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The Influence of Prior Load Carriage Experience on Landing Mechanics

Research Brief

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Abstract

Introduction: Inexperience carrying heavy loads may be the cause of the high rate of musculoskeletal injury in military personnel. The objective of the study was to determine the difference in landing quality between those with (EXP) and without (IEXP) prior training experience with military load carriage.

Methods: Cross-sectional study design. Twenty-four participants were recruited (EXP, n=12; IEXP, n=12). Participants in the EXP group included active duty personnel, reservist and Army ROTC. Participants in the IEXP group had no prior military experience. All twenty-four participants performed three drop-jumps (DJ) under two conditions: unloaded (UL) and loaded. The loaded condition required the participants to wear a combat helmet, tactical vest and rucksack (HVR). Two cameras recorded the three DJ trials. Drop-jump trials were scored using the landing error scoring system (LESS). A two-way mixed ANOVA was used to determine the effects of training experience and load on landing quality.

Results: There was no significant interaction (p=0.914) between group (EXP and IEXP) and condition (UL and HVR). There was not a significant main effect for condition (p=0.551). For group (EXP and IEXP) the test for between subjects effects was not significantly different (p=0.762).

Conclusions: The results suggest that prior load carriage experience does not result in better landing quality.

Key Words: Military, Experience, LESS

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Introduction

Inexperience carrying heavy loads while performing athletic maneuvers may be the cause of the high rate of musculoskeletal injury in Basic Training Recruits. The injury rates during military training are high, ranging from 6 to 12 per 100 male recruits per month during basic training.[1] Investigators have identified several intrinsic (e.g., worker strength and fitness level) and extrinsic (e.g. footwear, equipment and load carriage) injury risk factors.[2] A practical method to address modifiable intrinsic risk factors is to improve worker's movement quality under loaded conditions. Investigators[3-6] have reported that military personnel that are poor movers are at greater odds of injury. Arguably, in individuals that display abnormal movement patterns during weight bearing activities, injury may be a result of increased stress on tissue structures via abnormal loading patterns. If true, this necessitates the integration of activities to enhance movement quality into already existing training programs. A viable, inexpensive tool used to measure landing quality is the landing error scoring system (LESS).[7] The LESS is a reliable and valid[7,8] clinical assessment tool that uses two standard video cameras to record an individual's landing mechanics for review of potentially high-risk movement patterns ("errors") during a jump-landing maneuver.[8] The purpose of the study was to determine the difference in landing quality between experienced (EXP) and inexperienced (IEXP) loaded conditions. We hypothesized that the EXP group would have significantly better (lower) LESS scores as compared to the IEXP group.

Methods

Study design and setting

This study was a cross-sectional design. The STROBE guidelines for cross-sectional research were followed in the design/reporting of this analysis.[9] All data was collected at a university research laboratory.

Participants

Twenty-four participants were recruited for this study. Each participant was assigned to one of two groups based on military training experience: EXP and IEXP. There were 12 participants in each group: EXP and IEXP. Participants in the EXP group included Army ROTC (9 males, 3 females; 25.42±7.05 yr., 174.22±8.83 cm, 80.13±17.95 kg). Those assigned to the IEXP group were participants with no prior military training experience and considered to be recreationally active (9 males, 3 females; 21.58±1.51 yr., 171.7±8.94 cm, 77.64±13.64 kg). Prior to participation, all participants read and signed an informed consent document approved a university institutional review board. Participants were excluded if they had any of the following conditions: a) had sustained a shoulder, back, lower extremity injury within the last 6 months, or had b) surgery to the shoulder, back, hip, knee or ankle within the last 2 years. All participants had to be 18 years or older to participate in the study.

Protocol

All participants reported to the laboratory wearing athletic attire. Each participant's height and weight were collected. Next, each participant performed 3 trials of a drop jump (DJ) task from a 30 cm box. The 30 cm box was placed 10% of the participant's height away from a 120 cm x 80 cm target. The participants performed 3 DJ trials under two separate randomized counterbalanced conditions, unloaded and loaded. There was a 5-minute rest period between conditions. Traditionally, the LESS is performed with the 30 cm high box positioned 50% of the participant's height away from the landing target;[10] however, the investigators modified the distance of the task to address safety concerns raised by the university institutional review board because of the lack of load carriage experience for those participants unaccustomed to landing with heavy loads. The modified DJ task demonstrated excellent intra-rater reliability (ICC3,k=.933). Each participant wore shorts, t-shirt and combat boots for the unloaded condition (UL). The loaded condition (22 to 23 kg, dependent on vest and helmet size) required the participants to don a 1.4 kg -1.6 kg combat helmet, 5.1 kg - 5.4 kg improved outer tactical vest, and 15.7 kg rucksack (HVR). All trials of the DJ were recorded using two, digital HD video cameras (SH-2, Olympus Imaging America, Center Valley, PA) at 120 frames per second. There was a camera positioned in the sagittal plane and also in the frontal plane at a distance of 3.45 m and a height of 1.22 m.[8] The 3 recorded trials from each condition were scored using the LESS and averaged. The LESS is a clinical assessment tool that uses two standard video cameras to record an individual's landing mechanics for immediate or future review for potentially high-risk movement patterns ("errors") during a jump-landing maneuver.[8] The LESS is an inexpensive alternative in the absence of expensive 3-D motion capture systems.[7] The lower the LESS values the better an individual's quality of landing. The LESS is interpreted using the following scale: Excellent (<4), good (>4 to ≤5), moderate (>5 to ≤6) and poor (>6).[8]

Statistical Analysis

A two-way mixed ANOVA was used to determine the effects of training experience and load on landing quality. The independent variables included a between-subjects variable, group (EXP and IEXP), and within-subject variable for condition (UL and HVR). The dependent variable (outcome measure) was mean LESS scores. All data was analyzed using SPSS Statistic 21 (IBM Corp., Armonk, NY, USA). Alpha level was set at 0.05. Results for model assumptions of normality, homogeneity of covariance, and linearity were satisfactory.

Results

Table 1 provides the means and standard deviations of the LESS scores for each group under the UL and HVR conditions. Table 2 provides the pairwise comparisons between groups and between conditions. All twenty-four participants completed all aspects of the study. There was no significant interaction ($p=0.914$, $F(1, 22)=.012$, $\eta^2=.001$) between group (EXP and IEXP) and condition (UL and HVR). There was not a significant main effect for condition (UL and HVR) ($p=0.551$, $F(1, 22)=.366$, $\eta^2=.016$). For group (EXP and IEXP) the test for between subjects effects was not significantly different ($p=0.762$, $F(1, 22)=.094$, $\eta^2=.004$).

Table 1. Demographics and LESS scores for EXP and IEXP load carriers.

GROUP	AGE (YRS.)	HEIGHT (CM)	MASS (KG)	UL	HVR
EXP	**25.42±7.05**	**174.22±8.83**	**80.13±17.95**	**5.98±1.75**	**6.23±1.63**
IEXP	**21.58±1.51**	**171.70±8.94**	**77.64±13.64**	**5.76±2.98**	**5.94±2.26**

EXP=EXPERIENCED; IEXP=NO PRIOR TRAINING EXPERIENCE; UL=UNLOADED; HVR=HELMET, VEST AND RUCKSACK

Table 2. Pairwise comparisons of LESS scores.

Comparison	MD	95% CI
UL - HVR	**-.214**	**-0.95 to 0.52**
EXP - IEXP	**.256**	**-1.48 to 1.99**

UL=unloaded; HVR=helmet, vest and rucksack; EXP=experienced; IEXP=no prior training experience; MD=mean difference in LESS scores

Discussion

The results suggest that prior load carriage experience does not result in a statistically significant reduction in LESS scores. This is the first study to the authors' knowledge to explore the differences in landing quality between EXP and IEXP loaded carriers. The results of the present study are in contrast with our hypothesis. We hypothesized that LESS scores would be significantly lower in EXP load carriers compared with IEXP carriers. Arguably, recreational athletes may have a movement base similar to that of active duty military personnel. This movement base may have lead the IEXP group to misrepresent the scores which may be achieved by a truly untrained individual. Future studies should seek to explore if these findings are similar across a wider range of fitness/activity levels.

Under the unloaded condition both the EXP and IEXP groups demonstrated LESS scores which fell into the moderate category. A closer look at mean LESS scores for the EXP group under the unloaded condition indicated the group's landing quality was high moderate to poor. We also observed that upon loading, the IEXP group slightly improved, as compared to their unloaded condition. This arguably may indicate a learning effect; however, we did attempt to minimize this occurrence, by allowing 1-2 practice trials and randomly counterbalancing the testing order. It is also possible that the participants in the IEXP group could have changed their landing strategy to compensate for the perceived difficulty of landing with a tactical vest and loaded rucksack.[11,12]

The present study did not evaluate quality of landing post-fatigue. Fatigue, which is based on a performer's individual capabilities, has been observed to alter an individual's pattern of movement in tasks such as sidestep cutting and walking.[13,14] In an early study involving, healthy college aged males and load carriage, Wang et al.[14] observed a significant alteration in ankle kinematics post-fatigue. Further investigation is required to determine if the patterning of landing is persistent across conditions while participants are in a fatigued state. In the current study, landing patterns (i.e. kinematics) were similar across conditions. The results suggest that a person's pattern of landing is persistent. It is also possible that the load increases were not great enough to cause instability in the participants' preferred patterns of landing and force a transition to a faultier pattern of landing.

Media-Friendly Summary

This study sought to investigate the differences between those who have had previous experience carrying military loads and those who have not when performing a drop jump task. To accomplish this, a landing error scoring system was used to evaluate individuals on the quality of their landing techniques. Unloaded and loaded scores from each group were compared and no significant differences were found between those with experience and those without. These findings indicate that there is no statistical advantage to having carried military loads in the past as it relates to safe landing techniques while carrying a military load.

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