FAST BREAK

Publication for team medical personnel

ACL injuries in Women's Basketball

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WELCOME to FAST BREAK!

Welcome to Fast Break, the official quarterly news bulletin of the FIBA Medical Commission. Our goal is to introduce our FIBA sports medicine and sports science community to newsworthy research topics and develop a community of practice among physicians and clinicians involved with basketball at every level of play across the globe.

We hope this publication will foster friendly communication and discussions within the world of basketball. We welcome and encourage your questions, comments, suggestions, and contributions to this publication.

MESSAGE FROM THE EDITOR

If you Google “what sport has the highest risk of Anterior Cruciate Ligament (ACL) tears” the answer is, “…soccer and basketball, particularly for female athletes.”

In the United States of America, the Women’s National Basketball Association (WNBA) reports 37% of knee injuries are ACL tears. A 2013 study of high-school age youth sustaining an ACL injury in the USA found that basketball accounted for 26.5% of all ACL tears in females, but only 5% of males. A 2023 meta-analysis co-authored by FIBA medical commission member Prof. Dragan Radovanović further elaborated that ACL injury increases with increasing level of competition and game play versus practice, with the female-to-male ratio of 3.33 for ACL injury.

Basketball is a sport fraught with risk to the ACL due to the nature of the game: directional changes, stop/start and jump/land mechanisms. The higher risk for female basketball athletes relates to varying unmodifiable anatomical factors (increased Q-angle, notch size, smaller volume of the ACL), and possibly hormonal and menstrual cycle influence (estrogen receptors on the ACL). But modifiable factors like appropriate coaching and training for females, and neuromuscular control of the trunk and lower extremity can significantly diminish the risk for ACL injury in the female athlete.

ACL injury is a serious injury for a basketball player; it is detrimental to longevity in sport and has serious long-term consequences to the health of the knee joint. The FIBA medical commission is currently working to establish an ACL-injury prevention program for basketball athletes. In the spirt of that work, this thematic edition of the Fast Break will focus on female ACL injury prevention.

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IN THIS ISSUE

EDIFICATION FROM THE MEDICAL COMMISSION

In this segment of the Fast Break Dr. Jose Raul Canlas, FIBA Medical Commission member and orthopedic surgeon in Manila, Philippines, outlines why ACL injury is so common in basketball.

ACL injury in Basketball

Dr José Paul Canlas, M.D.

There seems to be surge of anterior cruciate ligament (ACL) injuries in female athletes. This seeming uptick in incidence is surely related to the increasing number of women getting involved in sports. Together with this expanding population of active individuals is the background of high-profile athletes getting injured.

In markedly disproportionate numbers, ACL injuries are 5 to 8 times more likely to occur in women than men in the same sport. This gender gap has been attributed to a number of factors: there are inherent characteristics of the female individual that have been highlighted, including biomechanical, anatomical, physiological and hormonal differences from the male athlete. Poor mechanics, structural differences and neuromuscular deficits will not cause an ACL injury by themselves but certainly increase the risk for a female athlete to sustain such an injury.

Hormonal differences have also been cited as a risk for sustaining an ACL injury, but more research seems to be needed to further address this question for the female athlete. There are also socioeconomic factors that contribute to a higher risk in having an ACL injury in females. There is an inequality of coaching and training programs that are available to females at all ages. This is more evident in the pre-pubertal and pubertal ages groups, when neuromuscular recruitment is being developed.

What is certain is that a properly supervised neuromuscular training program can reduce ACL injuries in females by as much as 70%. Key components of such a program includes dynamic warm up, plyometric training programs, balance and proprioception training, and hip, core and hamstring strength. It is vital that athletes, coaches, physicians, trainers and team managers are aware that such training programs reduce risks of an ACL injury.

The gender gap in ACL injuries is not destiny. The factors that contribute to it can be modified. Success starts with better science-based programs, better education and better compliance from all stakeholders in the sport of basketball.

GUEST EDITORIAL

In this edition, Ahmed Yahya Mohamed, PT, HCPC, GPTS, former lead physical therapist for the Egyptian basketball team discusses ACL injury prevention.

Anterior cruciate ligament (ACL) injury is one of the most devastating injuries that occurs in basketball. Each year, hundreds of athletes, from youth players to professionals, experience ACL injury that can alter the course of their athletic career. The urgent need to address this issue should be one of the top priorities of the medical personal involved in basketball.

Although the overall rate of ACL injury is higher in males, primarily due to greater opportunities to participate in contact sports, the relative risk of ACL injury in women is three to eight times greater than males. Anatomical differences contribute significantly to the increased risk in females. Hormonal factors, both endogenous and exogenous, play a role in ACL laxity and may modify the risk of injury. However, data are still limited.

The science and literature for prevention techniques are readily available, however, the implementation of these techniques is not. We need to understand that injury prevention protocols should be a 'must' rather than 'good to have' in the training program of athletes. These techniques should be established and integrated into the culture of sport, beginning with youth players, coaches, and medical personal. We can no longer accept that ACL injury prevention programs are optional. There is compelling evidence that integrating ACL injury prevention programs as warm up routines in youth athletes during early puberty is effective in limiting the development of high-risk movement patterns associated with ACL injury.

Evidence shows ACL injury prevention programs with higher volumes of neuromuscular training have greater prophylactic effectiveness and increased benefit in ACL injury reduction among female athletes. Including plyometric training combined with neuromuscular and balance training during warm up has shown superiority over conventional warm up routines.

The solution to the rising problem of ACL injuries is to educate coaches, parents, athletes and medical personal about the risk factors and implementing proven methods of injury prevention. Basketball programs should require structured warm-up and neuromuscular training as a routine part of practices not as an optional add-on program. We must continue to bridge the gap between science and the field-of-play, and provide ACL injury prevention programs that are easy to implement for all levels of play.

Stojanović E, Faude O, Nikić M, Scanlan AT, Radovanović D, Jakovljević V. The incidence rate of ACL injuries and ankle sprains in basketball players: A systematic review and meta-analysis. Scand J Med Sci Sports. 2023 Jun;33(6):790-813. doi: 10.1111/sms.14328. Epub 2023 Feb 19. PMID: 36752659.

Silvers-Granelli H. Why Female Athletes Injure Their ACL's More Frequently? What can we do to mitigate their risk? Int J Sports Phys Ther. 2021 Aug 1;16(4):971-977. doi: 10.26603/001c.25467. PMID: 34386276; PMCID: PMC8329328.

Mancino F, Gabr A, Plastow R, Haddad FS. Anterior cruciate ligament injuries in female athletes. Bone Joint J. 2023 Oct 1;105-B(10):1033-1037. doi: 10.1302/0301-620X.105B10.BJJ-2023-0881.R1. PMID: 37777208.

Otsuki R, Benoit D, Hirose N, Fukubayashi T. Effects of an Injury Prevention Program on Anterior Cruciate Ligament Injury Risk Factors in Adolescent Females at Different Stages of Maturation. J Sports Sci Med. 2021 Apr 15;20(2):365-372. doi: 10.52082/jssm.2021.365. PMID: 34211330; PMCID: PMC8219262.

Sugimoto D, Myer GD, Foss KD, Hewett TE. Dosage effects of neuromuscular training intervention to reduce anterior cruciate ligament injuries in female athletes: meta- and sub-group analyses. Sports Med. 2014 Apr;44(4):551-62. doi: 10.1007/s40279-013-0135-9. PMID: 24370992; PMCID: PMC3969416.

Dargo L, Robinson KJ, Games KE. Prevention of Knee and Anterior Cruciate Ligament Injuries Through the Use of Neuromuscular and Proprioceptive Training: An Evidence-Based Review. J Athl Train. 2017 Dec;52(12):1171-1172. doi: 10.4085/1062-6050-52.12.21. Epub 2017 Nov 27. PMID: 29172648; PMCID: PMC5759702.

SELECTED PUBLICATIONS OF INTEREST

ACL injury prevention: Where have we come from and where are we going?

Arundale AJH, Silvers-Granelli HJ, Myklebust G. Journal of Orthopedic Research, Jan 2021. DOI: 10.1002/jor.25058

Anterior cruciate ligament (ACL) injuries are one of the most common and severe knee injuries across sports. As such, ACL injury prevention has been a focus of research and sports medicine practice for the past three-plus decades. Examining the current research and identifying both clinical strategies and research gaps, the aim of this review is to empower clinicians and researchers with knowledge of where the ACL injury prevention literature is currently and where it is going in the future. This paper examines the mechanism of ACL injury prevention, screening, implementation, compliance, adherence, coronavirus, and areas of future research. Clinical significance: The time lag between research and practical implementation in general healthcare settings can be as long as 17 years; however, athletes playing sports today are unable to wait that long. With effective programs already established, implementation and adherence to these programs is essential. Strategies such as coaching education, increasing awareness of free programs, identifying barriers, and overcoming implementation obstacles through creative collaboration are just a few that could help improve both ACL injury prevention implementation and adherence.

Exercise-Based Knee and Anterior Cruciate Ligament Injury Prevention: Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability and Health from the Academy of Orthopaedic Physical Therapy and the American Academy of Sports Physical Therapy

Summary of Recommendations:

SCIENTIFIC LITERATURE FOR EXERCISE-BASED KNEE INJURY PREVENTION PROGRAMS

A Clinicians should recommend use of exercise-based knee injury prevention programs in athletes for the prevention of knee and anterior cruciate ligament (ACL) injuries. Clinicians may recommend the use of an exercise-based neuromuscular training program in the late phase of ACL reconstruction rehabilitation for the secondary prevention of ACL injuries.

EFFECTIVE EXERCISE-BASED KNEE INJURY PREVENTION PROGRAMS FOR SPECIFIC SUBGROUPS OF ATHLETES

Clinicians, coaches, parents, and athletes should implement exercise-based knee injury prevention programs prior to practices/training sessions or games in women athletes to reduce the risk of ACL injuries, especially in athletes younger than 18 years of age.

COMPONENTS, DOSAGE, AND DELIVERY OF EXERCISE-BASED KNEE INJURY PREVENTION PROGRAMS

Exercise-based knee injury prevention programs used for women should incorporate multiple components, proximal control exercises, and a combination of strength and plyometric exercises. Exercise-based knee injury prevention programs should involve training multiple times per week, training sessions that last longer than 20 minutes, and training volumes that are longer than 30 minutes per week. Clinicians, coaches, parents, and athletes should start exercise-based knee injury prevention programs in the preseason and continue performing the program through the regular season. Clinicians, coaches, parents, and athletes must ensure high compliance with exercise-based knee injury prevention programs, particularly in women athletes. Exercise-based knee injury prevention programs may not need to incorporate balance exercises, and balance should not be the sole component of a program.

IMPLEMENTING EXERCISE-BASED KNEE INJURY PREVENTION PROGRAMS

Clinicians, coaches, parents, and athletes should implement exercise-based knee injury prevention programs in all young athletes, not just those athletes identified through screening as being at high risk for ACL injury, to optimally mitigate injuries and reduce cost. For the greatest reduction in future medical costs and prevention of ACL injuries, osteoarthritis, and total knee replacements, clinicians, coaches, parents, and athletes should encourage implementation of exercise-based ACL injury prevention programs in athletes 12 to 25 years of age involved in sports with a high risk of ACL injury. Clinicians, coaches, parents, and athletes should support implementation of exercise-based knee injury prevention programs led by either coaches or a group of coaches and medical professionals.

Neuromuscular training injury prevention strategies in youth sport: a systematic review and meta-analysis

Emery CA, Roy TO, Whittaker JL, Nettel-Aguirre A, van Mechelen W. BJSM June 2015. http://dx.doi.org/10.1136/bjsports-2015-094639.

Youth have very high participation and injury rates in sport. Sport is the leading cause of injury in youth. Sport injury reduces future participation in physical activity which adversely affects future health. Sport injury may lead to overweight/obesity and post-traumatic osteoarthritis. The objective of the systematic review and meta-analysis was to evaluate the efficacy of injury prevention neuromuscular training strategies in youth sport. Three electronic databases were systematically searched up to September 2014. Studies selected met the following criteria: original data; analytic prospective design; investigated a neuromuscular training prevention strategy intervention(s) and included outcomes for injury sustained during sport participation. Two authors assessed the quality of evidence using Downs and Black (DB) criteria. Meta-analyses including randomised controlled trials only (RCTs) to ensure study design homogeneity were completed for lower extremity and knee injury outcomes. Of 2504 potentially relevant studies, 25 were included. Meta-analysis revealed a combined preventative effect of neuromuscular training in reducing the risk of lower extremity injury (incidence rate ratio: IRR=0.64 (95% CI 0.49 to 0.84)). Though not statistically significant, the point estimate suggests a protective effect of such programmes in reducing the risk of knee injury (IRR=0.74 (95% CI 0.51 to 1.07)). There is evidence for the effectiveness of neuromuscular training strategies in the reduction of injury in numerous team sports. Lack of uptake and ongoing maintenance of such programmes is an ongoing concern. A focus on implementation is critical to influence knowledge, behaviour change and sustainability of evidence informed injury prevention practice.

Effect of specific exercise-based football injury prevention programmes on the overall injury rate in football: a systematic review and meta-analysis of the FIFA 11 and 11+ programmes

Thorborg K, Krommes KK, Esteve E, Clausen MB, Bartels EM, Rathleff MS. BJSM

Objective: To investigate the effect of FIFA injury prevention programmes in football (FIFA 11 and FIFA 11+). **Design**: Systematic review and meta-analysis. **Eligibility criteria for selecting studies**: Randomised controlled trials comparing the FIFA injury prevention programmes with a control (no or sham intervention) among football players. **Data sources**: MEDLINE via PubMed, EMBASE via OVID, CINAHL via Ebsco, Web of Science, SportDiscus and Cochrane Central **Register of Controlled Trials**: from 2004 to 14 March 2016. **Results**: 6 cluster-randomised controlled trials had assessed the effect of FIFA injury prevention programmes compared with controls on the overall football injury incidence in recreational/subelite football. These studies included 2 specific exercise-based injury prevention programmes: FIFA 11 (2 studies) and FIFA 11+ (4 studies). The primary analysis showed a reduction in the overall injury risk ratio of 0.75 (95% CI 0.57 to 0.98), p=0.04, in favour of the FIFA injury prevention programmes. Secondary analyses revealed that when pooling the 4 studies applying the FIFA 11+ prevention programme, a reduction in the overall injury risk ratio (incidence rate ratio (IRR) 0.61; 95% CI 0.48 to 0.77, p<0.001) was present in favour of the FIFA 11+ prevention programme. No reduction was present when pooling the 2 studies including the FIFA 11 prevention programme (IRR 0.99; 95% CI 0.80 to 1.23, p=0.940). **Conclusions**: An injury-preventing effect of the FIFA injury prevention programmes compared with controls was shown in football. This effect was induced by the FIFA 11+prevention programme which has a substantial injury-preventing effect by reducing football injuries by 39%, whereas a preventive effect of the FIFA 11 prevention programme could not be documented.

The incidence rate of ACL injuries and ankle sprains in basketball players: A systematic review and meta-analysis

Emilija Stojanović, Oliver Faude, Miloš Nikić, Aaron T Scanlan, Dragan Radovanović, Vladimir Jakovljević. Scand J Med Sci Sports 2023; 33(6), 790-813. DOI: 10.1111/sms.14328

Objective: To quantify the incidence rate of anterior cruciate ligament (ACL) injuries and ankle sprains according to player sex, playing level, and exposure setting (training vs. games) in basketball players. **Methods:** PubMed, MEDLINE, Google Scholar, and ScienceDirect were searched. Only studies reporting the number of ACL injuries and/or ankle sprains alongside the number of athlete-exposures (training sessions and/or games) in basketball players were included. **Results:** Thirty studies (17 reporting ACL injuries and 16 reporting ankle sprains) were included in the meta-analysis. Higher ($p < 0.05$) ACL injury incidence rates per 1000 athlete-exposures were recorded in females (female: 0.20 95% confidence intervals [0.16-0.25]; male: 0.07 [0.05-0.08]; female-to-male ratio: 3.33 [3.10-3.57]), in players competing at higher playing levels (amateur: 0.06 [0.04-0.09]; intermediate: 0.16 [0.13-0.20]; elite: 0.25 [0.14-0.64]), and in games (games: female, 0.27 [0.21-0.32]; male, 0.06 [0.03-0.08]; training: female, 0.03 [0.02-0.05]; male: 0.01 [0.00-0.02]; game-to-training ratio: 7.90 [4.88-12.91]). Higher ($p < 0.05$) ankle sprain incidence rates per 1000 athlete-exposures were observed in males (female: 0.82 [0.61-1.03]; male: 0.90 [0.61-1.19]; female-to-male ratio: 0.91 [0.83-0.99]), in players competing at higher playing levels (amateur: 0.54 [0.51-0.57]; intermediate: 1.12 [1.00-1.24]; elite: 1.87 [1.29-2.46]), and in games (games: 2.51 [1.85-3.16]; training: 0.80 [0.52-0.80]; game-to-training ratio: 2.77 [2.35-3.26]). **Conclusion:** According to player sex, ACL injury incidence rate is higher in females,

while ankle sprain incidence rate is greater in males. ACL injury and ankle sprain incidence rates are greater in players competing at higher playing levels and during games compared to training.

The ACL: Anatomy, Biomechanics, Mechanisms of Injury, and the Gender Disparity

Noyes, F.R., Barber-Westin, S. (2018). The ACL: Anatomy, Biomechanics, Mechanisms of Injury, and the Gender Disparity. In: Noyes, F., Barber-Westin, S. (eds) ACL Injuries in the Female Athlete. Springer, Berlin, Heidelberg.

https://doi.org/10.1007/978-3-662-56558-2_1

This chapter summarizes the current knowledge regarding ACL anatomy, biomechanics, common injury mechanisms, and the differences in ACL injury rates between male and female athletes. At least two-thirds of ACL tears occur during noncontact situations such as cutting, pivoting, accelerating, decelerating, and landing from a jump. Reduced knee flexion angles, increased hip flexion angles, valgus collapse at the knee, increased hip internal rotation, and increased internal or external tibial rotation are frequently reported at the time of or just prior to ACL injury. Female athletes are at greater risk for sustaining an ACL injury compared with male athletes participating in soccer, basketball, rugby, and handball. Research has shown that comprehensive training programs can effectively "reprogram" the neuromuscular system to avoid potentially dangerous body mechanics and positions.

Effect of gender on lower extremity kinematics during rapid direction changes: an integrated analysis of three sports movements.

McLean SG, Walker KB, van den Bogert AJ. *Journal of Science & Medicine in Sport. 8(4):411-22, 2005 Dec.*

Anterior cruciate ligament (ACL) injury is a common sport injury, particularly in females. Gender differences in knee kinematics have been observed for specific movements, but there is limited information on how these findings relate to other joints and other movements. Here we present an integrated analysis of hip, knee and ankle kinematics across three movements linked to non-contact ACL injury It was hypothesised that there are gender differences in lower extremity kinematics, which are consistent across sports movements. Ten female and ten male NCAA basketball players had three-dimensional hip, knee and ankle kinematics quantified during the stance phase of sidestep, sidejump and shuttle-run tasks. For each joint angle, initial value at contact, peak value and between-trial variability was obtained and submitted to a two-way mixed design ANOVA (gender and movement), with movement condition treated as a repeated measure. Females had higher peak knee valgus and lower peak hip and knee flexion, with the same gender differences also existing at the beginning of stance ($p<0.05$). Peak valgus measures were highly correlated between movements, but not to static valgus alignment. Kinematic differences demonstrated by females for the sports movements studied, and in particular knee valgus, may explain their increased risk of ACL injury. These differences appear to stem largely from subject-specific neuromuscular mechanisms across movements, suggesting that prevention via neuromuscular training is possible.

Rehabilitation for the 10- to 18-Year-Old Adolescent Athlete: Practice Guidelines Based on International Delphi Consensus

van Melick N, Dietvorst M, van Oort MIAM et al. J Sports Med 2023; 11(7). DOI: 10.1177/23259671231172454

Background: There are 2 treatment options for adolescent athletes with anterior cruciate ligament (ACL) injuries-rehabilitation alone (nonsurgical treatment) or ACL reconstruction plus rehabilitation. However, there is no clear consensus on how to include strength and neuromuscular training during each phase of rehabilitation. **Purpose:** To develop a practical consensus for adolescent ACL rehabilitation to help provide care to this age group using an international Delphi panel. **Study design:** Consensus statement. **Methods:** A 3-round online international Delphi consensus study was conducted. A mix of open and closed literature-based statements were formulated and sent out to an international panel of 20 ACL rehabilitation experts. Statements were divided into 3 domains as follows: (1) nonsurgical rehabilitation; (2) prehabilitation; and (3) postoperative rehabilitation. Consensus was defined as 70% agreement between panel members. **Results:** Panel members agreed that rehabilitation should consist of 3 criterion-based phases, with continued injury prevention serving as a fourth phase. They also reached a consensus on rehabilitation being different for 10- to 16-year-olds compared with 17- and 18-year-olds, with a need to distinguish between prepubertal (Tanner stage 1) and mid- to postpubertal (Tanner stages 2-5) athletes. The panel members reached a consensus on the following topics: educational topics during rehabilitation; psychological interventions during rehabilitation; additional consultation of the orthopaedic surgeon; duration of postoperative rehabilitation; exercises during phase 1 of nonsurgical and postoperative rehabilitation; criteria for progression from phase 1 to phase 2; resistance training during phase 2; jumping exercises during phase 2; criteria for progression from phase 2 to phase 3; and criteria for return to sports (RTS). The most notable differences in recommendations for prepubertal compared with mid- to postpubertal athletes were described for resistance training and RTS criteria. **Conclusion:** Together with available evidence, this international Delphi statement provides a framework based on expert consensus and describes a practice guideline for adolescent ACL rehabilitation, which can be used in day-to-day practice. This is an important step toward reducing practice inconsistencies, improving the quality of rehabilitation after adolescent ACL injuries, and closing the evidence-practice gap while waiting for further studies to provide clarity.

"What's my risk of sustaining an ACL injury while playing sports?" A systematic review with meta-analysis

Montalvo AM, Schneider DK, Yut L, Webster KE, Beynnon B, Kocher MS, Myer GD.

Br J Sports Med 2019, 53(16): 1003-1012. DOI: 10.1136/bjsports-2016-096274

Objective: To estimate the incidence proportion (IP) and incidence rate (IR) for ACL injury in athletes. **Design:** Systematic review with meta-analysis DATA SOURCES: The PubMed, CINAHL and SPORTDiscus electronic databases were searched from inception to 20 January 2017. **Eligibility criteria for selecting studies:** Studies were included if they reported total number of participants/population by sex, total number of ACL injuries by sex and total person-time by sex. **Results:** Fifty-eight studies were included. The IP and IR of ACL injury in female athletes were 3.5% (1 out of every 29 athletes) and 1.5/10 000 athlete-exposures over a period of 1 season-25 years. The IP and IR of ACL injury in male athletes were 2.0% (1 out of every 50 athletes) and 0.9/10 000 athlete-exposures over a period of 1-25 years. Female athletes had a higher relative risk (RR) for ACL injury compared with males (RR=1.5; 95% CI 1.2 to 1.9; P<0.01)

and a higher incidence rate ratio (IRR) of ACL injury compared with males over 1 season-25 years (IRR=1.7; 95% CI 1.4 to 2.2; P<0.010). When accounting for participation level, the disparity in the IR between female and male athletes was highest for amateur athletes compared with intermediate and elite athletes (IRR=2.1; 95% CI 1.3 to 3.4; P<0.01; I^2=82%). Amateur female athletes remained at higher risk of ACL injury than did with amateur male athletes. In studies where follow-up length was <1 year, female athletes had a higher IR of ACL injury than did to males (IRR=1.7; 95% CI 1.3 to 2.2; P<0.01). Where follow-up was 1 year and beyond, there was no sex difference in the IR of ACL injury (IRR=2.1; 95% CI 0.9 to 4.8; P=0.06; I^2=65%). **Summary/conclusions:** One in 29 female athletes and 1 in 50 male athletes ruptured their ACL in a window that spanned from 1season to 25 years. The IR of ACL injury among female athletes in a season was 1.7 times higher than the IR of ACL injury among male athletes and the IP of ACL injury among female athletes was 1.5 times higher than the IP of ACL injury among male athletes. The reported sex disparity in ACL injury rates is independent of participation level and length of follow-up.

Anterior cruciate ligament injury: towards a gendered environmental approach

Parsons JL, Coen SE, Bekker S. Br J Sports Med, 202, 55(17):984-990.

DOI: 10.1136/bjsports-2020-103173

Background: The anterior cruciate ligament (ACL) injury rate for girls/women has not changed in over 20 years, and they remain 3-6 times more likely to experience injury compared with boys/men. To date, ACL injury prevention and management has been approached from a sex-based biological point of view which has furthered our understanding of injury risk factors, mechanisms, and prevention and rehabilitation programmes. However, the traditional sex-based approach does not take into account the growing recognition of how sex and gender (a social construct) are 'entangled' and influence each other. **Objective**: This paper discusses the curious absence of gender as an influencer in the dialogue surrounding ACL injuries. We propose adding gender as a pervasive developmental environment as a new theoretical overlay to an established injury model to illustrate how gender can operate as an extrinsic determinant from the presport, training and competition environments through to ACL injury and the treatment environment. **Approach**: We draw on social epidemiological theories of the embodiment of gender and health to provide plausible examples of how gender may influence ACL injury, and demonstrate the opportunity for new, interdisciplinary research in the field. **Conclusion**: Over 20 years of research has failed to decrease the ACL injury rate disparity between girls/women and boys/men. Embedding gender in the study of ACL injury will heighten awareness of possible influences outside the traditional biological elements, challenge us to think about the inextricable 'entanglement' of sex and gender, and inform more effective approaches to ACL injury prevention and treatment.

Anterior cruciate ligament rupture: differences between males and females

Sutton KM, Bullock JM. J Am Acad Orthop Surg, 2013, 21(1): 41-50.

DOI: 10.5435/JAAOS-21-01-41

The rate of anterior cruciate ligament (ACL) rupture is three times higher in female athletes than in male athletes. Intrinsic factors such as increased quadriceps angle and increased posterior tibial slope may predispose girls and women to ACL injury. Compared with males, females have

smaller notch widths and smaller ACL cross-sectional area; however, no conclusive correlation between ACL size and notch dimension exists, especially in relation to risk of ACL injury. Female athletes who land with the knees in inadequate flexion and in greater-than-normal valgus and external rotation are at increased risk of ACL injury. No conclusive link has been made between ACL injury and the menstrual cycle. Neuromuscular intervention protocols have been shown to reduce the rate of injury in girls and women. Females are more likely than males to have a narrow A-shaped intercondylar notch, and special surgical considerations are required in such cases. Following ACL reconstruction, female athletes are more likely than male athletes to rupture the contralateral ACL; however, males and females are equally likely to rupture the reconstructed knee. Although self-reported outcomes in the first 2 years following reconstruction are worse for females than for males, longer-term studies demonstrate no difference between males and females.

Sport-specific biomechanical responses to an ACL injury prevention programme: A randomised controlled trial

Taylor JB, Ford KR, Schmitz RJ, Ross SE Ackerman TA, Schultz SJ. Sports Medicine and Biomechanics, 2018.

https://doi.org/10.1080/02640414.2018.1465723

Anterior cruciate ligament (ACL) injury prevention programmes have not been as successful at reducing injury rates in women's basketball as in soccer. This randomised controlled trial (ClinicalTrials.gov #NCT02530333) compared biomechanical adaptations in basketball and soccer players during jump-landing activities after an ACL injury prevention programme. Eighty-seven athletes were cluster randomised into intervention (6-week programme) and control groups. Three-dimensional biomechanical analyses of drop vertical jump (DVJ), double- (SAG-DL) and single-leg (SAG-SL) sagittal, and double- (FRONT-DL) and single-leg (FRONT-SL) frontal plane jump landing tasks were tested before and after the intervention. Peak angles, excursions, and joint moments were analysed using two-way MANCOVAs of post-test scores while controlling for pre-test scores. During SAG-SL the basketball intervention group exhibited increased peak knee abduction angles (p = .004) and excursions (p = .003) compared to the basketball control group (p = .01) and soccer intervention group (p = .01). During FRONT-SL, the basketball intervention group exhibited greater knee flexion excursion after training than the control group (p = .01), but not the soccer intervention group (p = .11). Although women's soccer players exhibit greater improvements in knee abduction kinematics than basketball players, these athletes largely exhibit similar biomechanical adaptations to ACL injury prevention programmes.

Correlation of Anthropometric Measurements, Strength, Anterior Cruciate Ligament Size, and Intercondylar Notch Characteristics to Sex Differences in Anterior Cruciate Ligament Tear Rates

Anderson AF, Dome DC, Rennirt GW. AJSM, 2001, 29(1).

https://doi.org/10.1177/03635465010290011

We performed a prospective study based on the hypothesis that physiologic differences exist between men and women in strength after adjustments for body weight; that the size of the anterior cruciate ligament is proportionate to the strength of its antagonists, the quadriceps muscles; and that women have a relatively small anterior cruciate ligament, thus predisposing

them to a disproportionate number of anterior cruciate ligament injuries. One hundred matched high school basketball players, 50 male and 50 female, were evaluated with anthropometric measurements, body fat analysis, muscle strength evaluation, and magnetic resonance imaging measurements of the intercondylar notch and cross-sectional area of the anterior cruciate ligament at the outlet. The male players were taller and heavier than their female counterparts, although they had 11% less body fat. Male players had statistically greater quadriceps and hamstring muscle strength than female players, even when adjustments were made for body weight. With adjustments for body weight, the size of the anterior cruciate ligament in girls was found to be statistically smaller than in boys. There was no statistically significant difference in the notch width index between the sexes. The study data support our hypothesis that sex differences in anterior cruciate ligament tear rates are caused primarily by several interrelated intrinsic factors. Most importantly, stiffness and muscular strength increase stress on the anterior cruciate ligament in female athletes. The anterior cruciate ligament, when adjustments have been made for body weight, is smaller in female athletes, and therefore, probably does not compensate for the lack of stiffness and strength.

Kinetic and kinematic differences between first and second landings of a drop vertical jump task: implications for injury risk assessments.

Bates NA, Ford KR, Myer GD, Hewett TE. Clinical Biomechanics. 28(4):459-66, 2013 Apr.

BACKGROUND: Though the first landing of drop vertical jump task is commonly used to assess biomechanical performance measures that are associated with anterior cruciate ligament injury risk in athletes, the implications of the second landing in this task have largely been ignored. We examined the first and second landings of a drop vertical jump for differences in kinetic and kinematic behaviors at the hip and knee. **METHODS**: A cohort of 239 adolescent female basketball thletes (age=13.6 (1.6) years) completed drop vertical jump tasks from an initial height of 31 cm. A three dimensional motion capture system recorded positional data while dual force platforms recorded ground reaction forces for each trial. **FINDINGS**: The first landing demonstrated greater hip adduction angle, knee abduction angle, and knee abduction moment than the second landing (P-values<0.028). The second landing demonstrated smaller flexion angles and moments at the hip and knee than the first landing (P-values<0.035). The second landing also demonstrated greater side-to-side asymmetry in hip and knee kinematics and kinetics for both the frontal and sagittal planes (P-values<0.044). **INTERPRETATION**: The results have important implications for the future use of the drop vertical jump as an assessment tool for anterior cruciate ligament injury risk behaviors in adolescent female athletes. The second landing may be a more rigorous task and provides a superior tool to evaluate sagittal plane risk factors than the first landing, which may be better suited to evaluate frontal plane risk factors.

Clinical correlates to laboratory measures for use in non-contact anterior cruciate ligament injury risk prediction algorithm.

Myer GD, Ford KR, Khoury J, Succop P, Hewett TE. *Clinical Biomechanics. 25(7):693-9, 2010 Aug.*

BACKGROUND: Prospective measures of high knee abduction moment during landing identify female athletes at high risk for non-contact anterior cruciate ligament injury. Biomechanical laboratory measurements predict high knee abduction moment landing mechanics with high sensitivity (85%) and specificity (93%). The purpose of this study was to identify correlates to

laboratory-based predictors of high knee abduction moment for use in a clinic-based anterior cruciate ligament injury risk prediction algorithm. The hypothesis was that clinically obtainable correlates derived from the highly predictive laboratory-based models would demonstrate high accuracy to determine high knee abduction moment status. **METHODS**: Female basketball and soccer players (N=744) were tested for anthropometrics, strength and landing biomechanics. Pearson correlation was used to identify clinically feasible correlates and logistic regression to obtain optimal models for high knee abduction moment prediction. **FINDINGS**: Clinical correlates to laboratory-based measures were identified and predicted high knee abduction moment status with 73% sensitivity and 70% specificity. The clinic-based prediction algorithm, including (Odds Ratio: 95% confidence interval) knee valgus motion (1.43:1.30-1.59 cm), knee flexion range of motion (0.98:0.96-1.01 degrees), body mass (1.04:1.02-1.06 kg), tibia length (1.38:1.25-1.52 cm) and quadriceps to hamstring ratio (1.70:1.06-2.70) predicted high knee abduction moment status with C statistic 0.81. **INTERPRETATION**: The combined correlates of increased knee valgus motion, knee flexion range of motion, body mass, tibia length and quadriceps to hamstrings ratio predict high knee abduction moment status in female athletes with high sensitivity and specificity. **CLINICAL RELEVANCE**: Utilization of clinically obtainable correlates with the prediction algorithm facilitates high non-contact anterior cruciate ligament injury risk athletes' entry into appropriate interventions with the greatest potential to prevent injury.

Three-dimensional motion analysis validation of a clinic-based nomogram designed to identify high ACL injury risk in female athletes.

Myer GD, Ford KR, Khoury J, Hewett TE. Physician & Sportsmedicine. 39(1):19-28, 2011 Feb.

AIMS: Prospective measures of high knee abduction moment (KAM) during landing identify female athletes at increased risk for anterior cruciate ligament (ACL) injury. Laboratory-driven measurements predict high KAM with 90% accuracy. This study aimed to validate the clinic-based variables against 3-dimensional motion analysis measurements. **METHODS**: Twenty female basketball, soccer, and volleyball players (age, 15.9 +/- 1.3 years; height, 163.6 +/- 9.9 cm; body mass, 57.0 +/- 12.1 kg) were tested using 3-dimensional motion analysis and clinic-based techniques simultaneously. Multiple logistic regression models have been developed to predict high KAM (a surrogate for ACL injury risk) using both measurement techniques. Clinic-based measurements were validated against 3-dimensional motion analysis measures, which were recorded simultaneously, using within- and between-method reliability as well as sensitivity and specificity comparisons. **RESULTS**: The within-variable analysis showed excellent inter-rater reliability for all variables using both 3-dimensional motion analysis and clinic-based methods, with intraclass correlation coefficients (ICCs) that ranged from moderate to high (0.60-0.97). In addition, moderate-to-high agreement was observed between 3-dimensional motion analysis and clinic-based measures, with ICCs ranging from 0.66 to 0.99. Bland-Altman plots confirmed that each variable provided no systematic shift between 3-dimensional motion analysis and clinic-based methods, and there was no association between difference and average. A developed regression equation also supported model validity with > 75% prediction accuracy of high KAM using both the 3-dimensional motion analysis and clinic-based techniques. **CONCLUSION**: The current validation provides the critical next step to merge the gap between laboratory identification of injury risk factors and clinical practice. Implementation of the developed prediction tool to identify female athletes with high KAM may facilitate the entry of female athletes with high ACL injury risk into appropriate injury-prevention programs.

Video analysis of trunk and knee motion during non-contact anterior cruciate ligament injury in female athletes: lateral trunk and knee abduction motion are combined components of the injury mechanism.

Hewett TE, Torg JS, Boden BP. *British Journal of Sports Medicine. 43(6):417-22, 2009 Jun.*

BACKGROUND: The combined positioning of the trunk and knee in the coronal and sagittal planes during non-contact anterior cruciate ligament (ACL) injury has not been previously reported. **HYPOTHESIS**: During ACL injury female athletes demonstrate greater lateral trunk and knee abduction angles than ACL-injured male athletes and uninjured female athletes.**DESIGN**: Cross-section control-cohort design. **METHODS**: Analyses of still captures from 23 coronal (10 female and 7 male ACL-injured players and 6 female controls) or 28 sagittal plane videos performing similar landing and cutting tasks. Significance was set at p < or = 0.05. **RESULTS**: Lateral trunk and knee abduction angles were higher in female compared to male athletes during ACL injury (p < or = 0.05) and trended toward being greater than female controls (p = 0.16, 0.13, respectively). Female ACL-injured athletes showed less forward trunk lean than female controls (mean (SD) initial contact (IC): 1.6 (9.3) degrees vs 14.0 (7.3) degrees, p < or = 0.01). **CONCLUSION**: Female athletes landed with greater lateral trunk motion and knee abduction during ACL injury than did male athletes or control females during similar landing and cutting tasks. **CLINICAL RELEVANCE**: Lateral trunk and knee abduction motion are important components of the ACL injury mechanism in female athletes as observed from video evidence of ACL injury.

YOU CAN HELP

The FIBA medical commission is working with experts from across the globe to design an ACL injury prevention program for basketball athletes. This will be an evidence-based literature and expert-opinion training program that we will then want to research to establish the impact on reducing ACL injuries. To do this will require knowledge of ACL injury rates prior to, and after the introduction of the injury prevention program.

If your team, club, organization or national federation does injury surveillance and collects statistics on ACL injury rates, we would like to hear from you. You can help us make a very positive impact on improving the safety of basketball.

If you are able to assist the FIBA in this regard please email the editor at medical@FIBA.basektball.

FROM THE HISTORY BOOK

The anterior cruciate ligament (ACL) was first described by Galen (circa 170 A.D.). During a period of some 1600 years, the importance of the ACL seems not to have been sufficiently appreciated. With the advent of arthroscopy, motor vehicle accidents, and professional athletics, the ACL emerged to the forefront of orthopedic problems. Hey Groves'

operation (1917) forms the basis of the modern intra-articular reconstruction. Campbell (1936) described the [unhappy] triad of torn medial meniscus, medial collateral ligament, and ACL.

(Snook GA. A short history of the anterior cruciate ligament and the treatment of tears. Clin Orthop Relat Res, 1983 Jan-Feb:(172):11-3.)

SHARE YOUR PHOTOS

Please send us your funny, interesting, or remarkable basketball pictures that we can share with the medical and sport science basketball community.

Email: medical@FIBA.basketball

Dikembe Mutombo shoe! "Mount" Mutombo made an impact in NBA; he led in blocked shots for five consecutive seasons and blocks per game for a record three consecutive seasons. His most lasting influence on the game might be his commitment and dedication to improving life in the Democratic Republic of Congo (DRC).

(From the FIBA FOUNDATION COLLECTION)

THE STUDENT'S CORNER

This space is intended for sport science and medical students, residents, and fellows to contribute to our knowledge and conversation.

Please encourage your students to contribute to the Fast Break on a topic of their choosing related to basketball injury, rehabilitation or sport science. The work published here is reviewed and approved for submission by the student's preceptor.

Unfortunately, there were no student submissions to this edition of the Fast Break.

UPCOMING WEBINAR SESSION

The FIBA medical commission would like to invite you to join our second webinar session of 2025.

Concussion in Basketball

The session will be presented by Dr Michael Makdissi and will be scheduled early October, and the link will be shared by email.

Dr Michael Makdissi is a sport and exercise physician from Melbourne Australia. He completed his PhD (concussion identification and management) and is a member of the International Concussion in Sport Consensus Group as well as the International Contact Sport CMO Group. He has wide athlete care experience, especially in concussion, and is the current CMO for the Australian Football League.tips.

The recordings of previous webinar sessions can be found here:
https://about.fiba.basketball/en/services/medical/webinars

Resources from the FIBA Medical Commission can be found here:
https://about.fiba.basketball/en/services/medical/information-for-medical-staff

BASKETBALL CME OPPORTUNITIES

A listing of varied sport medicine and basketball meetings and conferences you may be interested in attending:

Sports Medicine Australia conference events can be found here: **https://sma.org.au/about-sma/honour-board/sma-national-conferences/**

Sports Medicine New Zealand conference events can be found here: **https://sportsmedicine.co.nz/**

The Australasian College of Sport and Exercise Physicians events can be found here: **https://www.acsep.org.au/page/events**

The Asian Federation of Sport Medicine conference events can be found here: **https://afsm2024.com/index.php**

The South African Sports Medicine Association hosts several events throughout the year:

https://www.sasma.org.za/events/

The South African Sports Medicine Association hosts several events throughout the year:

https://www.sasma.org.za/events/

The British Association of Sport and Exercise Medicine conference events can be found here: **https://basem.co.uk/learning/**

The FIMS (International Sport Medicine Federation) list of events can be found here: **https://www.fims.org/news-events/events/**

The National Basketball Strength and Conditioning Association hosts a performance conference. Check here for the latest updates regarding the date of their next conference: **https://thenbsca.com.**

The Euroleague Strength and Conditioning Coaches Association list of upcoming events can be found here: **https://escca.net/events/.**

The High-Performance Basketball Symposium dates are coming soon: **https://www.highperformancebasketball.com/index.cfm.**

A listing of all the American Medical Society for Sports Medicine conferences can be found here:

https://www.amssm.org/Conferences.php

The Society for Sport Exercise and Performance Psychology website lists a number of mental performance educational opportunities:

https://www.apadivisions.org/division-47/about/resources/conferences

Conference Locate.com allows you to search globally for conferences on an extensive array of medical topics:

https://www.clocate.com

A listing of exercise physiology conferences across the world can be found here: **https://conferenceindex.org/conferences/exercise-physiology**

And for something a little different:

https://unconventional.com.au/conferences/south-america/medical-conferences/2024/

If you prefer self-study to earn CME credits while you are on vacation, have a look at these options.

Date	Location	Event website
Dec 11-13, 2025	Austin (USA)	American Medical Society for Sport Medicine Advanced Team Physician Conference
April 24-29, 2026	Seattle (USA)	American Medical Society for Sport Medicine annual symposium
May 26-30, 2026	Salt Lake City (USA)	American College of Sport Medicine Annual symposium
April 29-May 2, 2026	Kelowna, BC, (Canada)	Canadian Academy of Sport and Exercise Medicine annual symposium
Sept 9-11, 2026	Singapore (Singapore)	Medical Fair Asia + Medicine and Sports Conference
Jun 1-4, 2027	Indianapolis (USA)	American College of Sport Medicine Annual symposium