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## LIMITED HIP AND KNEE FLEXION DURING LANDING IS ASSOCIATED WITH INCREASED FRONTAL PLANE KNEE MOTION AND MOMENTS

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### Abstract

**Background**—It has been proposed that female athletes who limit knee and hip flexion during athletic tasks rely more on the passive restraints in the frontal plane to deceleration their body center of mass. This biomechanical pattern is thought to increase the risk for anterior cruciate ligament injury. To date, the relationship between sagittal plane kinematics and frontal plane knee motion and moments has not been explored.

**Methods**—Subjects consisted of fifty-eight female club soccer players (age range: 11 to 20 years) with no history of knee injury. Kinematics, ground reaction forces, and surface electromyography were collected while each subject performed a drop landing task. Subjects were divided into two groups based on combined sagittal plane knee and hip flexion angles during the deceleration phase of landing (high flexion and low flexion).

**Findings**—Subjects in the low flexion group demonstrated increased knee valgus angles ( $P = 0.02$ , effect size 0.27), increased knee adductor moments ( $P = 0.03$ , effect size 0.24), decreased energy absorption at the knee and hip ( $P = 0.02$ , effect size 0.25; and  $P < 0.001$ , effect size 0.59), and increased vastus lateralis EMG when compared to subjects in the high flexion group ( $P = 0.005$ , effect size 0.35).

**Interpretation**—Female athletes with limited sagittal plane motion during landing exhibit a biomechanical profile that may put these individuals at greater risk for anterior cruciate ligament injury.

### Keywords

ACL; Injury Prevention; Joint Moments; Stiff Landing

## INTRODUCTION

Females are 4 to 6 times more likely to tear their anterior cruciate ligament (ACL) than their male counterparts (Arendt and Dick, 1995). Over the past decade, considerable attention has focused on understanding why females incur this disproportionate number of ACL injuries. What is particularly perplexing is the fact that the majority of ACL tears are non-contact

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