Author	Tay, Josephine Boon Lynn
Title	The effects of plyometric and balance training on lower extremity biomechanical variables in secondary school female netball athletes
Institute	Thesis (M.Sc.) (Exercise & Sports Studies) National Institute of Education, Nanyang Technological University
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Supervisor	Kim, Jeoung Kon

Abstract

Anterior cruciate ligament (ACL) injuries occur commonly in non-contact sports, particularly in female athletes, and there are many contributory risk factors. The increased participation of females in sports in recent years has exacerbated the problem. Of the risk factors, the way in which athletes perform sports maneuvers, particularly landing and cutting maneuvers like cross-cut and side-step, holds greatest potential for modification. High varus/valgus and internal/external rotation moments at the knee encountered during sports maneuvers have been established as a risk factor to ACL injury. Plyometric and balance training have been suggested as effective measures to help reduce ACL injury risk; although it is not known which program is superior. The purpose of this study was to evaluate the relative effectiveness of an eight-week plyometric and balance training program on young female netball athletes in terms of reducing varus/valgus, and internal/external rotation moments at the knee, which may have implications on ACL injuries. In addition, the peak vertical joint reaction forces were evaluated to see if they were within safe levels as recommended by earlier research, as excessive joint reaction forces can contribute to ACL rupture.

30 secondary school female netball athletes were assigned to either a plyometric, balance, or control training group. Peak knee joint reaction forces and moments at the knee joint were measured before and after the program for three maneuvers – cross-cut, landing, and side-step. Group differences in peak knee joint reaction force, varus/valgus and internal/external rotation moments were evaluated. Results were analyzed with repeated measures ANOVA individually with speed of approach, playing experience and training

group as between-subjects factors. Chi-square analysis was performed on the independence of peak vertical knee joint reaction force, varus/valgus moments, and internal/external rotation moments with speed of approach separately, using playing experience as a layer variable.

No significant group differences were found in magnitude of peak vertical knee joint reaction force and varus/valgus moments for all three maneuvers. The plyometric group showed an increase of 32% in varus/valgus moments post-test for cross-cut, and reductions of 16% for landing, 15% for side-step. The balance group demonstrated an increase of 23% for landing and a decrease of 9% for side-step. Varus/valgus moments were significantly related to speed of approach for the cross-cut maneuver in both novices and experienced athletes (novices: = 6.199, $p = .013$; experienced athletes: = 6.24, $p = .012$).

The control group landed with greater internal/external rotation moments than the balance group ($p = .028$). Comparing pre- and post-test results, the plyometric group showed a decrease of 17% in magnitude of internal/external rotation moments for the side-step. The balance group demonstrated an increase of 16% for cross-cut. Internal/external rotation moments were significantly related to speed of approach during pre-test landing (= 6.533, $p = .011$).

Although the plyometric and balance training did not contribute much to reduction of peak knee joint reaction forces, there were small reductions on varus/valgus moments in both trained groups for side-stepping maneuvers. Plyometric training also shows potential for reducing internal/external rotation moments for the side-step.