OVERGROUND WALKING AND TREADMILL WALKING AT LEVEL AND UPHILL INCLINES DEMONSTRATE DIFFERENCES IN LOWER LIMB MUSCLE ACTIVITY PATTERNS FOR OLDER ACTIVE FEMALE ADULTS

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INTRODUCTION

A significant amount of research addressing the similarities and differences between overground walking and treadmill walking on a level surface exists [1,2,3]. There is a gap in the literature, however, with respect to i) the similarities and differences in muscle activation patterns between overground and treadmill walking on an incline and ii) the differences between overground and treadmill level surface walking for older adults. Therefore the purpose was to analyze lower limb muscle activation patterns and describe differences and/or similarities while walking on overground and treadmill surfaces, both on a level and uphill incline in an older active female population. It was hypothesized that there would not be a surface effect on muscle activity and that muscle activity would increase with an uphill incline regardless of the surface.

METHODS

Twenty healthy active older female adults (56.4 ± 4 yrs; 68.7 ± 14.3 kg; 162.9 ± 5.8 cm) performed a walking protocol at a self-selected speed that involved overground and treadmill walking at two inclines. Surface electromyography (EMG) (Myomonitor IV, Delsys Inc.) recorded muscle activity patterns of the medial and lateral gastrocnemii, medial and lateral hamstrings, and vastus lateralis and medialis during all walking trials. The EMG data was captured at 2000 Hz and linear enveloped waveforms were obtained using a zero-lag 4th order Butterworth filter with a cutoff frequency of 6 Hz. Muscle activity waveforms were then magnitude normalized using a series of maximum voluntary isometric contractions (MVICs) performed on a dynamometer (System 3, Biodex Medical Systems, Inc.). Footswitches allowed for the stance and swing phase to be determined for each stride. Using Matlab (MathWorks Inc.), principal component analysis (PCA) identified key features of variation in the waveform patterns for both the stance and swing phase of each muscle. A two way repeated ANOVA (PASW Statistics 18, SPSS Inc.) was used to test for a surface (overground versus treadmill), an incline (level versus uphill) or an interaction effect for each of the six muscles. Where an interaction effect was present for a specific waveform feature, each of the four groups (level overground, level treadmill, uphill overground, and uphill treadmill) were statistically compared using Bonferroni corrected pair-wise comparisons.

RESULTS

For both gastrocnemii, overground walking resulted in greater activity magnitudes throughout stance compared to treadmill walking (Figure 1A and 1B) (surface effect). Uphill walking also generated greater gastrocnemii muscle activity magnitudes compared to level walking for both surfaces (incline effect). Phase shifts in peak gastrocnemii activity were also captured (surface effect for lateral and interaction effect for medial). Differences were more varied for the two hamstrings. Midstance magnitude was greater during uphill treadmill walking compared to level treadmill walking for the lateral hamstring (interaction effect). Greater medial hamstring activity magnitudes during stance were observed for uphill compared to level walking for both surfaces. Uphill walking produced a greater overall vastus lateralis activity magnitude during early stance compared to level walking for both surfaces (interaction effect). There was only a trend towards an incline effect for the vastus medialis during stance. For the swing phase, the only significant difference was a greater medial hamstring activity magnitude for uphill walking (incline effect).

DISCUSSION & CONCLUSIONS

This study is the first study to identify differences between overground and treadmill surfaces while walking for both a level and uphill condition. Uphill walking and overground walking tend to utilize higher levels of muscle activity, and therefore appear to be greater stressors of the locomotor system. These findings could have important implications for future research related to exercise programs that aim to stress the locomotive system.

REFERENCES