

# Effects of Various Gait Speeds on the Latissimus Dorsi and Gluteus Maximus Muscles Associated with the Posterior Oblique Sling System

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**Abstract.** [Purpose] This study investigated the effect of different gait speeds on the muscle activities of the latissimus dorsi and gluteus maximus muscles in relation to the posterior oblique sling system. [Subjects] We recruited 14 young adult males. [Methods] We measured the left latissimus dorsi muscle activity and right gluteus maximus muscle activity of all subjects while they walked on a treadmill at speeds of 1.5 km/h, 3.5 km/h and 5.5 km/h. [Results] There was a significant increase in latissimus dorsi muscle activity with a treadmill speed of 5.5 km/h compared with 1.5 km/h and 3.5 km/h. The gluteus maximus muscle activity significantly increased in the order of 1.5 km/h < 3.5 km/h < 5.5 km/h. [Conclusion] The present results indicate that arm swing connected to increasing gait speed influences the muscle activity of the lower limbs through the posterior oblique sling system.

**Key words:** Electromyography, Gait speed, Posterior oblique sling system

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## INTRODUCTION

The latissimus dorsi and gluteus maximus muscles are linked obliquely to the posterior spine by the thoracolumbar fascia, and this is referred to as the posterior oblique sling system<sup>1)</sup>. When walking, the muscles of the posterior oblique sling provide trunk stability for extension and work together to help deliver power from the lower body to the upper body. In addition, they are necessary for trunk stability for rotation and for promoting a mutual gait pattern between the upper and lower extremities<sup>2)</sup>. Moreover, the contralateral gluteus maximus and latissimus dorsi are connected functionally via the thoracolumbar fascia. Therefore, they contract together not only while running, but also during gait and axial movement of the trunk<sup>1, 3)</sup>. The muscles of the posterior oblique sling are essential for promoting mutual gait patterns involving trunk stability and the lower and upper extremities. They also create joint contraction, not only in running but also in turning the trunk and in walking<sup>4, 5)</sup>. It has also been suggested that the increased gait speed increases the angle of arm swing<sup>6)</sup>. However, few studies have examined the effect of a change in arm swing with gait speed on the activities of the latissimus dorsi and gluteus maximus via the posterior oblique sling system. Therefore, this study examined the effect of arm swing at

different gait speeds in terms of improvement of both gait function and indirect lower extremity muscle activity via the posterior oblique sling system, as it relates to the latissimus dorsi and gluteus maximus.

## SUBJECTS AND METHODS

The subjects of this study were 14 young adult males who voluntarily consented to participate in the study and had no history of disease or any problem with walking. Their average age, height and weight were  $28.36 \pm 4.31$  years,  $174.84 \pm 6.6$  cm and  $74.52 \pm 7.9$  kg, respectively. Surface EMG was used to collect raw EMG data using a Trigno Wireless System (Delsys, Boston, MA, USA). The sampling rate of the EMG signal was 2,000 samples/s using a band-pass of 20–450 Hz. The root mean square (RMS) was calculated. Two surface electrodes were placed on following muscles: the left (nondominant side) latissimus dorsi (lateral to the T9 spinous process over the muscle belly) and right (dominant side) gluteus maximus (the midpoint of a line running from the last sacral vertebrae to the greater trochanter)<sup>7)</sup>. EMG data were normalized using the maximum voluntary isometric contraction (MVIC) of each muscle measured using the manual muscle test as described by Kendall et al<sup>8)</sup>. All subjects walked on a treadmill at speeds of 1.5 km/h, 3.5 km/h, and 5.5 km/h for 30 seconds. The test order was randomized. The left latissimus dorsi, and right gluteus maximus muscle activities were measured in subject while walking on the treadmill. The EMG signal was collected for 30 seconds, and the first and last 5 seconds were discarded. The data were analyzed using one-way repeated-measures analysis of variance (ANOVA). Bonferroni correction was

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**Table 1.** Comparison of normalized EMG data of the two muscles at each treadmill speed

Muscles	Mean $\pm$ SD (%MVC)		
	1.5 km/h	3.5 km/h	5.5 km/h
Latissimus dorsi	9.4 $\pm$ 5.1	11.1 $\pm$ 6.9	13.3 $\pm$ 7.2*
Gluteus maximus	19.0 $\pm$ 8.6	20.4 $\pm$ 8.9*	22.4 $\pm$ 9.7*

performed to identify specific differences between multiple pairwise comparisons. All significance levels were  $p < 0.05$ , and SPSS version 20.0 (IBM, Armonk, NY, USA) was used for the statistical analyses.

## RESULTS

There was a significant increase in latissimus dorsi muscle activity with a treadmill speed of 5.5 km/h compared with 1.5 km/h and 3.5 km/h ( $p < 0.05$ ). The gluteus maximus muscle activity significantly increased in the order of 1.5 km/h  $<$  3.5 km/h  $<$  5.5 km/h ( $p < 0.05$ ) (Table 1).

## DISCUSSION

This study investigated the changes in the activities of the latissimus dorsi and gluteus maximus muscles, as related to the posterior oblique sling system, with changing gait speed. The latissimus dorsi and gluteus maximus activities differed significantly with gait speed. Perry suggested that the angle of arm swing increases with gait speed<sup>6</sup>. A study of children with cerebral palsy showed that increased arm swing is significantly related to gait speed<sup>9</sup>. In addition, Ford et al. suggested that rotation of the trunk and pelvis is decreased when arm swing is limited and that gait speed increases due to increased cooperation between the upper and lower extremities when there is no limitation<sup>10</sup>. Consequently, it turns out that the change of angle in arm swing due to increased speed affects gluteus maximus and latissimus dorsi activity via the posterior oblique sling system during walking. One study in which one or both arms were

limited suggested that the maximum gait speed was decreased, stride frequency was increased, and stride length was decreased<sup>11</sup>. This means that arm swing during walking can affect the movement of the lower extremity, which is similar to our result, suggesting that muscle activity in the upper extremity can affect that of the lower extremity as arm swing increases. These results indicate that arm swing connected to increasing gait speed influences lower limb muscle activity via the posterior oblique sling system.

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