

# DECREASED KNEE FLEXION DURING LANDING INCREASES FRONTAL PLANE LOADING OF THE KNEE

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## INTRODUCTION

Female athletes have been reported to have a 4 to 6 greater chance of tearing their anterior cruciate ligament (ACL) than their male counterparts (Arendt et al., 1995). It has been theorized that the number of ACL injuries in female athletes is due to gender related differences in the performance of athletic activities. Investigations of gender differences in knee joint kinematics have revealed that, when compared to males, females demonstrate decreased knee flexion and increased knee valgus during landing and cutting. Hewett et al. (2005) has found both knee valgus motion and moments to be predictors of ACL injury. In general, the knee joint mechanics exhibited by females are thought to place them at a greater risk of ACL injury.

It has been proposed that females lack the strength and/or neuromuscular control of the sagittal plane musculature (i.e. hip and knee extensors) to effectively decelerate the body center of mass during landing and cutting tasks. More specifically, it is thought that females limit the amount of knee flexion during dynamic tasks, and instead, rely more on their passive restraints in the frontal plane (i.e. ligaments) to control these tasks (Hewett et al., 2002).

The purpose of this study was to examine differences in frontal plane kinematics and kinetics at the knee between females who exhibit “high knee flexion” angles and those

who exhibit “low knee flexion” angles during landing.

## METHODS

Subjects consisted of 43 healthy female club soccer players ranging in age from 11 to 17 years (average age 13.5 yrs). Three-dimensional kinematics (eight camera Vicon motion analysis system, 250 Hz) and ground reaction forces (AMTI, 1500 Hz) were collected while each subject performed a drop landing task from a height of 46 cm (3 trials). Kinematics and net joint moments at the knee (normalized by body mass) were calculated using inverse dynamics equations (Visual 3D™ software).

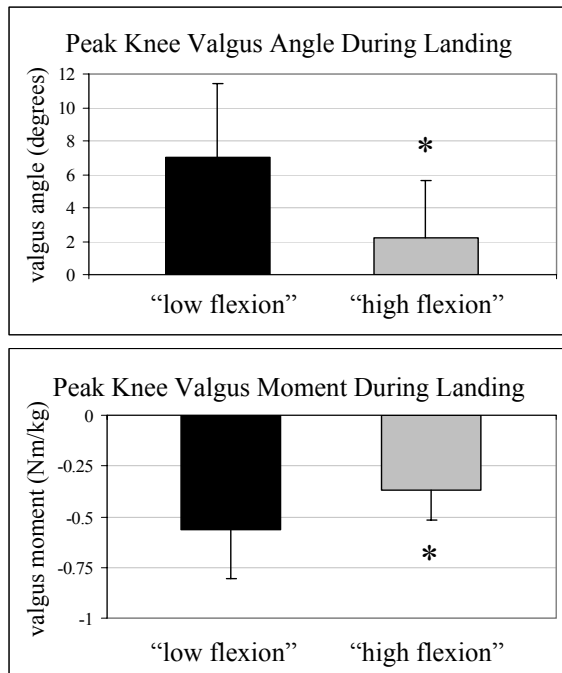
In order to compare frontal plane knee kinematics and moments between subjects who utilized “high knee flexion” angles during landing versus those who exhibited “low knee flexion” angles, subjects were divided into groups based on their peak knee flexion angle during the landing task. Subjects who exhibited a peak knee flexion angle 0.5 standard deviation above the overall group average peak knee flexion angle of 92° were assigned to the “high knee flexion” group and those who exhibited a peak knee flexion angle 0.5 standard deviation below the overall group average were assigned to the “low knee flexion” group. Using this criteria 10 subjects were placed in the “high knee flexion” group (average peak knee flexion angle = 110°) and 12 were placed in the “low knee

flexion” group (average peak knee flexion angle = 78°).

Variables of interest included the peak knee valgus angle and peak knee valgus moment during the deceleration phase of landing. Differences between groups were evaluated using independent sample t-tests. Statistical analyses were performed using SPSS statistical software (Chicago, IL). Significance levels were set at  $P \leq 0.05$ .

## RESULTS AND DISCUSSION

On average, subjects in the “low knee flexion” group demonstrated increased peak knee valgus angles (7.0° vs. 2.2°;  $P < 0.01$ ) and increased peak knee valgus moments (-0.56 vs. -0.36;  $P = 0.02$ ) when compared to subjects in the “high knee flexion” group. (Figure 1).



**Figure 1:** Comparison of frontal plane knee kinematics and kinetics between subjects who demonstrate “low flexion” and “high flexion” knee angles during landing.

Our data indicate that individuals who utilize greater sagittal plane knee motion demonstrate less loading at the knee in the frontal plane. This finding is important since it has been shown that individuals who exhibit increased knee valgus angles and moments are at a greater risk of ACL injury. These results support the premise that females who limit deceleration in the sagittal plane may employ a strategy of absorbing impact in the frontal plane during landing.

The current study provides support for the underlying framework of numerous ACL injury prevention programs which train females to land with increased sagittal plane motion (Hewett et al., 1999). This emphasis may increase sagittal plane strength and control as well as deter individuals from relying on their passive restraints.

## SUMMARY/CONCLUSIONS

Individuals who utilize “low knee flexion” angles during landing exhibit increased peak knee valgus angles and valgus moments compared to those who utilize “high knee flexion” angles. Future work is needed to better understand the underlying reason for this particular movement strategy.

## REFERENCES

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