

## NEUROMUSCULAR GENDER DIFFERENCES EXIST DURING UNANTICIPATED RUNNING AND CUTTING MANEUVERS WITHIN AN ELITE ADOLESCENT SOCCER POPULATION

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### INTRODUCTION

The anterior cruciate ligament (ACL) is an extremely important ligament for knee joint stability and proper function, particularly during sporting activities that involve running, jumping and cutting. Injury to the ACL can be detrimental to an athlete's career, with approximately 70-80% of these injuries being non-contact in nature [1,2] and females being 2-8 times more likely of sustaining an ACL injury than males [3]. The non-contact mechanism of this injury most often involves landing from a jump or cutting to change directions during activities such as basketball or soccer. The purpose of this study was to identify gender related neuromuscular differences of the lower limb in unanticipated running and cutting maneuvers within an elite soccer population.

### METHODS

20 elite male and 20 elite female adolescent soccer players underwent a complete 3D kinematic, kinetic and electromyographic (EMG) analysis of the lower limb, with only the EMG findings being discussed in this abstract. Subjects were required to run at 3.5±0.2 m/s down the laboratory runway and just prior to the right foot landing on the force plate, a light system randomly cued the individuals to either 1) cut to the left (side-cut), 2) continue running straight or 3) cut to the right (cross-cut). For the stance portion of the maneuver, muscle activation patterns of the rectus femoris, vastus medialis and lateralis, lateral and medial hamstring and medial and lateral gastrocnemius were normalized to maximum voluntary isometric contractions (MVIC). All cuts were made at 35°-60° from the direction of travel and all waveforms were analyzed for gender differences using principal component analysis (PCA) [4].

### RESULTS AND DISCUSSION

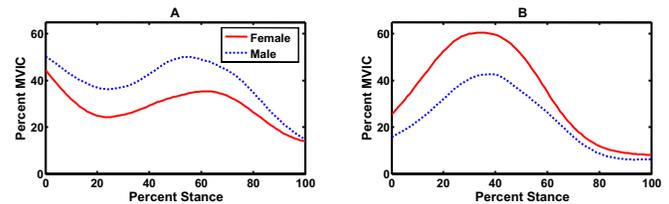
While all subjects were free from injury at the time of testing, many reported minor lower limb injuries previously in their soccer careers (Male=62%, Female=86%). The most common injuries included ankle sprains and muscle strains of the hip flexors, quadriceps, adductors and hamstrings. Descriptives comparing the male and female subject groups indicated that the only group differences were that males were taller and heavier than the females (Table 1).

**Table 1:** Descriptives for male and female subject groups. \* indicates stat. sign. (p<0.05). Values are mean (STD).

	Males	Females
Age (yrs)	17.2 (0.8)	16.9 (1.0)
Weight (kg) *	69.6 (6.6)	60.8 (5.5)
Height (m) *	1.8 (0.1)	1.6 (0.1)
BMI (kg/m <sup>2</sup> )	22.1 (1.7)	22.4 (1.8)
Soccer (yrs)	10.7 (1.7)	9.8 (2.1)

Using PCA to compare the EMG waveforms between males and females, it was determined that females had on average

higher lateral gastrocnemius activation magnitudes than their male counterparts during the side-cut, cross-cut and straight run (p<0.05) throughout stance. The overall activation magnitude of the rectus femoris in females was also larger than males during the both the cross-cut (Figure 1B) and straight run (p<0.01). For the lateral hamstring, however, females generated a smaller overall activation magnitude than the male soccer players (Figure 1A) (p<0.01) and this difference was only evident for the cross-cut maneuver.



**Figure 1:** (A) Lateral hamstring and (B) rectus femoris activation patterns for males and females during the stance phase of the cross-cut, normalized to % MVIC and % stance.

Comparing only peak stance activation levels between gender, females had an approximate 30% larger activation level for their lateral gastrocnemius for the run and two cutting maneuvers. For the cross-cut only, females had a 40% smaller lateral hamstring peak activation level and an approximate 40% larger peak activation compared to males.

These results confirm that athletic females tend to be more quadriceps dominant and do not use their hamstrings to the same degree as males [5] during cutting and running tasks. Having the higher rectus femoris and lateral gastrocnemius activity may also potentially expose females to earlier fatigue onset and may thereby result in reduced knee joint stabilization. Proper muscle function is crucial in preventing knee injuries while landing from a jump and/or cutting to change direction during activities like soccer and basketball.

### CONCLUSIONS

Neuromuscular differences between genders were most evident in the unanticipated cross-cut maneuver. The higher rectus femoris and lower lateral hamstring activity in females, in combination with specific knee joint loading patterns, appears to play a significant role in predisposing females to higher non-contact ACL injury rates.

### REFERENCES

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