CONCURRENT VALIDITY OF A TRI-AXIAL ACCELEROMETER FOR MEASURES OF GAIT VARIABILITY

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INTRODUCTION
Accelerometers are becoming an increasingly important tool in the study of human movement. Their ease and affordability, combined with the potential to collect large amounts of continuous data outside the laboratory setting makes them excellent tools for gait analysis. Research has demonstrated the effectiveness of a single tri-axial accelerometer in measuring mean spatiotemporal parameters of gait, but there is limited information on their ability to assess measures of gait variability [1]. While the clinical applications of gait variability are not yet fully understood, these measures are believed to be critical in understanding the motor control of gait [2]. Therefore, it is necessary to establish an effective method to measure gait variability with the tri-axial accelerometer for future gait analysis applications. The purpose of this study was to assess the concurrent validity of a tri-axial accelerometer in measuring mean spatiotemporal gait parameters and their variability, compared to a criterion footswitch device.

METHODS
A total of 82 healthy adults, ranging in age from 19 to 85 years, wore a tri-axial accelerometer (ADXL330, Sparkfun Electronics) and footswitch device (Interlink Electronics) concurrently during a 10 minute walk around a 200m indoor track. Data was sampled at 100 Hz and stored in separate logomatic v2 data loggers. Acceleration data was processed using a fourth-order, zero-lag, low pass Butterworth filter with a cut-off frequency of 2 Hz. Individual step times were then measured with a common peak-positive method [3] and an alternative peak-negative method, both from the anteroposterior acceleration signal. These processing techniques computed separate mean step times and stride times, as well as step time and stride time variability (SD), which were then compared to those measures determined by the criterion (footswitch) device.

RESULTS
The results showed that both methods displayed excellent agreement (ICC = 0.970 – 1.0) with the footswitch device on all measures, except step time variability, where the peak-negative method displayed fair levels of agreement (ICC = 0.524), but the peak-positive method displayed poor levels of agreement (ICC = 0.181). Additional statistical procedures (repeated measures ANOVA) confirmed the methods only differed significantly (p < 0.001) on the measure of step time variability. Follow up tests revealed step time variability computed with the peak-positive method was significantly different than both the footswitch (p < 0.001) and the peak-negative method (p < 0.001), but the peak-negative method was not significantly different from the footswitch (p = 0.107).

DISCUSSION
The findings of this study confirm that the accelerometer is an effective tool for measuring mean spatiotemporal parameters of gait, as well as stride time variability. On the other hand, the measurement of step time variability may not be as robust. Specifically, the peak-positive method displayed significantly different results than both the footswitch and the peak-negative method. While this peak-positive method has been the method of choice in many tri-axial accelerometer gait variability studies, it was originally only validated using stride times [3]. The findings may be related to extraneous positive peaks observed with certain individuals and walking speeds [3]. These additional peaks could greatly affect the timing when using the peak-positive method, but may be minimized with the peak-negative method. Furthermore, the differences in validity between steps and strides may relate to differences in these additional peaks between left and right limbs. For example, step time requires a foot event in the contralateral limb, but stride time only requires a foot event in the same limb. Therefore any idiosyncrasies in acceleration patterns of contralateral steps would be irrelevant in the latter example.

CONCLUSION
Accelerometers are effective tools for measuring mean spatiotemporal parameters and stride time variability, but less effective for step time variability. Using a peak-negative method, as opposed to a peak-positive method, may be a more effective way of measuring of step time variability, as it is less affected by multiple positive peaks that can occur in some individuals and walking speeds.

REFERENCES