The Women's Sports Foundation Report Brief:

Her Life Depends On It III & Female Athletes and Knee Injuries

For an athlete, there is a sound that they hope never to hear. That sound, often described as a "pop," signals that the athlete may likely have torn an anterior cruciate ligament (ACL), a ligament that serves as a key stabilizer for the knee. As more and more athletes at all ages have entered the competitive arena and found their way into recreational sport programs, there has been an increase in the public understanding of knee injuries. And there is reason for concern.

In general, irrespective of gender, ACL injuries account for 50% or more of all knee injuries (Joseph et al., 2013) and have been described as the "largest single problem in orthopaedic sports medicine" (Renstrom et al., 2008). Knee injuries also are among the most economically costly of sports injuries, frequently requiring expensive surgery and rehabilitation (Joseph et al., 2013). However, the overall incidence of ACL injuries is low, occurs more frequently in men's sports, and constitutes approximately 3% of all injuries in the NCAA sample (Hootman, Dick & Agel, 2007).

For female athletes, who do tend to be more vulnerable to ACL tears and ruptures, the problem of knee injuries has been described as an "epidemic." While it is the case that female athletes do experience knee injuries at higher rates than their male counterparts in some sports, sometimes being four to six times more likely to experience a knee injury, understanding the gendered dynamics around knee injuries helps to put what this increased vulnerability means – and what it doesn't mean – into perspective.

updated 9.19.16

The manner in which injuries occur in male and female athletes is often represented differently in the media. While data does support that female athletes are more vulnerable to ACL injuries, there is almost no discussion in contrast regarding the fact that NCAA male soccer players are 64% more likely to experience hamstring injuries compared to female soccer players (Cross, Gurka, Saliba, Conaway, & Hertel, 2013). There has been no news account that has viewed the higher incidence of hamstring injuries among male soccer players as being epidemic in proportions. Thus, the challenge is sorting through the reasons why female athletes may be more vulnerable to ACL tears.

And some of those reasons are social. The most recent FIFA Women's World Cup in 2015, which was held in venues across Canada, provides further insight into the gendered dynamic that affects incidence of injury. According to NCAA research, playing surface affects incidence of knee injury. In a study looking at the incidence of ACL tears among college football players, "The rate of ACL injury on artificial surfaces is 1.39 times higher than the injury rate on grass surfaces. Non-contact injuries occurred more frequently on artificial turf surfaces (44.29%) than on natural grass (36.12%)." In the case of the FIFA Women's World Cup, contrary to the Men's World Cup, which has historically been played on grass fields, and despite international protests, the women's games would be played in venues with artificial turf.

Based on research, there are other reasons, stemming from hormonal and biomechanical sources, which contribute to the incidence of knee injuries in female athletes. To follow are highlights from some of the most recent research on the subject.

Incidence

A variety of analyses of the NCAA data highlight the rates of ACL injuries among women athletes with particular attention paid to gender differences in basketball and soccer, sports in which the rules of play are largely the same for men and women, and thus gender comparisons are thought to be especially meaningful.

- Over a 16-year period, from 1988-89 to 2003-04, the rate of ACL injuries was .07 for men and .23 for women in basketball and was .09 for men and .28 for women in soccer. Both the rate of ACL injuries among women athletes and the gender gap remained stable over this period (Hootman et al., 2007).
- The NCAA data also showed that three of the four sports with the highest rates of ACL injuries were women's sports (gymnastics, basketball, and soccer). The fourth sport with a high rate of this injury is spring football. All had significantly higher ACL injury rates than any other sport (Hootman et al., 2007).
- An analysis of ACL injury rates in a sample of U.S. high schools found that, overall, girls and boys had similar rates of ACL injuries, and, consistent with the NCAA data, the sports with the highest rates were football, girls' soccer, and girls' basketball (Joseph et al., 2013).
- An expanding body of research, employing different measures and samples from different countries provides further support for the finding that females have higher rates of ACL injuries than males when exposed to the same sport (Moses, Orchard & Orchard, 2012).
- Gender differences in the incidence of ACL injuries occur after the onset of puberty (Hewett, Myer, Ford, Paterno & Quatman, 2012).
- While research and commentary continues to focus on gender differences in rates, leading to a common belief that ACL injuries are a problem particular to women athletes, it is important to note that the highest incidence, that is number of ACL injuries, occurs in men's sports. Both the early analyses of collegiate athletes by Hootman, Dick & Agel (2007) and the more recent high school data reported by Joseph et al. (2013) indicate that football had the highest number of ACL injuries.

Mechanisms of ACL Injuries

Research consistently demonstrates that the majority of ACL tears among women athletes are non-contact, that is to say, the forces applied to the knee at the time of injury were a result of the athlete's movements, not contact with another athlete or object (Shultz, 2008; Arendt, 2007).

- Typically, these injuries occur during planting, cutting, and landing maneuvers (Giugliano & Solomon, 2007).

The occurrence of a high proportion of ACL injuries through non-contact mechanisms is significant, as it points to features of the athlete's movement and not the circumstances of the sport activity as the precipitating event for the injury.

This presents possibilities for prevention through training to alter movement patterns. Accordingly, recent research has concentrated extensively on identifying and understanding the mechanisms whereby risk factors operate and following from this, prevention strategies that are based on understanding risk factors and mechanisms.

Risk Factors

Investigations employing different techniques, most notably video analysis, have identified gender differences in movement patterns that place athletes at risk for ACL tears. While these patterns are not exclusive to women, research suggests that females perform riskier neuromuscular patterns more often than men when doing similar sporting moves (Arendt, 2007; McLean, 2008). A variety of factors have been studied to determine why females are more at risk than males for sustaining a non-contact ACL injury.

The most extensive research has been directed to landing techniques and neuromuscular recruitment patterns, as well as anatomical and hormonal influences. Notable about these is that the first two offer the greatest potential for modification through training programs, whereas the anatomical and hormonal influences are largely not modifiable.

- Research on neuromuscular and biomechanical factors has examined factors such as muscle activation, strength, balance, control, and lower-extremity biomechanics. Deficiencies in these factors may leave athletes more susceptible to the knee motions that are considered mechanisms of ACL injury (Hewett et al., 2012).

- Research on anatomical factors has concerned knee geometry and alignment. Hormonal research has been directed to determine the influence of hormonal variations associated with menstrual cycle phase (Smith et al., 2012, part 1). There is also preliminary evidence of genetic influences on familial disposition to ACL injuries (Hewett et al., 2012; Smith et al., 2012, part 2). Research advances in these areas may enable the identification of individuals at higher risk, who may be targeted for interventions (Hewett et al., 2012).
- External risk factors, that is those external to the athlete, that have been identified for ACL injuries relate to shoe surface interaction and include weather, playing surface, and footwear (Smith et al., 2012, part 2). These factors may interact with those that are gender-related.
- Individuals who have sustained an ACL injury are at high risk for a subsequent ACL injury (Shultz et al, 2012; Smith et al., 2012, part 2).
- There is consensus that the causes of ACL injuries are multifactorial and risk factors operate in combination (Shultz et al., 2012).

Prevention

The main development in research on ACL injuries since the previous version of this report was issued is the growing attention to research on prevention and the accumulating evidence on the components of successful interventions to reduce the incidence of ACL injuries.

- Prevention programs concentrate on reducing neuromuscular deficits that increase the incidence of ACL injury, and there is evidence that neuromuscular training reduces the level of risk factors (Hewett et al., 2012).
- Successful training programs involve extensive training volumes and time commitment on the part of athletes and coaches. These can deter the implementation of successful interventions (Hewett et al., 2012).
- Research in Norway on the reduction of ACL injuries in team handball provides evidence of the importance of a comprehensive approach to injury prevention. Results from the Norwegian experience emphasize the importance of educational initiatives to promote the importance of injury prevention and reinforce the importance of support and involvement by coaches and team and club officials (Myklebust, Skølberg & Bahr, 2013).

- There is growing recognition of the importance of the timing of prevention initiatives. The emergence of gender differences in joint laxity and neuromuscular control during maturation, coupled with a divergence in the incidence of injuries after puberty, indicates that injury prevention efforts should be introduced in preadolescence or early puberty (Hewett et al., 2012).

Future Research and Actions Needed

While there is evidence of the success of training programs to reduce the incidence of ACL injuries, research is needed to understand more clearly the elements of the programs that contribute to injury reduction, in order to improve their efficiency and effectiveness.

Publicizing the importance of interventions to reduce injuries and to gain the support of coaches and team and club officials could help to ensure compliance with training programs.

There also is a need to identify barriers and facilitators to maximize acceptance, compliance, and retention of community-based interventions to reduce ACL injuries (Shultz et al., 2012).

Adapted from Staurowsky, E. J., DeSousa, M. J., Miller, K. E., Sabo, D., Shakib, S., Theberge, N., Veliz, P., Weaver, A., & Williams, N. (2015). *Her Life Depends On It III: Sport, Physical Activity, and the Health and Well-Being of American Girls and Women*. East Meadow, NY: Women's Sports Foundation.

The full report can be accessed online at: www.WomensSportsFoundation.org/HerLifeDependsOnIt3

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