

THE EFFECTS OF STRENGTH AND PLYOMETRIC TRAINING ON JOINT POSITION AND JOINT MOMENTS OF THE FEMALE KNEE Trowbridge CA*, Ricard MD*, Knight KL[†], Hopkins JT[†], Draper DO[†], Hilton SC[†] University of Texas at Arlington, Arlington, TX* and Brigham Young University, Provo, UT[†].

INTRODUCTION: Female athletes have experienced a 2 to 6 times greater chance of non-contact anterior cruciate ligament (ACL) injury. Previous research has indicated that specific prevention training programs can reduce the number of female knee injuries; however, we do not know how different training programs affect the specific mechanics of different sport activities. The purpose of this study was to determine the effects of pyometric and strength training programs on the kinematics and kinetics of the knee joint during various performance conditions.

METHODS: A 2 x 3 x 3 x 6 factorial was used. The factors were time (pretest and posttest), training program (control, plyometric training, and traditional strength training), trial replication (3 trials), and performance condition (run, deceleration run, cut 45°, deceleration cut 45°, drop landing, and single-leg hop). Time, replication, and performance condition were repeated measures. Thirty-six healthy female recreational athletes (age = 21.4 ± 0.1 yrs, height = 165.1 ± 2.6 cm, mass = 63.3 ± 2.9 kg) with the inability to maintain knee joint stabilization when performing functional tasks were the subjects. Separate 6-week plyometric and strength training programs were used. Pretesting and posttesting occurred within a week of the assigned training program. The order of performance conditions was counterbalanced using a 6 x 6 balanced-Latin square. Running and cutting speed (4.0 to 5.0 m/s) were monitored by timing lights. Drop landing was from 46 cm and single-leg hop was performed at a distance of 45% of subject's height. The right foot was the plant foot for all conditions. All data were collected in the Human Performance Research Center Laboratory. Kinetic data were collected using an imbedded force plate. Kinematic data were collected using a five camera phase locked motion analysis system integrated with the force plate. Dependent variables included joint angles and internal joint moments in three planes during the weight acceptance phase. Weight acceptance was the average of all the points between the initial contact and maximum knee flexion. Custom software used the Euler angle convention to calculate knee joint angles and used inverse dynamics to calculate internal joint moments. Change scores (posttest-pretest) were analyzed with 3 x 6 repeated measure factorial ANOV As. Mixed models accounted for the variance between subjects. Alpha level was set *a priori* to 0.05. If group-by-condition differences were detected among the training programs, then post hoc testing was used.

RESULTS: The plyometric group had significant increases in their knee flexion angles for the deceleration cut ($p \leq 0.003$), the drop landing ($p \leq 0.0001$), and the single-leg hop ($p \leq 0.0007$) when compared to the control group. Significant results were obtained when the plyometric group was compared to the strength group for the drop landing ($p \leq 0.0006$) and the single-leg hop ($p \leq 0.0006$). The plyometric group increased their average flexion angle up to 8° for both the drop landing and single-leg hop and up to 4° for the deceleration cut. The plyometric group also demonstrated a greater extensor torque at the posttest for the 45° cut than the control ($p \leq 0.03$) and strength ($p \leq 0.0003$) groups. The control and plyometric groups exhibited lesser valgus moments during posttesting, but only the plyometric groups' decreased valgus moment for the 45° cut corresponded with an angular change.

DISCUSSION: It appears that plyometrics can modify technique and muscle force during cutting and landing conditions. The clinical application of these findings is relevant to the prevention of the "position of no return", because an increase in flexion angle at foot planting or landing, an increase in extensor moment, and a reduction in the valgus moment and the external rotary moment might prevent the knee from collapsing into the position of injury. Therefore, plyometric training may be used to treat ligament dominance, quadriceps dominance, and leg dominance which are often seen in female athletes.

CONCLUSIONS: These data support the role of plyometric training in improving deceleration and landing. Our findings indicate that the plyometric group might have improved functional joint stability more than the strength group. Further research is encouraged to investigate the role of different prevention programs in the establishment of functional joint stability.