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Stride Length, but Not Body Borne Load Impacts Gait Stability

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Abstract

Military personnel are required to alter their stride length to run with heavy body borne loads during training. This may compromise their gait stability and increase the risk of suffering fall related musculoskeletal injury. This study quantified how running with body borne loads impact gait stability and whether it differed with stride length. Twelve male participants had medial-lateral (ML) gait stability quantified while running 4.0 m/s with four borne loads (20, 25, 30, and 35 kg). Each participant had ML margin of stability (MoS) calculated when using a normal stride (NS), short (SS, -15% of NS), and long stride (LS, +15 of NS) to run. The MoS measures were submitted to RM ANOVA to test main and interactions effects of load (20,25,30, and 35 kg) and stride (NS, SS, LS) with alpha level at p

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INTRODUCTION

During military activates, soldiers are often required to run with heavy loads at a fixed cadence. The body borne loads can often exceed 35 kg and can compromise gait stability, increasing the risk of a fall-related musculoskeletal injury [1].

When running with body borne load, soldiers may adjust their margin of stability (MoS), a measure of balance, to reduce risk of suffering a fall. Soldiers may further compromise balance by altering their stride length, as often required during training. Yet, it is unknown how stride length impacts MoS of running with heavy body borne loads.

PURPOSE

To quantify how running with body borne load impacts gait stability when stride length is altered.

METHODS

Twenty male participants had 3D biomechanics quantified while running at 4 m/s with four body borne load conditions: 20 kg, 25 kg, 30 kg, and 35 kg (Fig. 1).

Each participant ran using three different stride lengths: normal stride (NS), 15% shorter (SS), and 15% longer than NS (LS). Filtered marker trajectories were processed in using Visual 3D (C-Motion, Rockville, MD) to determine whole-body center of mass (COM). Mediolateral (ML) MoS was then calculated, by using a method derived from Hof et al. (2005) [2], as the difference between the ML base of support (width of the foot) and extrapolated COM (a variable which accounts for the position and velocity of the center mass) (Fig. 2).

For analysis, ML MoS was submitted to a RM ANOVA to test the main effect and interaction between load (20, 25, 30, 35 kg) and stride (NS, SS, and LS). Significant interactions were submitted to a simple effects analysis, and a Bonferroni correction was used for pairwise comparisons. Alpha level was set at 0.05.

METHODS CONT'D

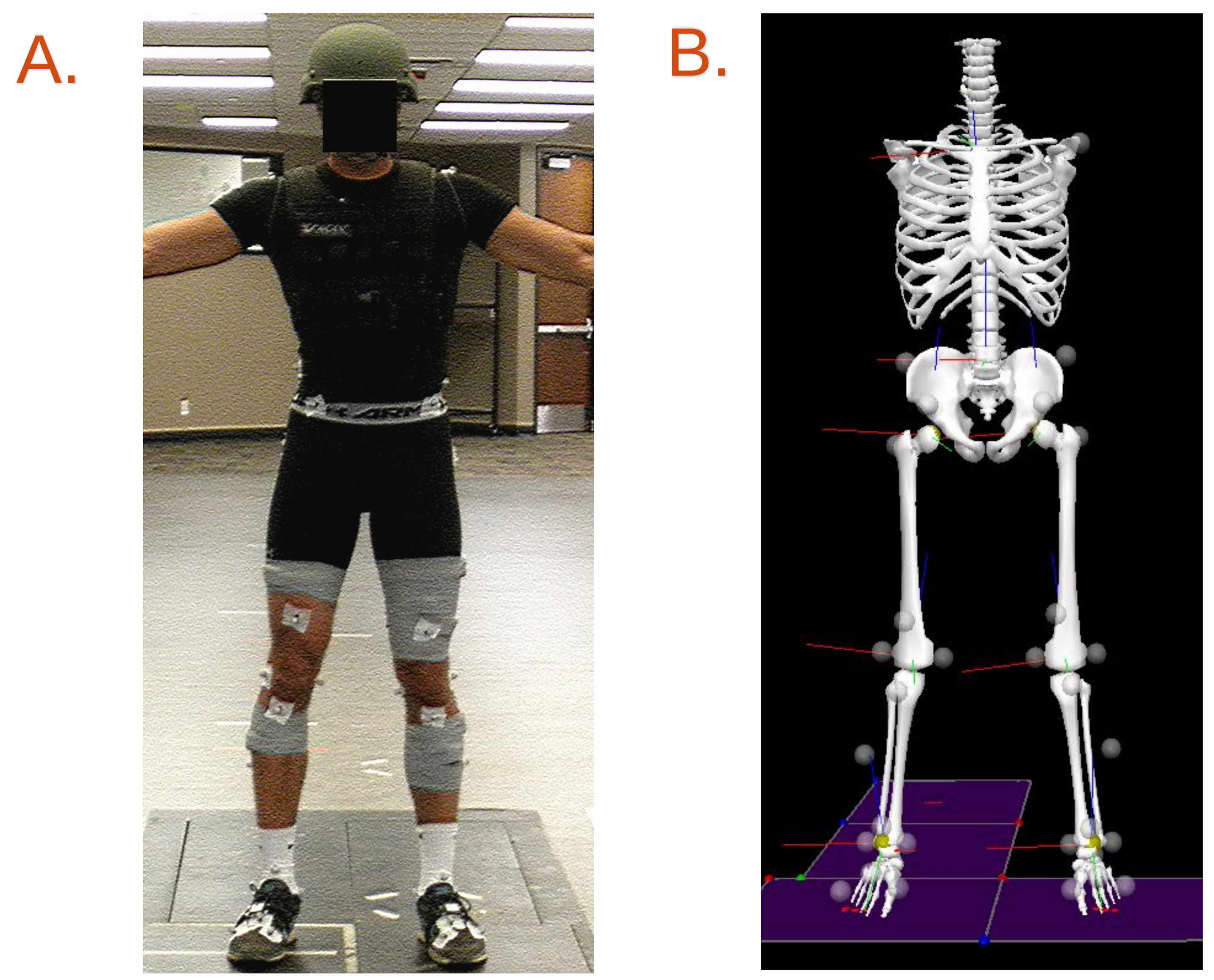

Figure 1. For each load condition, participants were outfitted with a helmet, weighted vest, and a mock weapon (**A**). The weight of the vest was adjusted to meet the corresponding load requirement. A kinematic model with seven segments (bilateral foot, shank, thigh and pelvis) and 24 DoF was then created from a static trial (**B**).

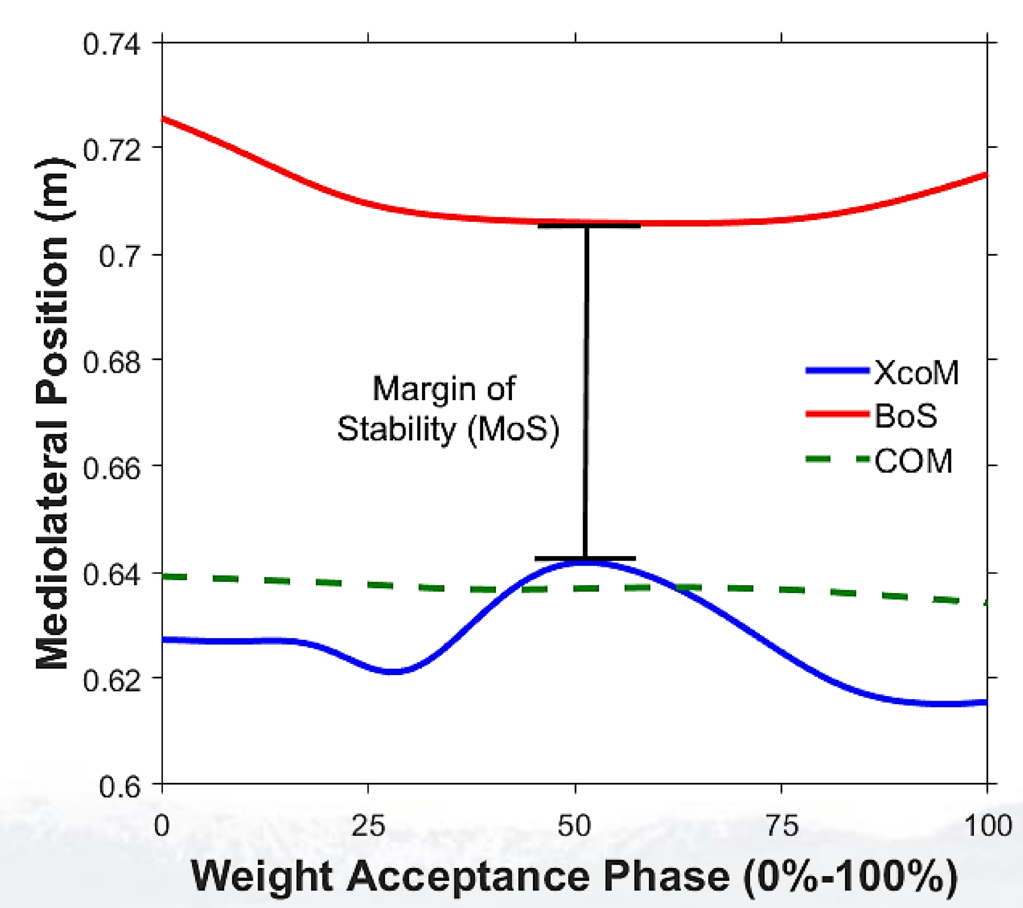

Figure 2. Schematic representation of mediolateral margin of stability (MoS) during the weight acceptance phase of the run task. MoS was calculated as the difference between the trajectory of the extrapolated COM (XcoM) and the base of support (BoS) at the instant in which the MoS reached its minimum value within the period of one step [2].

RESULTS

Stride length ($p<0.001$) had a significant effect on ML MoS. Specifically, participants increased MoS with SS compared to LS ($p=0.001$) and NS ($p=0.011$) (Fig. 3). But, no difference was observed between NS and LS ($p=0.450$).

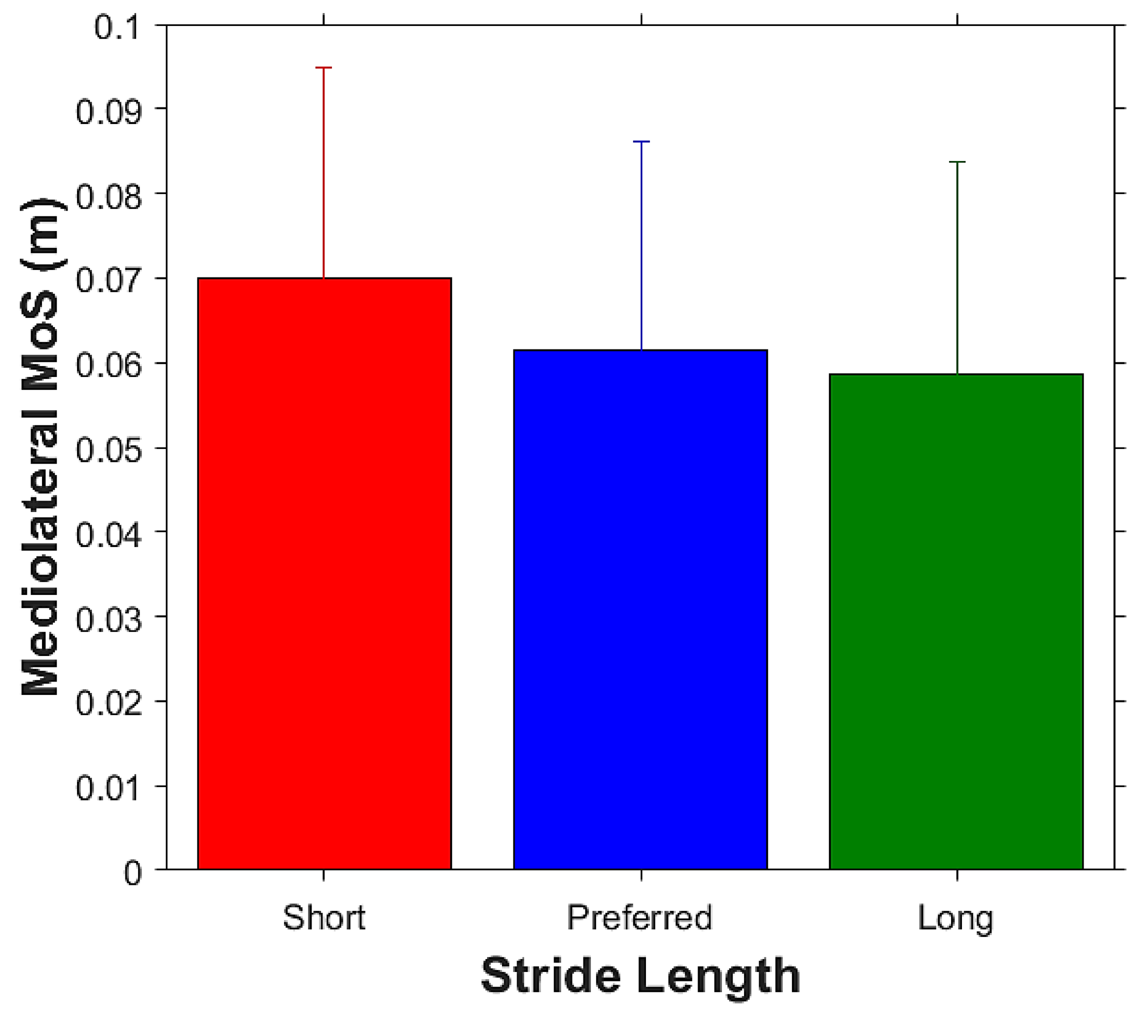

Figure 3. Average mediolateral MoS (m) for each stride length during the run task.

Body borne load ($p=0.818$) had no effect on ML MoS.

CONCLUSION

Preventing falls and avoiding fall-related injuries while running with different body borne load requires dynamic control of gait stability. When running 4 m/s, participants were able to increase side-to-side gait stability by shortening, but not by lengthening their strides. Soldiers may need to take shorter length steps while running with body borne load to maintain stability and decrease musculoskeletal injury risk. But, interestingly body borne load does not appear to compromise running gait stability.

REFERENCES

1. Patton J.F., et al. *Eur J Appl Physiol*, 63:89-93, 1991
2. Hof A.L., et al. *J Biomech* 38:1-8, 2004