INTRODUCTION
Iliotibial band syndrome (ITBS) is the second most common chronic running injury [1], and a leading cause of knee pain in runners [2]. While a clear understanding of the cause of ITBS would elucidate proper treatment protocols, the literature is not conclusive. Work by Noehren et al [3] has shown that runners who go on to develop ITBS tend to have increased hip adduction and knee internal rotation angles. They suggest that this posture may increase the strain on the fibers of the iliotibial band, and may also increase the friction with the contact surface of the lateral femoral epicondyle. While this work is useful for understanding dynamic malalignment that may lead to ITBS, its usefulness in understanding gait mechanics in runners currently experiencing symptoms may be limited. As pointed out by Miller et al [4] fatigue is a likely component of abnormal gait mechanics and is likely to play a role in running injury, particularly one such as ITBS whose symptoms typically worsen with fatigue. Miller et al. showed that runners with ITBS had larger foot adduction and knee flexion values pre-fatigue and larger foot inversion and knee flexion values post-fatigue as compared to healthy runners. However, in light of the findings of Noehren et al., and the physiological pull of the iliotibial band across the hip and knee joints, frontal and transverse kinetics and kinematics at these joints may be more closely related to the injury mechanism. Therefore, the purpose of this study was to compare hip and knee kinetics and kinematics between runners with ITBS and healthy runners before and after a fatiguing run. Following a fatiguing run, as compared to the healthy runners, runners with ITBS were expected to exhibit larger increases in hip and knee angles and moments.

METHODS
As part of an ongoing study, data from 14 female runners were included in this analysis. Gait mechanics from seven healthy runners (28.6±8.3 yrs; 1.6±0.1 m; 56.9±5.8 kgs) and seven ITBS runners (31.9±9.0 yrs; 1.7±0.1 m; 59.3±5.2 kgs) were measured during overground running. Data were collected before and after a treadmill run to fatigue. Subjects were prompted to run on the treadmill at a speed that approximated their 5K race pace and were asked to stop when they reached a self-reported Rating of Perceived Exhaustion of 17/20 or a Pain Score of 6/10 [5].

Hip and knee kinetics and kinematics were collected from a standard 6-degree-of-freedom marker set using a 12-camera motion capture system (Motion Analysis; Santa Rosa, CA) and four forceplates (Bertec; Columbus, OH and AMTI; Watertown, MA). Subjects ran through the data collection volume as they traversed a 25 m runway. Analog and video were smoothed at 50Hz and 8Hz, respectively, using a fourth-order Butterworth filter. Peak values of the following parameters were identified from the stance phase of each of five trials and averaged: hip adduction and internal rotation angles, knee abduction and internal rotation moments, and knee adduction and external rotation moments. Data from the dominant limb was used for the healthy runners, and data from the involved limb was used for the ITBS runners.

Statistical analyses were carried out in SPSS 16.0 (Chicago, IL). Two-way mixed-factor ANOVAs were used to test for any effects of injury status (between factor) and fatigue status (within factor) for each variable. Due to the preliminary nature of this work, significance was set at p < 0.10 for all analyses.

RESULTS AND DISCUSSION
Healthy runners and ITBS runners fatigued after approximately 25±7 min and 26±8 min of treadmill running, respectively.

The results of this study were not supportive of the hypotheses. As a result of fatigue, the ITBS runners were expected to demonstrate larger increases in all of the variables of interest, as compared to the
healthy runners. Yet there was only one significant interaction between group and time, and this showed that peak hip internal rotation angles were significantly decreased in ITBS runners as a result of fatigue (p = 0.03, Figure 1A). This equated to an average difference of 53.5% between pre and post-fatigue.

There were a significant main effect of time, which suggested that both groups demonstrated decreases in peak hip adduction angles (p = 0.08, Figure 1B) and peak hip abduction moments (p = 0.03, Figure 1C). This is contrary to the expectation that these parameters would increase with fatigue. It should be noted, however, that these differences tended to be small. On average there was a 9.1% difference in peak hip adduction angle and a 4.2% difference in peak hip abduction moment between pre and post-fatigue.

A significant main effect of group was demonstrated for knee adduction moment (p = 0.01, Figure 1D), which suggested that ITBS runners have increased values both pre and post-fatigue. The average difference in peak knee adduction moment between groups was 46.4%.

**CONCLUSIONS**

These findings suggest that, with increased fatigue, ITBS runners do not tend to exhibit changes hip and knee gait patterns that place higher strains on the iliotibial band. Only one variable demonstrated large changes as a result of fatigue. The unexpected tendency of the ITBS runners to decrease hip internal rotation may be a neuromuscular attempt at reducing iliotibial band strain as the body begins to fatigue. This theory is also supported by the fact that the ITBS runners exhibited increased knee adduction moments as compared to the healthy runners. These findings suggest that runners with ITBS may adopt dynamic postures that avoid excessive strain on the iliotibial band, or excessive contact friction with the lateral femoral epicondyle. It is also possible that these avoidance postures are exaggerated with repetitive motions and the onset of fatigue.

**REFERENCES**

5. Borg's Perceived Exertion and Pain Scales 1998

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**Figure 1:** Comparisons of hip and knee kinetics and kinematics between ITBS runners and healthy control runners in the pre and post-fatigue state, where * indicates an effect of time, ** indicates an effect of group, and *** indicates an interaction.