

Research Retreat IV: ACL Injuries—The Gender Bias, April 3–5, 2008, Greensboro, NC

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In April 2008, more than 80 attendees from across the United States and Canada participated in the fourth research retreat focused on the gender bias in anterior cruciate ligament (ACL) injury. The retreat was cofounded by Irene Davis, PhD, PT, and Mary Lloyd Ireland, MD, who hosted the 3 previous research retreats in Lexington, Kentucky, in April of 2001, 2003, and 2006. In the first year (2001), a consensus document of what we know, don't know, and still need to know related to this problem was developed.¹ Each subsequent retreat has revisited and updated the previous consensus statement as new evidence has emerged.^{2,3} Over the past 6 years, the number of attendees has grown, and the retreats have attracted some of the foremost nationally and internationally known clinicians and scientists with a common interest in ACL injury. We were pleased to continue this important work by hosting Research Retreat IV in Greensboro, North Carolina.

The meeting featured an opening presentation from ACL Retreat cofounder Mary Lloyd Ireland, MD; invited keynote presentations by Scott McLean, PhD, and Bruce Beynon, PhD — expert scientists well known for their research into factors associated with the gender bias in ACL injury; and 31 fifteen-minute podium presentations of recently completed research relating to the gender bias in ACL injuries. The opening presentation set the stage for the meeting by providing a historical perspective of what research has taught us about the ACL injury gender bias over the past 20 years, and the keynote presentations focused on the current knowledge and theories associated with neuromuscular, biomechanical, anatomical, and hormonal risk factors. The podium presentations were organized into thematic sessions centered on sagittal-plane landing mechanics, sex comparisons in landing and cutting, fatigue and perturbation studies in landing and cutting, anatomical and hormonal factors, and risk factor screening and prevention. Significant time was provided for group discussion after each keynote and each group of podium presentations. At the conclusion of the meeting, participants revisited and updated the consensus statement from the 2006 retreat.² Following are the consensus statement, keynote presentation summaries, and abstracts organized by topic and presentation order.

CONSENSUS STATEMENT

As in past retreats, the consensus statement was developed with the input of all participants at the end of

the meeting. Participants were divided into groups focusing on neuromuscular, biomechanical, anatomical, and hormonal factors and risk factor screening and prevention factors, as in previous meetings. Within each group, the relevant section of the previous consensus document was updated as to (1) what we know based on new evidence that has emerged from the literature and the research presented at the retreat, (2) what remains unknown about these factors related to ACL injury, and (3) the important directions for future research to address these unknowns. The individual groups then presented their working drafts to the entire group of participants for further discussion. After further refinement, final drafts were circulated to consensus leaders and attendees for final comment after the meeting.

From these discussions, some general themes emerged that deserve special note. First, when understanding the risk factors associated with injury, a working definition of the injury is critical: in this case, a noncontact ACL injury. The participants at this meeting support the definitions presented by Marshall et al⁴ that distinguish among direct contact, indirect contact and noncontact, where noncontact is defined as “forces applied to the knee at the time of injury resulted from the athlete's own movements and did not involve contact with another athlete or object.” It may very well be that the risk factors associated with noncontact injury (eg, landing and change direction with no opponent nearby) are different from the risk factors for injury resulting from indirect contact (eg, perturbation from another player before the landing), and these distinctions should be carefully considered and documented in future retrospective and prospective injury risk studies.

A second important theme was the need to move beyond the purely descriptive sex comparison studies that continue to dominate the literature. Although much has been learned about characteristic sex differences in neuromuscular and biomechanical function over the past 12 years, we still know very little about the underlying causes (eg, anatomical, hormonal, other) of these differences or whether many of the observed differences truly reflect an increased injury risk for the physically active female. Also, more integration across risk factor categories is needed, rather than the continued examination of isolated risk factors. It is well accepted that ACL injury is likely a multifactorial problem in which the effects of one risk factor may be difficult to identify without accounting for other relevant risk factors. This approach appears to be

particularly important in our understanding of anatomical factors, as the effect of one alignment factor on knee loading patterns is difficult to quantify without accounting for the collective alignment of the entire lower extremity. It is also possible that risk factors for noncontact ACL injury might even differ among sport populations: for example, between elite and recreational athletes or between men and women. These differences may stem from the varied incidences of key risk factors—such as anatomy, hormones, and movement—across populations.

A similar integrative approach is needed when reporting neuromuscular and biomechanical outcomes associated with the examination of these risk factors. Oftentimes, neuromuscular (eg, muscle strength, muscle activation) and biomechanical (eg, kinematic and kinetic) outcomes are reported in separate studies; seldom are neuromuscular, kinematic, and kinetic variables collected on the same group of participants and reported together. Although the collective findings of neuromuscular and biomechanical studies have led to assumptions of their relationship to one another (eg, quadriceps-dominant activation patterns leading to reduced knee flexion and greater shear forces), these relationships have rarely been tested empirically. In order for scientists and clinicians to gain a more comprehensive and accurate understanding of the effect of relevant risk factors on weight-bearing knee joint function, future authors are encouraged to take a more comprehensive approach to risk factor assessment and make every effort to integrate and relate the neuromuscular and biomechanical outcomes of interest. As a step toward that end, the consensus statements related to neuromuscular and biomechanical factors have been integrated into a single section of this document.

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