Application of a Clinic-Based Algorithm as a Tool to Identify Female Athletes at Risk for Anterior Cruciate Ligament Injury

INTRODUCTION
Injuries to the Anterior Cruciate Ligament (ACL) are common, and can potentially lead to the early onset of post-traumatic osteoarthritis. Biomechanical risk factors and specific at-risk multi-planar movement patterns for non-contact ACL injuries have been identified. High knee abduction moment, or ‘knee valgus’ when landing from a jump, has been reported to predict non-contact anterior cruciate ligament injury in female athletes in one study. This research has been accomplished in laboratory settings with complex measurement systems that have characterized three-dimensional biomechanics of the lower extremity during landing from a jump. Therefore, there is a need for simple screening tools that can be used to identify individuals that are at increased risk of suffering non-contact ACL injuries.

METHODS
This study was approved by the University Institutional Review Board and all subjects and/or their legal guardians provided signed informed consent. This study was based on secondary analysis of previous work that focused on the use of the Drop Vertical Jump (DVJ) to assess the risk of ACL injury in female athletes. It was a prospective study with a nested case-control analysis. Over a 3 year interval, a total of 2,508 female athletes were screened before their athletic season using the DVJ testing procedure. Athletes participated in organized varsity or club sports at the high school or college level. Each subject completed 3 jump trials. Video data were acquired using standard Canon HDV video camcorders. Subjects who subsequently suffered a non-contact ACL injury were identified and up to 3 matched controls from the same team that were of the same age and sex were selected. Case subjects who had suffered a prior ACL injury and underwent reconstruction were eligible for inclusion. Pre-participation DVJ video data obtained from the injured case and matched controls were viewed and analyzed. This analysis was completed using Dartfish ProSuite software (Dartfish Ltd., Fribourg, Switzerland). Knee valgus motion, knee flexion range of motion, body mass, tibia length, and quadriiceps to hamstring strength ratio. The prediction algorithm was developed by regressing measures of knee abduction moment obtained through laboratory-based three-dimensional kinematic motion analysis on the co-ellinies. This tool has not yet been applied to assess its association with ACL injury risk.

The objective of this study was to determine if the probability of high knee abduction moment calculated by the algorithm can predict individuals at increased risk of suffering ACL injury.

RESULTS
A total of 20 females suffered non-contact ACL injuries from the cohort of 2,508 athletes. One subject suffered a contralateral injury and one subject suffered a graft injury. Each case was matched with 1-3 female controls that were the same age within 1 year and on the same athletic team at the time of injury, resulting in a total of 63 subjects (20 cases, 43 controls). Subject demographics are reported in Table 1.

<table>
<thead>
<tr>
<th>Group (n)</th>
<th>KAM mean±SD</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases (20)</td>
<td>0.5131 (0.2036)</td>
<td>0.367 (0.019-7.222)</td>
<td>0.5097</td>
</tr>
<tr>
<td>Controls (43)</td>
<td>0.5372 (0.2128)</td>
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DISCUSSION
This study did not find that the probability of high knee abduction moment measured by the algorithm has predictive value for identifying female athletes at increased risk of suffering non-contact ACL injury. It is important to point out that we evaluated 2,508 female subjects over 5 years and this generated 20 ACL injuries. To our knowledge this is the largest sample of subjects with non-contact injuries currently available in the literature. A much larger effort would be required to substantially increase the number of case subjects, indicating that prospective screening of athletes may not be practical for studies to evaluate risk factors for ACL injury.

Further investigation is needed to determine whether a relationship exists between landing biomechanics and the type and level of competition. Laboratory assessments and analyses have been shown to be effective methods for identifying those at increased risk for ACL injury (Hewett, 2005), but to be clinically applicable as a screening tool these methods must have the capability to effectively and efficiently identify large groups of individuals at risk for ACL injury or re-injury of the same kind. Additional research is needed to develop clinic-based screening tools that can be applied to large groups of subjects involved with activities that are associated with ACL injury.

SIGNIFICANCE
This is the first study to apply the algorithm developed by Myer et al. We did not find that this algorithm was able to identify those athletes at risk; therefore, more research needs to be conducted on potential screening tools so that athletes at risk for ACL injury can be identified and interventions can be targeted at them.

REFERENCES
1Lohmander2007;2Padua2009;3Renstrom2008;4Myer2010;5Hewett2005

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