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ASYMMETRY FOR VERTICAL PEAK GROUND REACTION FORCE DIFFERS BETWEEN FORWARD AND DROP LANDING TASKS

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SUMMARY
ACL tear is one of the most serious athletic injuries commonly resulting of landing from a jump. Considering that it commonly leads to knee osteoarthritis, it is important to detect the risk factors and create appropriate early injury prevention programs. This study tested twelve recreational athletes in forward and drop landings tasks. The subjects performed three trials of each jump task landing on two force plates for measurement of ground reaction force. Higher loading for the preferred leg in the landing tasks was observed for drop landing tasks. Different landing techniques elicited different results of asymmetry.

INTRODUCTION
Annually between 80,000 and 250,000 cases of anterior cruciate ligament (ACL) tears are observed in USA [4,3,6], which costs up to $850M per year [4]. Research on ACL injury prevention tries to describe the best variables when screening for injury risks. Previous research has demonstrated that lower extremity kinematic asymmetry may predict ACL injury [5]. A comparison of drop landing and forward landing techniques found that forward landings elicited greater hip adduction and knee valgus asymmetries than drop landings and, therefore it may be more appropriate for field testing when screening for asymmetries [7]. Regarding kinetics, the preferred leg is in general subject to greater forces compared to the contralateral leg during stop jump tasks [2]. The influence of task technique on movement and force asymmetries is an important issue when screening for asymmetries that may predict ACL injury. Kinetic data acquisition and processing are relatively simple and force plates may be easy to install around the places of training. Additionally, force plates that measure vertical forces have lower costs compared to 3D force plates. The objective of this study was to quantify the vertical ground reaction force asymmetries of healthy recreational athletes performing forward and drop landings.

METHODS
Twelve recreational athletes, 11 male and 1 female (9 volleyball players and 3 runners) participated. They were age 22±3 years, weight 76.4±12kg and height 180±1cm. The inclusion criteria were participation in recreational sports that involved plyometric activities at least three times per week for a minimum of 45 min per practice session. Subjects were excluded if they had previous participation in injury prevention programs, gymnastics or dance. The subjects visited the laboratory in one day. They performed three trials of bilateral forward (FL) and drop landings (DL) tasks on two force plates, while vertical ground reaction force asymmetry was calculated for landing.

For the forward landing they were instructed to start with the front of their shoes aligned with a mark placed in the ground 20 cm from the force plate, jump as high as they can and land on the force plate (each foot on one force plate). In the drop landing, they were instructed to drop directly down off the box (height of 32 cm) and land with each leg on one of the two force plates. Subjects did not receive any instructions on the landing technique to avoid a coaching effect.

Ground reaction force (GRF) was measured using two force plates (OR6-2000 AMTI Inc., Watertown, MA) embedded flush to laboratory floor and calibrated according to manufacturer recommendations. GRF was sampled at 2000 Hz using specialized software and hardware (NetForce, Advanced Mechanical Technology, Inc., Watertown, MA). The peak of vertical force was identified for each subject and condition.

Data were tested for normality with the Shapiro-Wilk's test. Statistical comparisons were performed using analysis of variance in a mixed model, considering the jump tasks and leg as factors and by applying Bonferroni's corrections for multiple comparisons. When significant effects or interactions were observed, GRF data were compared between leg and tasks by using t-test for paired samples. The level of significance was set *a priori* at 0.05 for all the comparison.

RESULTS AND DISCUSSION
The preferred leg was subject to higher loading during the drop landing task (Figure 1).

A leg effect was observed [$F(1.11)=9.849$; $P=0.009$], which indicated statistically higher force for the preferred compared to the non-preferred leg during drop landing [$t(11)=2.639$;

P=0.023], but not forward landing [t(11)=1.132; P=0.282]. There was no effect of task [F(1.11)=1.750; P=0.213].

The literature overwhelmingly supports the concept that kinematic and kinetic assessment of landing tasks is useful when screening for asymmetries that place athletes at greater risk for ACL injury. As vertical peak force did not differ between legs in the forward landing, peak forces alone may not provide adequate information when screening for asymmetry in landing tasks [1].

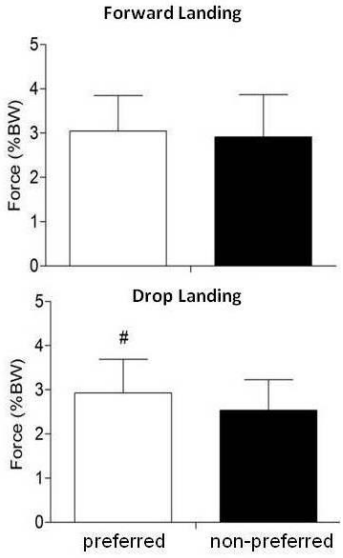

Figure 1. Normalized vertical GRF for different landing tasks. # indicates statistical difference between the legs.

Drop landings are more novel tasks and as such athletes may have elicited side-to-side differences. As previous kinematic studies have found that forward landings are more sensitive in detecting side-to-side differences, a combination of drop and forward landings is recommended for screening purposes.

CONCLUSIONS

The preferred leg consistently received higher vertical force during the drop landing task. As different landing techniques elicited different results of asymmetry, testing multiple tasks challenges athletes in distinctly different ways may be more useful when screening for injury risk.

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