INTRODUCTION
In 2015, the U.S. Armed Services granted women access to combat positions. These positions require soldiers to run, cut and land while wearing body borne loads that often exceed 35 kg. Female soldiers are reportedly two times more likely to suffer a musculoskeletal injury than males [1], which may be attributed to sex dimorphism in lower limb biomechanics during common military tasks, such as landing. Without body borne load, females landed with an extended hip and knee compared to males [2], biomechanical patterns thought to increase injury risk [3]. Yet, increasing lower limb flexion has been reported to decrease injury risk during landing, particularly with body borne load [4]. To date, it is unknown if body borne load increases the sex dimorphism in lower limb biomechanics and whether using greater lower limb flexion can decrease potential injury risk for females during drop landings.

METHODS
Research is ongoing with 11 male (1.81 ± 0.083 m, 81.84 ± 8.21 kg, 21.18 ± 2.82 years) and 4 female (1.6 ± 0.058 m, 62.82 ± 2.83 kg, 20.5 ± 1 years) participants. Each participant had 3D lower limb biomechanics quantified during a series of drop landings with four load conditions: 20 kg, 25 kg, 30 kg and 35 kg. For each load condition, participants carried a mock weapon, and wore a helmet and 20 kg, 25 kg, 30 kg and 35 kg. Each participant had 3D lower limb biomechanics quantified (from heel strike to peak knee flexion). Each variable was instructed to either: land normal (NL) or exaggerate lower limb flexion (EL), and required to perform five trials of each landing condition.

During each drop landing, trunk and lower limb biomechanics were quantified from the 3D trajectories of 34 reflective markers. During each landing, synchronous GRF data and marker trajectories were low pass filtered with a fourth-order Butterworth filter (12 Hz). The filtered marker trajectories were processed to solve joint rotations using Visual 3D (C-Motion, Rockville, MD).

For analysis, peak vGRF, and trunk, hip, knee, and ankle flexion joint angle were quantified during the landing phase (from heel strike to peak knee flexion). Each variable was submitted to a RM ANOVA to test the main effect and interaction between load (20 kg, 25 kg, 30 kg, 35 kg), sex (male, female) and condition (NL, EL). Where statistically significant (p < 0.05) differences were observed, a modified Bonferroni procedure was used.

RESULTS AND DISCUSSION
Exaggerating lower limb flexion during landing significantly decreased peak vGRF (P = 0.001) from 2.24 BW during the NL to 1.83 BW during the EL condition. The decrease in vGRF may reduce injury risk by lowering the impact forces the musculoskeletal system must attenuate for a safe landing. This reduction peak vGRF may be attributed to the increase in trunk and lower limb flexion presented in EL landings. Participants exhibited significantly greater peak trunk (P < 0.001), hip (P < 0.001) and knee (P < 0.001) joint flexion during the EL compared to the NL condition. Lower limb flexion reportedly promotes greater energy absorption during landing [4] and may reduce vGRF and injury risk by helping attenuate forces placed on the joints.

Females may not exhibit a similar reduction in injury risk during EL landings as male counterparts. The ANOVA revealed a significant landing condition by sex interaction for peak trunk (P = 0.025), hip (P = 0.031) and knee (P = 0.022) flexion (Table 1). Although, females landed with more trunk, hip and knee flexion than males during the NL landings, males exhibited greater peak flexion during the EL landings. Future research should determine if the inability of females to increase flexion during landing leads to the higher risk of musculoskeletal injury they exhibit. Interestingly, in contrast to previous experimental evidence there was no significant (P < 0.05) effect of body borne load on peak vGRF or kinematic variable.

CONCLUSIONS
Increasing trunk and lower limb flexion during landing may reduce peak vGRF and subsequent injury risk. Yet, females, despite exhibiting a more flexed posture during normal landings, were unable to adopt similar increases in trunk and lower limb flexion as their male counterparts.

REFERENCES

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* denotes a significant (p < 0.05) sex by landing condition interaction.