury risk. The three cadets that reported an ACWR > 1.3 also had different levels of injury. Cadet 1 had the lowest ACWR out of the three being 1.3, which categorizes the individual into the minimal risk of injury. Cadet 1 had an acute injury, related to physical training and received a total of 4 treatments. Cadet 2 had the highest ACWR being 1.8, categorizing into the danger zone of injury. This cadet had chronic pain following a shoulder strain during a physical training session. Cadet 2 received 11 treatments during a semester before being discharged. Lastly, cadet 9 had an ACWR of 1.5 which falls within the danger risk of injury. Based on the results found within the study an increase in RPE did increase the risk of injury within the ROTC group, however, only three out of the eleven injuries fell within the danger zone. Therefore, the alternative hypothesis can only be supported in part. Individuals who had an injury and higher ACWR reported a higher RPE and used more resources than those with the lower ACWR and injury.

Hulin et al.[56] studied workload ratios and associated injury risk in elite cricket players, finding that injury risk increases as the acute workload outweighs the chronic workload.[56] Also, the results demonstrate that injury risk increases significantly in the week following a sharp increase in acute workload.[56] The current study found the same results when talking about a sharp increase. Cadets reported the highest RPE values during week ten of the current study. During week ten of our study a physical training test occurred and as shown in Figure 3 there was one injury on the date of the test and two to follow the next week and 4 injuries within the 3 weeks following week ten. To limit these injuries from occurring after a physical training test rehabilitation, cool downs, planning the "spike" of exercise or some type of management needs to be implemented to reduce the risk of injury. After week 11 the ROTC cadets went home for winter break; they were to work out on their own during break to maintain physical fitness. As shown in Figure 3 there was an injury reported both weeks 12 and week 13 directly following the month break that had occurred. These injuries can be related to the "spike" of training which increases the acute workload.

Warren et al. [57] looked at fast bowlers and individual differences of acute: chronic workloads and injury and found that there was a non-linear relationship between acute: chronic workload and injury risk in the four-week study. The study also showed that an increase in acute workload and chronic workload of more than two standard deviations resulted in 4-5-fold increase in injury risk. [57] The seven cadets that reported injury but had ACWR that did not place them into the danger categories had similar results to Warren et al. [57] showing no comparison between workload and injury.

When calculating chronic workload, Hulin et al. [56] suggested that high chronic workload was associated with a reduced risk of injury because of adaptation. If the cadets were truly adapting to the exercises being placed on them they should provide lower RPE values in response. However, the cadets fatiguing would give higher RPE values to the same exercise level. Adaptation could be true within our study because physical training occurs throughout an academic year, 3-5 times a week, for 60-90 minutes, which would increase the chronic workload.

By continuous training throughout the year, the cadets could achieve a high chronic workload, which would reduce their risk of injury. Banister et al. [58] stated that preparedness for competition grows as the chronic workload outweighs the acute which is true for our study as well. Excessive and rapid changes in injury load are responsible for a large portion of non-contact, soft-tissue injuries. These results demonstrate that the monitoring of acute and chronic workloads can offer valuable insight into the likelihood of injury.

Individuals tend to report higher ratings of perceived exertion when they are at risk of injury. The reason for the increase in ratings is due to the internal training load, which is the athletes' perceived effort. [59] As an individual increases their training load, they are working harder, and now at a greater risk of injury. [59] In Gabbett [59] a strong relationship (r = 0.86) was reported between training load derived from RPE and training injury rates in semiprofessional rugby league players. We could not determine if this was true for our study due to the lack of consistency of attendance, making a true statistical analysis impossible for this study. Based on the variety of ACWR findings it would be of great importance to conduct research into ROTC cadets to determine the injury risk ranges.

Unfortunately, Hulin et al. [56], Warren et al. [57], and Gabbett [59] did not specifically look at fatigue and an increase in RPE and injury. Fatigue can be referred to as physical and mental exhaustion because of prolonged stimulation or exertion. Physical exertion and fatigue including similar factors such as heart rate, workload intensity, state anxiety, and work output fatigue, can increase an individual's rating of perceived exertion. [4, 10] As fatigue occurs, an individual must work harder to produce the same outcomes desired; because of this, a risk of injury increases. [2] Fatigue can be linked to our increased RPEs due to physical training session, training labs, as well as the mental exhaustion component of school. These findings are one reason we accept our alternative hypothesis in part, with an increase in fatigue, RPE increases, therefore injury occurs.

With an increase of fatigue an inability to maintain required force level of the muscle decreases. Fatigue induces performance deterioration due to the reduction of force production, lack of accuracy and reduced speed of motor units. [60] Kinchington et al. [60] supported that increased perceptional fatigue is related to an increased injury; this particular study looked at lower limb injuries and found ($r=0.88$; $p<0.001$). Kinchington et al. [60] as well as our results, supported this as well, reporting 7/11 injuries to the lower extremity. It is also important to note that the most common injuries in military occur at the lower extremity; therefore, it is very important to monitor the fatigue and RPE levels of cadets when training to reduce the risk of lower extremity injuries.

Overall, the injury findings from ROTC cadets are similar to those reported in other initial-entry military training routes. The findings of this study somewhat compared to other ACWR, however, ACWR has not been studied in the military population thus far. Therefore, by monitoring RPE and injury risk in ROTC cadets and military, the risk of injury could decrease due to the ability to intervene when ACWR entered the danger zone of injury, and the United States government spending on medical costs would decrease.

Confounding Factors

There were several confounding factors of the current study, which we believe altered the outcomes of the study. The Army ROTC cadets included in the study had differing levels of physical fitness, which could cause a higher RPE when others have rated lower. Also, the ROTC cadets were Marshall University students; therefore, they had semester breaks, which included Thanksgiving, winter, and spring break which were beyond our control. During these academic breaks, no ratings of perceived exertion were collected, although cadets were still training on their own.

When taking these breaks and the lack of consistent attendance of the ROTC cadets, many cadets were excluded for reported < 6 RPE. By excluding the individuals that reported < 6 RPE we concluded with a small sample population. These cadets that were inconsistent but reported more than 6 RPE might have avoided injury due to the lack of consistent participation and physical activity on their part. Many of the military studies that look at injury are during basic training, where there is daily consistency and control over attendance. Other studies that looked at ACWR and injury were also collected with sports teams that reported consistently. Although sports and military are different when looking at consistency of attendance and being able to calculate ACWR these studies that occur during pre-season training are more accurate than our current study.

The final confounding factor is the honesty and understandings of the cadets when reporting their perceived exertion and injury. Although confidentiality was expressed to the cadets daily, many expressed concern about the ability to contract if they became injured or reported an injury to the Athletic Trainer on staff. The concern expressed by cadets could lead to injury not being reported when a cadet was truly injured. Reporting concern could also lead to lower ratings of perceived exertion when a cadet was experiencing higher exertion levels if they believed the ratings were also showing how hard they thought the training session was rather than how hard they felt they were working.

Although many of these factors are beyond our control, there were multiple strengths of this study. One strength is the availability of an Athletic Trainer at all ROTC events, these include; physical training, physical training test, ruck marches, lab training, land navigation, ranger challenge, and field training exercises. Due to the availability of an Athletic Trainer and ample clinic time for evaluation, treatment, or any other concerns, injuries not reported were not due to the lack of resources. Another strength is that the physical training sessions were monitored and guided by a graduate assistant strength and conditioning coach. Lastly, unlike many studies, in our study each participant is doing the same exercises, training, or events.

Recommendations for Further Research

Future research should focus on the increase of ratings of perceived exertion during physical training and the prediction of injury before it happens. Research should also include uninterrupted periods of data collection with the collection of both RPE and injury. Include statistics between contracted and non-contracted cadets; this way monitoring the rise of RPE in cadets would be easier. As well as having a more private way of reporting the RPE after exercise, the privacy would likely decrease the competitiveness between cadets and increase the honesty of RPE and injury reporting. Lastly, future research should keep a detailed log of the physical training sessions each day and what they entail. The outcome of the research would provide additional information on the ratings of perceived exertion and increase of injury rate in ROTC cadets.

Conclusion

The risk of injury increased as ratings of perceived exertion increased in Army ROTC cadets. The ratings of perceived exertion increased with injury to follow in ten cadets; however, not all cadets were in the moderate to severe risk of injury when the injury was reported. By observing the ratings of perceived exertion, the prevalence of injury can be predicted, subsequently decreasing the amount of injury, cost, and lack of labor source in the military population.

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APPENDIX A: OFFICE OF RESEARCH INTEGRITY APPROVAL LETTER

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Office of Research Integrity
Institutional Review Board
One John Marshall Drive
Huntington, WV 25755

FWA 00002704

IRB1 #00002205
IRB2 #00003206

September 5, 2019

Mark Timmons, PhD
School of Kinesiology

RE: IRBNet ID# 1488742-1
At: Marshall University Institutional Review Board #1 (Medical)

Dear Dr. Timmons:

Protocol Title:	[1488742-1] Ratings of Perceived Exertion and Injury Risk	
Site Location:	MU	
Submission Type:	New Project	APPROVED
Review Type:	Expedited Review	

In accordance with 45CFR46.110(a)(5&7), the above study was granted Expedited approval by the Marshall University Institutional Review Board #1 (Medical) Chair. An annual update will be required on September 5, 2020 for administrative review and approval. The update must include the Annual Update Form and current educational certificates for all investigators involved in the study. All amendments must be submitted for approval by the IRB Chair prior to implementation and a closure request is required upon completion of the study.

If you have any questions, please contact the Marshall University Institutional Review Board #1 (Medical) Coordinator Anna Robinson at (304) 696-2477 or robinsonn1@marshall.edu. Please include your study title and reference number in all correspondence with this office.

Sincerely,

Bruce F. Day, ThD, CIP
Director, Office of Research Integrity

- 1 -

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APPENDIX B: INFORMED CONSENT

Informed Consent to Participate in a Research Study

Ratings of Perceived Exertion and Injury Risk

Mark Timmons PhD, Principal Investigator

Marshall University IRB

Approved on:	9/5/19
Study number:	1488742

Key Information

You are invited to participate in a research study. Research studies are designed to gain scientific knowledge that may help other people in the future. You may or may not receive any benefit from being part of the study. Your participation is voluntary. Please take your time to make your decision, and ask your research investigator or research staff to explain any words or information that you do not understand. The following is a short summary to help you decide why you may or may not want to be a part of this study. Information that is more detailed is listed later on in this form. The purpose of the study is to explore the association between your awareness of your exercise intensity and the risk of physical injury. The researchers will review information that you have already provided. There is no more information needed from you. The primary risk of participation is that people not in the research team might view your private medical record.

How Many People Will Take Part In The Study?

About 40 people will take part in this study. A total of 50 subjects are the most that would be able to enter the study.

What Is Involved In This Research Study?

The researchers will review the injury records that the School of Kinesiology Athletic Trainers keep regarding the injuries you have reported to them. If you have reported an injury the researchers will record your name, the date of injury, the area of your body that was injured, the severity of your injury, and the length of time that the Athletic Trainers treated your injury. The researchers will also use the ratings of perceived exertion that you have provided at the end of your regular physical training sessions, this information is identified with your Marshall Identification number. When the researchers have matched your medical record information to the perceived exertion data that you provided all identifying information, (name, date of injury, and Marshall ID number) will be removed.

What about Alternative Procedures?

You do not have to participate in this study.

What Are Your Rights As A Research Study Participant?

You may choose not to take part or you may leave the study at any time. Refusing to participate or leaving the study will not result in any penalty or loss of benefits to which you are entitled. If you decide to stop participating in the study we encourage you to talk to the investigators or study staff first.

The study investigator may stop you from taking part in this study at any time if he/she believes it is in your best interest; if you do not follow the study rule s; or if the study is stopped.

What About Confidentiality?

We will do our best to make sure that your personal information is kept confidential. However, we cannot guarantee absolute confidentiality. Federal law says we must keep your study records private.

Subject's Initials _________

Nevertheless, under unforeseen and rare circumstances, we may be required by law to allow certain agencies to view your records. Those agencies would include the Marshall University IRB, Office of Research Integrity (ORI) and the federal Office of Human Research Protection (OHRP). This is to make sure that we are protecting your rights and your safety. If we publish the information we learn from this study, you will not be identified by name or in any other way.

What Are The Costs Of Taking Part In This Study?

There are no costs to you for taking part in this study. All the study costs, including any study tests, supplies and procedures related directly to the study, will be paid for by the study.

Will You Be Paid For Participating?

You will receive no payment or other compensation for taking part in this study.

What About Identifiable Private Information?

Identifiers might be removed from the identifiable private information, after such removal, the information or biospecimens could be used for future research studies or distributed to another investigator for future research studies without additional consent from you.

Whom Do You Call If You Have Questions Or Problems?

For questions about the study or in the event of a research-related injury, contact the study investigator, **Mark Timmons at 304 696-2925**. You should also call the investigator if you have a concern or complaint about the research.

For questions about your rights as a research participant, contact the Marshall University Office of Research Integrity (ORI) at (304) 696-4303. You may also call this number if:

- You have concerns or complaints about the research.
- The research staff cannot be reached.
- You want to talk to someone other than the research staff.

You will be given a signed and dated copy of this consent form.

SIGNATURES

You agree to take part in this study and confirm that you are 18 years of age or older. You have had a chance to ask questions about being in this study and have had those questions answered. By signing this consent form you are not giving up any legal rights to which you are entitled.

Subject Name (Printed) ______________________________

Subject Signature ______________________________ Date ____________

Person Obtaining Consent (Printed) ______________________________

Person Obtaining Consent Signature ______________________________ Date ____________

Subject's Initials ________