Body Weight Support System Influence on the Patterns of Vertical Forces Applied to the Body

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INTRODUCTION

More and more physical rehabilitation related clinics are using some types of body weight support system (BWSS) in their practices. The use of the BWSS together with the repetition and consistent nature of walking on the treadmill makes the patient repeatedly practice the movement under controlled conditions. In addition to providing postural support, the body weight support system promotes coordination of the lower extremities, which traditional pre-gait training was unable to provide. Furthermore, the BWSS also helps to evaluate patients' gait without requiring the therapist to be at the patient's side to provide physical support. There is little information regarding how BWSS influence the actual gait pattern during treadmill walking. The purpose of this study was to examine how the BWSS influence the external forces at the vertical direction, and how the external forces were influenced by walking speed and the targeted body weight support.

METHODS

Sixteen college students have volunteered for the study. Their mean age (mean ± SD) and body mass were 22 ± 2 years old and 63 ± 11 kg, respectively. The subjects were instructed to walking on a force platform embedded treadmill (Gaitway, Kistler, Amherst, NY, USA) with a body weight support system (Vigor, Stevensville, MI, USA). They were walking at four different speed (.45, .67, .89, and 1.12 m/s) combined with four different levels of targeted body weight support (BWS) at 0, 15, 30, 45 %BWS. The testing order was balanced to prevent any possible order effects. Vertical ground reaction forces were measured by the force pates embedded within the Gaitway treadmill. The actual body weight being supported was measured by a force sensor installed between the harness and the supporting structure of the BWSS.

Maximum vertical ground reaction forces (RMVGRF), maximum and minimum (RMAXSF and RMINSF) suspension forces were calculated relative to participants' body weight and expressed as percentage body weight (%BW). Two factor (speed X %BW) ANOVA with repeated measures were used to analyze the data.

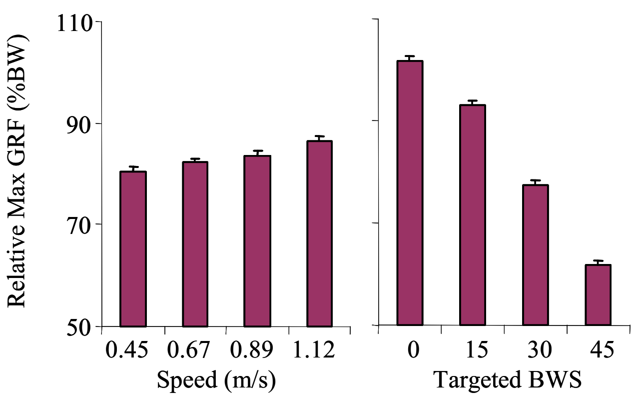

Figure 1: Maximum vertical ground reaction forces increases with walking speed and decreases with the amount of body weight being supported.

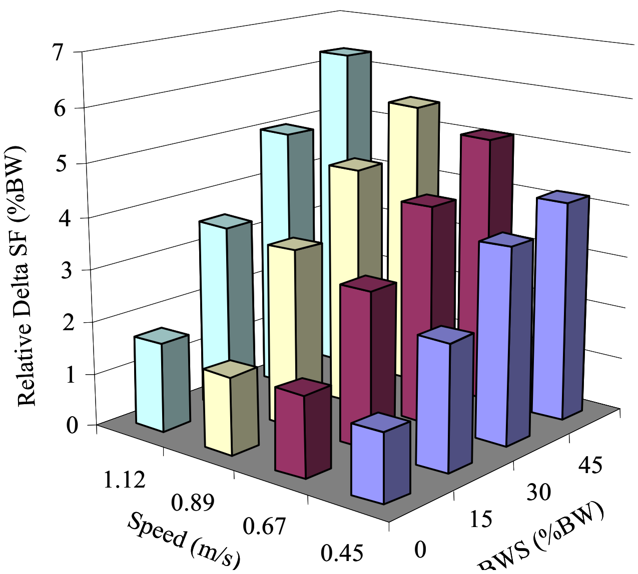

Figure 2: Body weight support amplifies the fluctuation of suspension forces larger then the proportion of body weight support. This influence was enhanced by greater walking speed.

RESULTS AND DISCUSSION

The mean and standard error of mean (SEM) of RMVGRF are reported in **Figure 1**. RMVGRF increased with walking speeds ($F_{3,45}$ = 512, P < 0.001) linearly ($F_{1,45}$ = 50.3, P < 0.001). It decreased with the increase of the targeted BWS ($F_{3,45}$ = 17, P < 0.0001) with both significant linear ($F_{1,45}$ = 1518, P < 0.001) and quadratic ($F_{2,45}$ = 16.3, P = 0.0002) trends. RMVGRF reduced from 101 to 92 %BW when %BWS increased from 0 to 15%, a reduction of approximately 9% BW. RMVGRF further reduced to 77 and 62 %BW (reductions of 15 %BW) when targeted BWS increased to 30 and 45%BW, respectively. RMAXSF ranged from 1.4 to 13.7 %BW and was influenced by both speed and %BWS (interaction, $F_{9,135}$ = 2.01, P < 0.05). The greatest RMAXSF was observed with 45% BWS and walking at 1.12 m/s. The fluctuation (RMAXSF-RMIMSF) of the suspension force is reported in **Figure 2**. The magnitude of this fluctuation changed from 1.3 %BWS, wit the lowest speed and targeted BWS, to 6.3, with the highest level of speed and targeted BWS. The fluctuation was influenced by both speed and targeted BWS (interaction, $F_{9,135}$ = 6.41, P < 0.0001).

CONCLUSIONS

Body weight support system does not provide consistent lift to the body being supported. The fluctuation of suspension force was amplified with greater proportion of body weight support and greater walking speed.