Step Length Perturbations Alter Variations in Center of Mass Horizontal Velocity

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ABSTRACT
PurPOSE: The purpose of this study was to investigate the effects of SL perturbations on system COM forward velocity (v) during walking gait. METHODS: Twelve healthy adults (25.6±1.4 yr; 173.5±3.6 m; 73.1±1.59 kg) performed 5 trials of preferred speed walking (PW) and running (PR) followed by 5 stride length perturbations based on percentage of leg length (60%, 80%, 100%, 120%, and 140%). Kinematic analysis was completed using a 12-camera infrared motion capture system (Vicon MX 410, 2004). Data filtering and interpretation included low-pass (4°/s) and high-pass (3+ 5 order Butterworth filter) cutoff frequencies (15). Maximum and minimum system COMv, compared were made independently among stride conditions using one-way repeated measures ANOVA and Bonferroni post-hoc contrasts. Change in system COMs across gait stride were evaluated using one-way repeated measures ANOVA and Bonferroni post-hoc contrasts. RESULTS: Differences in maximum COMv were detected among stride conditions (F[1.847,59.105]=339.458, p<.001, η²=.914). Post-hoc comparisons showed significant increases (p<.001) in max COMv at each percentage SL from 60% to 140%. Minimum COMv differences were detected among stride conditions (F[2.387,74.000]=40.364, p<.001, η²=.566). Pairwise comparisons detected significantly greater ACOMv at 140% SL, and significantly less ACOMv at 60% SL (p<.001). DISCUSSION: Differences in maximum COMv were detected among stride conditions (F[2.184,57.330]=130.951, p<.001, η²=.666). Post-hoc comparisons showed significant increases (p<.001) in max COMv at each successive SL from 60% to 140% LL. Minimum COMv, differences were detected among stride conditions (F[2.118,65.666]=130.951, p<.001, η²=.666). Differences in ACOMv were detected among stride conditions (F[2.387,74.000]=40.364, p<.001, η²=.566). Pairwise comparisons detected significantly greater ACOMv at 140% SL, and significantly less ACOMv at 60% SL (p<.001). CONCLUSION: Stride lengths greater than 100% LL demonstrate greater deviations in forward COM velocity, as a result of braking and subsequent loss of forward velocity.

INTRODUCTION
Humans typically perform one of two primary gait patterns, walking or running. Preferred gait speed has been attributed to optimization of mechanical efficiency and metabolic cost. Speed adjustments are associated with alterations in step frequency and step length (SL), with the latter implicated in gait instability. Specifically, longer SLs, exceeding preferred, have demonstrated greater vertical oscillation of the system center of mass (COM), increasing the cost of transport. From this, examining gait speed via system COM forward velocity under contrasting stride conditions is considered valuable in gaining insight into selection of SL during locomotion.

PURPOSE
The purpose of the study was to investigate the effects of SL perturbations on system COM forward velocity (v) during walking gait.

METHODS
• Participants: 12 healthy young adults 23 ± 1.6 yr; 1.72 ± 0.18 m; 73.1 ± 15.29 kg.
• Instrumentation: 12-camera motion capture system (Vicon MX410; 200Hz).
• Protocol: Institutionally approved written informed consent.
• Dependent Variables: Maximum and minimum system COMv; Change in COMv across stride conditions.
• Statistical Analysis: One-way repeated measures ANOVA (α = .05).

RESULTS
Differences in maximum COMv were detected among stride conditions (F[1.847,59.105]=339.458, p<.001, η²=.914). Post-hoc comparisons showed significant increases (p<.001) in max COMv at each successive SL from 60% to 140% LL (Figure 2). Minimum COMv differences were detected among stride conditions (F[2.118,65.666]=130.951, p<.001, η²=.809). No difference was shown in PW and stride lengths of 100% LL and above, in contrast to maximum COMv, where differences in ACOMv were identified among stride conditions (F[2.387,74.000]=40.364, p<.001, η²=.566). Pairwise comparisons detected significantly greater ACOMv at 140% SL, and significantly less ACOMv at 60% LL (p<.001). Differences in ACOMv were detected among stride conditions (F[2.387,74.000]=40.364, p<.001, η²=.566). Pairwise comparisons detected significantly greater ACOMv at 140% SL, and significantly less ACOMv at 60% LL (p<.001).

CONCLUSION
Stride lengths greater than 100% LL demonstrate greater deviations in forward COM velocity, as a result of braking and subsequent loss of forward velocity. This outcome may provide insight into mechanisms responsible for transitions to running gait due to the increased energy expenditure needed to maintain steady-state speed during transport.

REFERENCES