

# The effect of stride length changes on triceps surae excitation during walking

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## SUMMARY

The purpose of this study was to investigate the EMG response of the muscles of the triceps surae during walking to changes in stride frequency. Participants walked on a treadmill at eight different step frequencies while surface EMG was recorded from the gastrocnemii and soleus muscles. As stride frequency increased, the amplitude of EMG activity decreased in all three muscles, a finding that is different from that observed in cycling.

## INTRODUCTION

Sanderson *et al.* [1] examined the effect of pedalling cadence on surface EMG from the soleus and gastrocnemius muscles during cycling at a constant power output. They found that, as pedalling cadence increased, the integrated surface EMG from the lateral and medial gastrocnemii increased, while that from soleus did not. The current study was designed to investigate whether the differential effect of cadence on triceps surae EMG observed in cycling is also seen in walking. We hypothesized that with increased stride frequency, there would be an increase in both lateral and medial gastrocnemius EMG activity, while soleus activity would be unaffected.

## METHODS

After preferred walking speed and stride frequency were determined, participants walked on a treadmill set to their preferred speed for two minutes at eight randomly presented stride frequencies (85, 90, 95, 100, 105, 110, 115, 120% of preferred cadence). Correct stride frequency was kept by matching foot strikes to the sound of a metronome. Surface EMG was recorded from the lateral gastrocnemius, medial gastrocnemius, and soleus muscles, amplified at the electrodes (gain = 35) before being sampled at 1200Hz. The data were demeaned, rectified, and filtered using a fourth order dual-pass Butterworth filter with a cut-off frequency of 6 Hz to create a linear envelope. The data were then amplitude-normalized to the highest 100 ms window at the preferred cadence, separated into individual strides, and time-normalized to the shortest stride within each frequency condition. For each condition, the first ten strides were averaged to create one representative data set per participant.

## RESULTS AND DISCUSSION

As stride frequency decreased from the preferred value, integrated EMG from each of the muscles of the triceps surae increased (see Figure 1). As frequency increased above the preferred value, EMG decreased, although the rate of change was less than that seen at frequencies below the preferred value. The changes in muscle activation with changes in cadence found in walking were different than those seen in cycling: in walking, all three muscles of the triceps surae had a similar sensitivity to frequency manipulation. This could be due to the fact that, in walking, the foot remains on the floor, whereas in cycling, the pedal is free to rotate.

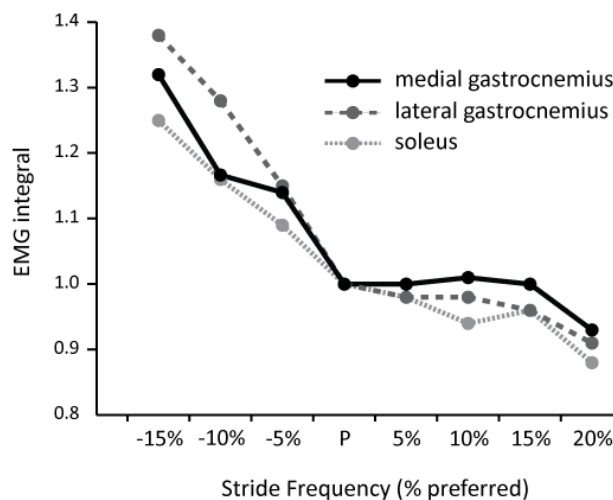


Figure 1: integrated EMG from the muscles of the triceps surae.

Donelan *et al.* [2] demonstrated that as stride length increases, the magnitude of negative work performed by the leading leg during step-to-step transitions increases, and that the magnitude of positive work performed by the trailing leg increases to replace the lost energy. In the current study, walking speed was held constant while stride frequency was manipulated, causing concurrent changes in step length. The ankle musculature is the primary source of the positive mechanical work during walking [3]; therefore, an increase in the excitation of the ankle plantarflexor muscles – the triceps surae – would be expected with a decrease in stride frequency.

## REFERENCES

1. Sanderson, DJ *et al.* *EMG Kines.* **16**, 642-649, 2006
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3. Winter, DA *J Mot Behav.* **21**(4), 337-55, 1989