DOI :https://doi.org/10.53555/nnmhs.v9i2.1551 Publication URL: https://nnpub.org/index.php/MHS/article/view/1551

RISK OF ANTERIOR CRUCIATE LIGAMENT INJURY IN FEMALE SOCCER ATHLETES: SYSTEMATIC REVIEW

Indra Gunawan*

*Faculty of Medicine, University of Jambi, Indonesia

***Corrponding Author:**
indrakabhuom@gmail.com

Abstract

Women's soccer is quickly becoming one of the most popular sports in the world. The quick acceleration and deceleration of many joints in the lower limbs is required for many of the common movements that occur during play, such as jumping and cutting. During these activities, participants frequently sustain injuries to the anterior cruciate ligament (ACL), which is one of the factors that contributes to the knee's overall stability. Injuries to the ACL almost always call for expensive surgery, significant time away from athletics, and put the long-term health of the joint at jeopardy. Women are more likely to suffer an ACL tear than men because of anatomical differences and gender-specific variables, such as menstruation. Injuries frequently occur in situations when there is no physical contact, typically as a result of rapid acceleration or deceleration motions. These motions have been the subject of research, which has uncovered a number of kinematic and kinetic mechanisms, in addition to muscle activation patterns that typically take place during the moment of injury; however, the findings tend to vary from population to population. This article provides a summary of recent and important research on the mechanisms of ACL injuries, and it also draws attention to the dearth of particular research on high-risk populations of female soccer athletes. Injury prevention strategies among this demographic have been all over the place because the risk variables have not been conclusively determined. The possibility of female soccer players sustaining an injury to their ACL needs to be investigated more thoroughly in order to identify more specific injury risks and devise more effective preventative strategies. A greater awareness of this need may attract the attention of the scientific and medical communities, which may, in turn, drive the development of measures that prevent future ACL injuries and, as a result, the issues that these injuries provide to high-risk female soccer athletes.

Keyword: *Athletes; Anterior Cruciate Ligament; Female Soccer; Injury*

INTRODUCTION

Soccer (football) is one of the most popular sports in the world, with over 260 million participants. Football is also a sport with a significant injury risk, given that the overall frequency of injuries is 6.6 per 1000 player hours.[1] Injury management (i.e., mitigating injuries and maximizing player availability) is one of the most pressing concerns for football teams, given that a high number of injuries decreases the likelihood of sports success.[2,3]

Specifically, lower injury incidence rates have been correlated with superior performance (i.e., higher league position, more games won, more goals scored, greater goal difference and total points) in professional football, whereas injuries that cause a high injury burden (i.e., those requiring a high number of days lost, such as ligament sprains and knee and ankle joint injuries) are more likely to have a negative impact on team performance.[4,5]

One of the most concerning injuries for a football player is an anterior cruciate ligament (ACL) injury because of the devastating consequences, such as an increased risk of developing early posttraumatic knee osteoarthritis or a high rate of reinjuries to the graft or the opposite knee.[6,7] Additionally, only 60% of players who ruptured their ACL in professional football performed at the top level 5 years later. Moreover, ACL injuries in football result in an injury load of 29.8 days per 1000 hours of exposure.[8,9]

Studies that looked at the influence of exercise-based therapies on ACL injury incidence or modifiable risk variables in adult football players. There were 29 trials that comprised 4502 male and 1589 female players: 14 included warm-up, 7 resistance training, 4 mixed training, 3 balancing, 1 core stability, and 1 technique modification intervention. Six of the 29 studies looked at the impact of treatments on ACL injury incidence, while the other 23 looked at the impact on risk factors. Just 21% and 13% of studies analyzing risk of injury factors, respectively, presented reliability measurements and/or data on the smallest meaningful change.[10]

Even if the rate of ligament injuries in European male professional football fell over the 2000s, the rate of ACL injuries did not.[11,12] As a result, initiatives to reduce the prevalence of ACL damage in football look to require additional development, with noncontact or indirect contact injuries receiving special attention because they account for 88% of all ACL injuries and might be targeted by injury risk mitigation programs. As a result, this systematic review will concentrate on non-contact or indirect contact ACL injuries.[13]

The purpose of this piece is to analyze previous research studies that have been conducted on the subject of the risk of anterior cruciate ligament damage in female soccer players.

METHODS Protocol

The author used the Preferred Reporting Items for Systematic Review and MetaAnalysis (PRISMA) 2020 guidelines to comply with in order to ensure that this research was carried out in accordance with the referenced standards. This is done to ensure that the results of this investigation are accurate.

Criteria for Eligibility

This literature review aims to assess the risk of anterior cruciate ligament injury in female soccer athletes by evaluating or analyzing previous studies on the subject. This article is made with a theme in order to show significant problems in the issues raised. Researchers participating in studies met the following criteria: 1) To be considered for publication, the publication must be written in English and focus on the risk of anterior cruciate ligament injury in female soccer athletes. 2) Articles published after 2013 but before the time period covered by this systematic review were included in this assessment. Editorials, submissions without DOI, previously published review articles, and entries substantially similar to those previously published in journals are examples of research excluded in this article.

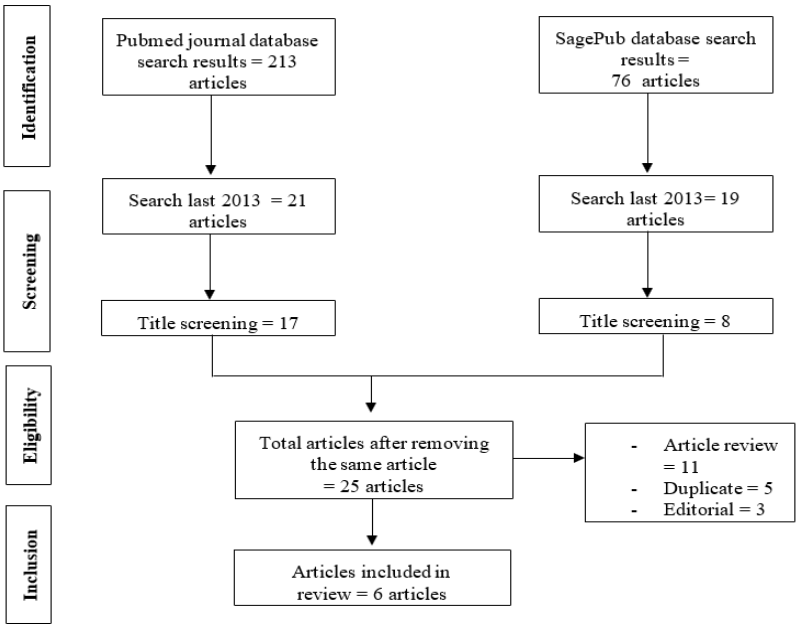

Figure 1. Article search flowchart

Search Strategy

We used "anterior cruciate ligament injury" and "female soccer" as keywords.The search for studies to be included in the systematic review was carried out from February, 5th 2023 using the PubMed and SagePub databases by inputting the words: ("anterior cruciate ligament injuries"[MeSH Terms] OR ("anterior"[All Fields] AND "cruciate"[All Fields] AND "ligament"[All Fields] AND "injuries"[All Fields]) OR "anterior cruciate ligament injuries"[All Fields] OR ("anterior"[All Fields] AND "cruciate"[All Fields] AND "ligament"[All Fields] AND "injury"[All Fields]) OR "anterior cruciate ligament injury"[All Fields]) AND ("femal"[All Fields] OR "female"[MeSH Terms] OR "female"[All Fields] OR "females"[All Fields] OR "female s"[All Fields] OR "femals"[All Fields]) AND ("soccer"[MeSH Terms] OR "soccer"[All Fields] OR "soccers"[All Fields]) used in searching the literature.

Data retrieval

The authors assessed studies that met the inclusion criteria after reading the title and research abstract. Then the authors select several studies that are considered to be used in this study. We come to this conclusion after reviewing several studies that followed a similar format. The included studies must be in English and have a publication year later than 2013. Only studies that meet all inclusion criteria are considered in the systematic review. This limits the search to relevant material. We exclude all research results that do not meet our specifications. This is followed by assessing the research as a whole. Names, authors, publication date, location, study activities, and parameters were found during examination of this study.

Quality Assessment and Data Synthesis

Before deciding which papers to further investigate, each author conducted their own independent analysis of the separate studies described in the title and abstract of the publication. After that, we will review all publications that meet the inclusion criteria and are suitable for inclusion in the systematic review. Then, based on our findings, we will decide which papers to include in the review. This criterion is used to select papers to be reviewed. to make the process of selecting articles for evaluation as simple as possible. Which previous studies have been conducted, and what characteristics of the studies qualifies for inclusion in the review?

RESULT

First study showed 28 athletes (24%) had a second ACL injury while playing soccer (21 ipsilateral and 7 contralateral ruptures). The 5-jump test, knee collapse on the non-ACL reconstructed leg in a drop vertical jump, tuck jump, limb symmetry index on side hop and single hop for distance, side difference in ankle dorsiflexion ROM, and scores for the questionnaires ACL-Return to Sport After Injury and the Swedish Universities Scales of Personality subscales of Stress Susceptibility and Adventure Seeking were chosen for CART analysis.[14]

The model's accuracy was 89%, with 100% sensitivity and 76% specificity. CART analysis revealed that the interaction of longer jumps in the 5-jump test (>916 cm) with more side difference in ankle dorsiflexion ROM (>-2.5°) and more knee valgus collapse in the nonreconstructed knee (>-1.4 cm) best predicted an increased likelihood of a second ACL injury (relative risk [RR] = 4.03; 95% CI = 2.21-7.36).[14]

Krosshaug, et al (2016)[15] registered 42 new noncontact ACL injuries, including 12 in previously ACL-injured players. Prior ACL injury (relative risk, 3.8; 95% confidence interval, 2.1-7.1) and medial knee displacement (odds ratio, 1.40; 95% confidence interval, 1.12-1.74 per 1-SD change) were linked with higher injury risk. In the 643 participants without a history of knee injury, however, we found no connection with medial knee displacement. A receiver operating characteristic curve study of medial knee displacement indicated an area under the curve of 0.6, indicating a poor-to-failed combination sensitivity and specificity of the test, even when included previously injured participants.

Nilstad, et al (2014)[16] showed higher body mass index (BMI) (OR = 1.51; 95% CI = 1.21-1.90; P =.001) was the sole predictor related with new lower extremity injuries in multivariate analysis. A higher BMI was associated with new thigh injuries (OR = 1.51; 95% CI = 1.08-2.11; P =.01), a lower knee valgus angle in a drop-jump landing was associated with new ankle injuries (OR = 0.64; 95% CI = 0.41-1.00; P =.04), and a previous knee injury was associated with new lower leg and foot injuries (OR = 3.57; 95% CI = 1.27-9.99; P = .02), whereas none of the factors investigated influenced the risk of new knee injuries.

Table 1. The litelature include in this study

Author	Origin	Method	Sample Size	Result
Falstrom, 2021[14]	Sweden	Prospective cohort study	117 active female soccer players	The CART-selected risk profiles might reliably identify female soccer players at high risk for a second ACL injury. There was an interaction between functional performance, clinical evaluation, and psychological concerns, and it is fair to consider these variables in return-to-sport choices and athlete screening following ACL damage.
Krosshaug, 2016[15]	Norway	Prospective cohort study	782 players were	Medial knee displacement was the only risk factor linked with an increased risk of ACL injury among the five evaluated. However, the receiver operating characteristic curve analysis revealed that medial knee displacement as a screening test for predicting ACL injury had a low combined sensitivity and specificity.
Nilstad, 2014[16]	Norway	Prospective cohort study	173 female players	It was shown that elite female soccer players who had a higher body mass index were more likely to suffer injuries to their lower extremities.
Brophy, 2015[17]	United State of America	Case series	32 male and 23 female soccer players	When defending, especially when tackling the opponent to gain possession of the ball, soccer players are at the highest risk for ACL injuries. When defending, females are more prone to suffer ACL injuries and are at a higher risk for noncontact injuries to the left lower extremity.
Allen, 2016[18]	United State of America	Retrospective cohort study	180 female ACLR	A second anterior cruciate ligament (ACL) injury occurred in 28% of all female soccer players and 34% of those players who returned to the sport after an absence. When compared with athletes who did not play soccer, soccer players had a much higher risk of tearing their grafts as well as their contralateral ACLs. In this study, major risk variables for graft rupture were older age as well as returning to soccer.
Celebrini, 2014[19]	Canada	Single-blind, randomized controlled clinical trial	19 female	According to the findings of this study, the Core-PAC is one approach of reducing high-risk soccer-specific motions that can be used within a realistic, team-based soccer warm-up. Because of the limited sample size, the results should be regarded with caution.

Brophy, et al (2015)[17] showed 73% of ACL injuries happened when the opposition side had possession of the ball and the injured player was defending. Girls were more likely to be defending when they tore their ACL (87 percent versus 63 percent for males, P = 0.045). Tackling was the most common playing activity (51%), followed by cutting (15%). The majority of injuries were caused by contact mechanisms (56%), with no significant gender differences. Girls (54%) were more likely than males (33%) to sustain a noncontact injury to their left knee (P = 0.05).

Allen, et al (2016)[18] study compared to non-soccer players, soccer players had greater second ACL injuries, including graft failures (11% vs. 1%; P 0.01) and contralateral ACL rips (17% vs. 4%; P 0.01). Of the 67 patients who returned to soccer after ACLR (mean age = 17.5 years; range, 13-27 years), significantly more had graft tears than those who did not return (P = 0.04); however, the difference in contralateral ACL tears was not significant (19% for returning players vs. 9% for those who did not return; P = 0.34) Age was a significant risk factor for ACL graft tear (odds ratio, 1.5 per year; P =0.03) but not for contralateral ACL damage.

Celebrini, et al (2016)[19] conducted a study with 19 sample. After the 6-week warm-up program without a reminder, the Core Position and Control movement strategy (Core-PAC) group increased peak flexion angles during the SH task (mean difference [MD] = 6.2°; 95% confidence interval [CI] = 1.9-10.5°; effect size [ES] = 1.01; P = 0.034).
Furthermore, after a reminder, the Core-PAC group displayed greater knee flexion angles for the side-cut (MD = 8.5°; 95% CI = 4.8-12.2°; ES = 2.02; P = 0.001) and SH (MD = 10.0°; 95% CI = 5.7-14.3°; ES = 1.66; P = 0.001) tasks.

DISCUSSION

There are an estimated 265 million active soccer players around the world as of the year 2006, making soccer the most popular sport in the world. When compared to other types of sports, the likelihood of tearing the anterior cruciate ligament (ACL) when playing this particular sport is significantly higher. Due to the fact that injuries to the anterior cruciate ligament (ACL) result in a significant amount of time missed from competition in soccer, there has been a strong impetus to conduct research that focuses on determining the risk factors for injury, and more importantly, to identify and teach techniques to reduce this injury in the sport of soccer.[20]

Somewhat more than half of injuries are caused by contact, but a large proportion of noncontact injuries occur when an opponent is close by. ACL tears typically develop in soccer when the lower extremity is at risk for both contact and noncontact injuries. Female soccer players are more prone than guys to hurt their left knee due to noncontact ACL rupture.[21] Many factors put soccer players at risk for ACL injuries when they are tackled. Secondly, tackling is frequently a reactionary maneuver that necessitates lastsecond alterations in body position and technique, putting either lower extremity at risk as the player reacts to the actions of his opponent.[17,22]

Female athletes with poor neuromuscular control and inferior biomechanics may be more prone to react in a manner that places the ACL at risk for injury when tackling. Nevertheless, contact is crucial to tackling. Although some ACL injuries sustained during tackling were noncontact, the most majority (79%) were caused by contact. Yet, this could be a significant result in terms of prospective injury prevention efforts, as good tackling technique should be emphasized during player development and training.[22–24]

Krosshaug, et al[15] showed none of the vertical drop jump (VDJ) factors were related with an increased risk of injury in athletes without a history of injury. The VDJ cannot therefore be utilized as a screening test to predict ACL injury in elite female soccer and handball players. Medial knee displacement was the only risk factor linked with an increased risk of ACL injury among the five evaluated. However, the ROC analysis revealed that the combined sensitivity and specificity of medial knee displacement as a screening test for ACL injury was inadequate.

It might be difficult to ascertain whether or not a soccer player with ACLR has adequate knee function and a low chance of incurring a second ACL injury. Nine factors were identified by the CART analysis as being predictive of a second ACL injury. These included (a) functional tests, such as jump length in the 5-jump test, knee collapse on the non-ACL reconstructed leg in the DVJ, number of flaws in the tuck jump, LSI on side hop, and the single hop for distance; (b) clinical assessment, such as side difference in ankle dorsiflexion ROM; and (c) player-reported data score Functional performance, as measured by hopping distance, qualitative assessment of knee collapse, and bilateral asymmetry in ankle dorsiflexion range of motion all interacted in the initial risk profile.[14] Athletes who leaped further than 916 cm on the 5-jump test yet had more than 2.5° of dorsiflexion ROM insufficiency and more knee collapse on the non-ACLR leg had a 4-fold risk of a second ACL injury. We are unaware of any study linking the 5jump test to a second ACL damage. Due to their more erect drop landing posture, people with limited ankle dorsiflexion ROM may stress their knees. Male athletes' primary ACL injury risk decreases 38% with a 1° ankle dorsiflexion ROM increase. Due to lower dorsiflexion ROM, female ACLR athletes with a second ACL injury had a more stiff ankle pattern.[14,25]

The goal of the other study was to find out how often ACL injuries (ACL graft rupture or opposite ACL tear) happened again in competitive female soccer players and to compare these rates and clinical outcomes with those of competitive female athletes who didn't play soccer. The current research shows that soccer players have a higher risk of re-injury, including graft tear and injury to the opposite side, especially when they go back to playing competitive soccer.[18]

Female soccer players treated with ACLR had a higher rate of graft retear and contralateral ACL damage than non-soccer female athletes. Among female soccer players, age and return to play were risk factors for graft rupture. About half of ipsilateral ACL graft ruptures happened within the first year of returning to sports, whereas contralateral natural ACL rips happened later. A second ACL injury (combined graft failure and contralateral ACL tear) occurred in 28% of all soccer players and 34% of players who returned to soccer, compared to 9% of players who did not return to soccer.[18] Pther study conducted by Nilstad, et al showed higher BMI was linked to lower extremity injuries in elite female soccer players.[16] However, while significant, the change in BMI between injured and noninjured players was rather small (22.6 vs 21.8 kg/m2, equating to 1.6 kg), suggesting that clinical implications may be limited. Neither study with female senior players contradicted they findings nor youth players found any influence of BMI on the injury risk.[20]

It is believed that the influence of a high BMI on the occurrence of ankle sprain is related to an individual's incapacity to change momentum effectively and swiftly. Noncontact sprains occur when a greater force is required to shift momentum than the ankle joint's stability can withstand. In addition, it is believed that the stresses exerted on the ligaments during the support phase of certain physically demanding talents are increased in players with a higher BMI, hence increasing the risk of injury.[26]

Athletes with a high BMI may be more susceptible to knee injury when changing direction and momentum and directly affecting knee stability. There is some evidence to suggest that obesity increases the likelihood of chondral injuries and degenerative meniscal tears in individuals with ACL injuries. In regards to patellar tendon injury, acute meniscal tears, and ACL injuries, however, there are still contradictory findings on obesity. We need additional scholarly research to analyze these areas. However, none of these studies revealed that a low BMI increased the risk ratio for knee injury. More research is required to determine whether weight loss minimizes knee injury.[26]

CONCLUSION

The purpose of this literature study was to provide insight into risk factors for anterior cruciate ligament injuries (ACL injuries) that practitioners might employ to prevent injuries in soccer.

REFERENCE

[1]. Association FI de F. FIFA Big Count 2006: 270 million people active in football. Zurich F éd ération Int Footb Assoc. 2007;
[2]. Sutton KM, Bullock JM. Anterior cruciate ligament rupture: differences between males and females. J Am Acad Orthop Surg. 2013 Jan;21(1):41–50.

[3]. Ekstrand J, Spreco A, Bengtsson H, Bahr R. Injury rates decreased in men's professional football: an 18-year prospective cohort study of almost 12 000 injuries sustained during 1.8 million hours of play. Br J Sports Med. 2021 Oct;55(19):1084–91.
[4]. Hägglund M, Waldén M, Magnusson H, Kristenson K, Bengtsson H, Ekstrand J. Injuries affect team performance negatively in professional football: an 11-year follow-up of the UEFA Champions League injury study. Br J Sports Med. 2013;47(12):738–42.
[5]. Eliakim E, Morgulev E, Lidor R, Meckel Y. Estimation of injury costs: financial damage of English Premier League teams' underachievement due to injuries. BMJ open Sport Exerc Med. 2020;6(1):e000675.
[6]. Svantesson E, Hamrin Senorski E, Webster KE, Karlsson J, Diermeier T, Rothrauff BB, et al. Clinical Outcomes After Anterior Cruciate Ligament Injury: Panther Symposium ACL Injury Clinical Outcomes Consensus Group. Orthop J Sport Med. 2020 Jul;8(7):2325967120934751.
[7]. Fältström A, Kvist J, Gauffin H, Hägglund M. Female Soccer Players With Anterior Cruciate Ligament Reconstruction Have a Higher Risk of New Knee Injuries and Quit Soccer to a Higher Degree Than Knee-Healthy Controls. Am J Sports Med. 2019 Jan;47(1):31–40.
[8]. Della Villa F, Hägglund M, Della Villa S, Ekstrand J, Waldén M. High rate of second ACL injury following ACL reconstruction in male professional footballers: an updated longitudinal analysis from 118 players in the UEFA Elite Club Injury Study. Br J Sports Med. 2021 Dec;55(23):1350–6.
[9]. Tabben M, Eirale C, Singh G, Al-Kuwari A, Ekstrand J, Chalabi H, et al. Injury and illness epidemiology in professional Asian football: lower general incidence and burden but higher ACL and hamstring injury burden compared with Europe. Br J Sports Med. 2022 Jan;56(1):18–23.
[10]. Olivares-Jabalera J, Fílter-Ruger A, Dos'Santos T, Afonso J, Della Villa F, Morente-Sánchez J, et al. Exercise-Based Training Strategies to Reduce the Incidence or Mitigate the Risk Factors of Anterior Cruciate Ligament Injury in Adult Football (Soccer) Players: A Systematic Review. Int J Environ Res Public Health. 2021 Dec;18(24).
[11]. Ekstrand J, Hägglund M, Kristenson K, Magnusson H, Waldén M. Fewer ligament injuries but no preventive effect on muscle injuries and severe injuries: an 11-year follow-up of the UEFA Champions League injury study. Br J Sports Med. 2013 Aug;47(12):732–7.
[12]. Waldén M, Hägglund M, Magnusson H, Ekstrand J. ACL injuries in men's professional football: a 15-year prospective study on time trends and return-toplay rates reveals only 65% of players still play at the top level 3 years after ACL rupture. Br J Sports Med. 2016 Jun;50(12):744–50.
[13]. Della Villa F, Buckthorpe M, Grassi A, Nabiuzzi A, Tosarelli F, Zaffagnini S, et al. Systematic video analysis of ACL injuries in professional male football (soccer): injury mechanisms, situational patterns and biomechanics study on 134 consecutive cases. Br J Sports Med. 2020;54(23):1423–32.
[14]. Fältström A, Kvist J, Bittencourt NFN, Mendonça LD, Hägglund M. Clinical Risk Profile for a Second Anterior Cruciate Ligament Injury in Female Soccer Players After Anterior Cruciate Ligament Reconstruction. Am J Sports Med. 2021 May;49(6):1421–30.
[15]. Krosshaug T, Steffen K, Kristianslund E, Nilstad A, Mok K-M, Myklebust G, et al. The Vertical Drop Jump Is a Poor Screening Test for ACL Injuries in Female Elite Soccer and Handball Players: A Prospective Cohort Study of 710 Athletes. Am J Sports Med. 2016 Apr;44(4):874–83.
[16]. Nilstad A, Andersen TE, Bahr R, Holme I, Steffen K. Risk factors for lower extremity injuries in elite female soccer players. Am J Sports Med. 2014 Apr;42(4):940–8.
[17]. Brophy RH, Stepan JG, Silvers HJ, Mandelbaum BR. Defending Puts the Anterior Cruciate Ligament at Risk During Soccer: A Gender-Based Analysis. Sports Health. 2015 May;7(3):244–9.
[18]. Allen MM, Pareek A, Krych AJ, Hewett TE, Levy BA, Stuart MJ, et al. Are Female Soccer Players at an Increased Risk of Second Anterior Cruciate Ligament Injury Compared With Their Athletic Peers? Am J Sports Med. 2016 Oct;44(10):2492–8.
[19]. Celebrini RG, Eng JJ, Miller WC, Ekegren CL, Johnston JD, Depew TA, et al. Effect of a novel movement strategy in decreasing ACL risk factors in female adolescent soccer players: a randomized controlled trial. Clin J Sport Med Off J Can Acad Sport Med. 2014 Mar;24(2):134–41.
[20]. Faude O, Junge A, Kindermann W, Dvorak J. Risk factors for injuries in elite female soccer players. Br J Sports Med. 2006;40(9):785–90.
[21]. Gans I, Retzky JS, Jones LC, Tanaka MJ. Epidemiology of Recurrent Anterior Cruciate Ligament Injuries in National Collegiate Athletic Association Sports: The Injury Surveillance Program, 2004-2014. Orthop J Sport Med. 2018 Jun;6(6):2325967118777823.
[22]. Faunø P, Wulff Jakobsen B. Mechanism of anterior cruciate ligament injuries in soccer. Int J Sports Med. 2006 Jan;27(1):75–9.
[23]. Thoma LM, Grindem H, Logerstedt D, Axe M, Engebretsen L, Risberg MA, et al. Coper Classification Early After Anterior Cruciate Ligament Rupture Changes with Progressive Neuromuscular and Strength Training and Is Associated With 2-Year Success: The Delaware-Oslo ACL Cohort Study. Am J Sports Med. 2019 Mar;47(4):807–14.
[24]. Lee DYH, Karim SA, Chang HC. Return to sports after anterior cruciate ligament reconstruction - a review of patients with minimum 5-year follow-up. Ann Acad Med Singapore. 2008 Apr;37(4):273–8.
[25]. Paterno M V, Kiefer AW, Bonnette S, Riley MA, Schmitt LC, Ford KR, et al. Prospectively identified deficits in sagittal plane hip–ankle coordination in female athletes who sustain a second anterior cruciate ligament injury after anterior cruciate ligament reconstruction and return to sport. Clin Biomech. 2015;30(10):1094–101.

[26]. Amoako AO, Nassim A, Keller C. Body mass index as a predictor of injuries in athletics. Curr Sports Med Rep. 2017;16(4):256–62.