CHANGING STRIDE LENGTH IMPACTS LOWER LIMB BIOMECHANICS WHEN RUNNING WITH BODY BORNE LOAD

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INTRODUCTION
During military activities, soldiers are often required to run at a fixed cadence with heavy body borne loads. These body borne loads, which can exceed 35 kg, reportedly decrease physical performance and increase injury risk by altering lower limb biomechanics [1]. Running with body borne load purportedly increases peak vertical ground reaction force (vGRF) and lower limb joint moments requiring an alteration in lower limb joint angles to maintain stability [2]. These biomechanical adaptations, and potential injury risk, may be further exaggerated by the changes in stride length that are required when running at a fixed cadence. Over-striding that results from walking at a fixed cadence increases mechanical load and injury risk in the lower limb, particularly with body borne load [3]. Yet, there is dearth of research on how stride length impacts lower limb biomechanics when running with body borne load. This study quantified lower limb biomechanics when running with different stride lengths across various body borne loads.

METHODS
This study is ongoing with 11 male participants (1.82 ± 0.072 m, 81.77 ± 8.60 kg, 21.18 ± 2.82 yrs). Each participant had 3D lower limb biomechanics quantified while running with four load conditions: 20 kg, 25 kg, 30 kg and 35 kg. For each load condition, participants were outfitted with a helmet, weighted vest, and mock weapon. The weight of the vest was systematically adjusted depending on the load condition. For the run task, participants were required to run at 4 m/s (± 5%) and use one of three stride lengths: preferred stride length (PSL), 15% shorter than PSL (SSL), and 15% longer than PSL (LSL). Participants performed five successful trials at each stride length. A successful trial required participants run with the correct stride length and speed, and only contact the force platform with their dominant leg.

During each running trial, lower limb kinematics were quantified from the 3D trajectories of 34 reflective markers. A kinematic model with seven segments (bilateral foot, shank, and thigh and pelvis) and 24 DoF was created from a static trial. Synchronous GRF data and marker trajectories were low pass filtered with a fourth-order Butterworth filter (12 Hz). Then, filtered marker trajectories were processed using Visual 3D (C-Motion, Rockville, MD) to solve joint rotations at each instant.

For analysis, peak vGRF, and hip, knee and ankle flexion angles were quantified during stance phase (0% - 100%) and submitted to a RM ANOVA to test the main effect and interaction between load (20 kg, 25 kg, 30 kg, 35 kg) and stride length (PSL, SSL, LSL). A Bonferroni correction was used for pairwise comparisons and significance was set at p < 0.05. Significant interactions were submitted to a RM ANOVA stratified by factor.

RESULTS AND DISCUSSION
The ANOVA revealed a significant stride length by load interaction for peak vGRF (p = 0.025) (Fig. 1). Specifically, the incremental addition of body borne load significantly increased peak vGRF when running with PSL (p = 0.034) and LSL (p = 0.036) conditions, but had no effect (p = 0.280) on the peak vGRF exhibited when running with SSL condition. Considering each incremental increase in stride length (SSL to PSL to LSL) produced a significant increase in peak vGRF (p < 0.001) using shorter stride lengths may reduce the injury risk of running with body borne load. Participants altered lower limb kinematics when running with different stride lengths. Specifically, participants exhibited greater peak hip (p < 0.001) and knee flexion (p < 0.001), and ankle dorsiflexion (p < 0.001) angles as they increased their stride length from SSL to PSL and LSL. These kinematic alterations may be adopted to maintain stability and help attenuate the increased GRF present when running with longer strides.

CONCLUSIONS
When running with shorter strides, participants did not exhibit the increase in vGRF, and injury risk that was apparent when running with their preferred or longer stride lengths. Participants, however, may need to increase lower limb flexion with longer strides to help attenuate the increases in vGRF evident with increasing stride length.

REFERENCES