INTRODUCTION
High vertical loading rates (VLR) of the ground reaction forces have been linked to increased risk of stress fractures when running [1]. Previous footwear research has shown that there are clear kinematic differences between shod, minimal and barefoot running conditions [2]. Moreover, it has been shown that these kinematic changes are coupled with altered loading rate patterns [2,3]. Runners who are transitioning away from traditional footwear may be unaware or misinformed of the biomechanical changes that are induced by minimalistic footwear. Gait retraining through biofeedback has been successful in reducing loading rates over an 8-week training protocol [4] but consumer availability to biofeedback when running is limited. To the authors’ knowledge, there have been no published studies reporting lower limb adaptations over a prolonged period of time (10 min) in minimal footwear, rather discrete running trials are typically used to characterize footwear differences. Therefore, the purpose of this study was to measure kinematic adaptations in the right lower limb while treadmill running in minimal footwear for a prolonged trial. Prior to conducting the study, it was hypothesized that a transition period would exist when running in minimal shoes with no prior experience.

METHODS
Seven recreational runners were recruited for this study. Inclusion criteria required participants to engage in a minimum of 20 km of running per week and be and injury free for the past year. Runners also had no previous experience with minimal footwear. Running was conducted on a treadmill at a self selected speed and included three prolonged trials each lasting 10 minutes. Runners were instructed to select a pace similar to a moderate day of training and once running speed was determined it was kept constant for all trials. The first and third trials were performed in runners’ own shoes. Trial two was considered the minimal running trial where runners wore a flexible shoe with minimal midsole construction (Nike Free 3.0, Nike Inc., Beaverton, OR, USA). Rating of perceived exertion was collected at the 5 and 10 minute mark of each running trial to obtain some metric of effort. Kinematic data were collected with an Optotrak Certus system (NDI, Waterloo, ON) at a sampling rate of 100 Hz. All data were processed using Visual3D software package (v4.85, C-Motion, Germantown, MD). Four sagittal plane dependent measures were used for analysis, including: (i) foot (relative to lab system), (ii) ankle, (iii) knee and (iv) hip joint motion. All raw (time-varying) kinematic waveforms were consolidated in MATLAB (2011b, The MathWorks Inc., Natick, MA) and analyzed over 50 stride epochs throughout each prolonged trial.

RESULTS
Average (SD) running speed was 3.27 m/s ±0.33. Across all epochs, sagittal plane foot angle relative to the lab system at heel strike was decreased in the minimal footwear condition (18.56° ±0.30°) compared to the baseline and post test landing angle in subjects’ own shoes (20.91°±0.30°, 22.0°±0.68°). Coefficient of variation for the pre, minimal and post trials for foot landing angle were 23%, 44% and 27% respectively. Upon heel strike, sagittal plane ankle motion decreased throughout the baseline trial as it went from 3.33° ±2.4 to 0.53° ± 4.4. Interestingly, a similar trend was observed in the minimal footwear condition, with decreased sagittal plane ankle motion (0.99° ± 3.58 to -0.58 ± 3.78).

DISCUSSION & CONCLUSIONS
Findings suggest there is an immediate adaptation in sagittal plane foot landing angle (relative to the lab) when wearing minimal shoes. It was hypothesized there would be a transition period as runners become familiar with the shoes. Sagittal plane ankle angle was decreased in the minimal condition compared to the baseline condition. Based on ankle motion changes that were observed within the minimal footwear condition kinematic variables may change while using a prolonged protocol. Current foot landing results do not support this contention as within trial values were consistent throughout each trial. When returning to one’s own shoes during the post-test, the amplitude of ankle dorsi flexion is elevated in comparison to both the pre and minimal conditions.

REFERENCES

Figure 1: Mean (± 1 SD) Sagittal plane foot motion (relative to the lab system) at heel strike.