

# CROSSOVER AND FREE MOMENT DURING RUNNING

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## INTRODUCTION

As the merits of exercise for health and wellness have gained public acceptance, running has become an exercise of choice for many. Unfortunately, the risk for injury is well documented in the literature. While the exact cause of overuse injury in runners is multifactorial, altered lower extremity kinematics and loads have been associated with overuse injury.

The free moment is the torsional force about a vertical axis due to friction between the foot and the ground. This moment has been used as an estimate of torsion in the lower extremity. Peak absolute free moment is positively associated with overuse injury in runners, specifically stress fracture (Milner *et al.*, 2005 and 2006). Furthermore, altered dynamic hip and knee kinematics have also been reported in persons with a history of stress fracture (Milner *et al.*, 2005). Specifically, hip adduction is increased in runners with a history of tibial stress fracture compared to a control group (Milner *et al.*, 2005).

Increased crossover of the lower extremity relative to the pelvis during the stance phase of gait would logically result in greater hip adduction angles and potentially increase one's risk for injury. Moreover, a crossover gait pattern could result in greater pelvic rotation that needs to be countered at the foot, via the free moment. The relationship between lower extremity crossover and the free moment has not been established. The purpose of this study was to identify the

relationship between the magnitude of crossover and the free moment.

## METHODS

Eight male and six female ( $26.1 \pm 6.51$  years) recreational runners participated in this study. None of the subjects had lower extremity abnormalities at the time of data collection that would affect their ability to participate in this study.

Three dimensional kinematic data were collected using a 120 Hz eight-camera motion capture system (Vicon Peak, Centennial, CO). Twenty-three retro-reflective markers were secured on both legs. Ground reaction forces and moments were collected at 1200 Hz.

Ten successful trials were collected for each limb. All subjects ran at a self-selected 5k race pace and were required to maintain this self-selected pace during each trial (average speed:  $3.90 \pm 0.33$  m/s). Data were exported to Matlab 7.0.4. and smoothed using a low-pass Butterworth filter with a cutoff frequency of 8 Hz for kinematics and 50Hz for kinetics.

Peak positive and peak negative free moment peaks were identified as the free moment tends to display a sinusoidal pattern. The magnitude of crossover was calculated as the difference between a sacral marker and the center of pressure in the medial/lateral direction.

All free moment peaks and crossover values were averaged across trials to obtain subject means. Linear regression determined the relationship between the magnitude of crossover occurring at the peak positive and peak negative free moment peaks.

## RESULTS

Significant correlations existed between the magnitude of crossover and the both the peak positive and peak negative free moments ( $p=.009$  for both) (Figures 1 & 2). In both cases, an increase in the magnitude of the free moment was associated with a greater magnitude of crossover.

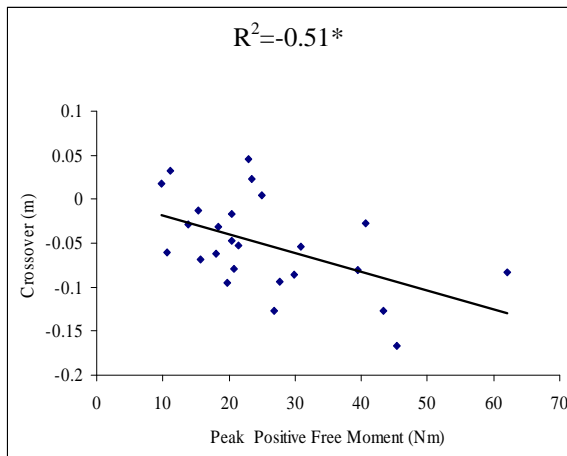


Figure 1. The relationship between crossover and peak positive free moment. A more negative crossover value indicates a greater magnitude of crossover.

## DISCUSSION

The purpose of this study was to identify the relationship between the magnitude of crossover and the free moment. A 1 cm increase in crossover resulted in a 4.76 Nm increase in the peak positive free moment. Similarly, a 1 cm increase in crossover resulted in a 3.70 Nm increase in the peak negative free moment.

The free moment, associated with crossover gait patterns in this study, has been related to overuse injury in runners. Thus, methods of controlling crossover may lead to new strategies preventing or managing injury.

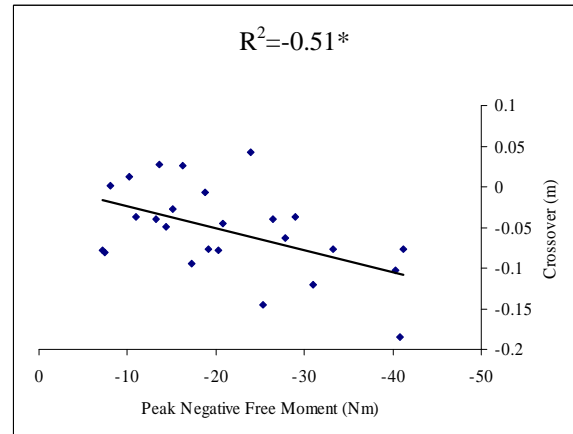


Figure 2. The relationship between crossover and peak negative free moment. A more negative crossover value indicates a greater magnitude of crossover.

## SUMMARY

The free moment, a measure of torsion in the lower extremity, has been associated with running injury. In this study, crossover of the lower extremity was significantly related to the free moment during running. Cues and/or training designed to decrease crossover may be beneficial in minimizing detrimental loads.

## REFERENCES

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