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Systematic Review

Return to sports in female athletes after anterior cruciate ligament reconstruction: A systematic review and metanalysis

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ABSTRACT

Importance: Return to sport (RTS) is considered an indicator of successful recovery after anterior cruciate ligament reconstruction (ACLR). In recent years, there has been major interest in documenting RTS following anterior cruciate ligament (ACL) injury. Despite women being at increased risk for ACL injuries and a global increase in women's participation in sports, research has not adequately focused on female athletes.
Objective: The purpose of this study is to conduct a systematic review and meta-analysis evaluating the RTS rate in female athletes after ACLR.
We hypothesize that most of the female athletes can RTS.
Evidence review: A systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. Electronic databases (PubMed, Embase, and Epistemonikos) were searched for articles reporting RTS rates and contextual data in female athletes.
The following search terms were used: "anterior cruciate ligament reconstruction" OR "ACL reconstruction" AND "female" OR "women" AND "return to sports" OR "return to play" to retrieve all relevant articles published between 2003 and 2023. A quality assessment of the included studies was conducted.
Findings: Fifteen articles were included, reporting on 1456 female athletes participating in pivoting sports.
The included studies comprised 9 cohorts, 1 case-control study, 2 case series, 2 descriptive epidemiology studies, and 1 observational study. Eight out of fifteen studies focused solely on elite-level athletes.
The participants had a mean age of 23.13 years. Soccer was the most prevalent sport among the participants, accounting for 49.7% of all athletes included. All 15 studies reported an RTS rate, yielding a meta-proportion of 69% [95% CI, 58–80%] for RTS. Nine articles reported the average time to RTS, which was 10.8 months [95% CI, 8.7–12.8 months].
Conclusions: This systematic review demonstrates that a majority of female athletes (69 %) can RTS participation at an average of 10.8 months, however, the available information is insufficient, and quantitative data and reasons for not returning to play are lacking. Future studies should establish return-to-play criteria in this population and determine reasons for not returning to play.
Level of evidence: III.

What is already known?

- Return to sport in female athletes after anterior cruciate ligament reconstruction varies within literature between 22 % and 100 %.
- Time to return to sport occurs between 8.3 and 11.1 months.
- Literature shows better rates to return to sport and better functional outcomes in male versus female athletes.

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What are the new findings?

- 69 % of female athletes can return to sport.
- 79 % of **elite** female athletes return to sport.
- 73.6 % (26–100 %) of female athletes return to sport to their preinjury level and this number rises up to 87.7 % in **elite** female athletes.
- Literature is lacking on reasons for not returning to play.

INTRODUCTION

Anterior cruciate ligament (ACL) injury is an increasingly common knee injury in young athletes participating in jumping, cutting, and pivoting sports [1,2]. Over the past few decades, there has been a significant increase in the rates of ACL reconstructions (ACLR) among both men and women in the USA and internationally [2–4], with over 100,000 ACLRs performed per year in the USA alone [5–8].

Female gender is a risk factor for sustaining ACL injury [9–11]. Compared to male counterparts within the same sport, it has been well established that female athletes are two to nine times more likely to sustain an ACL injury [11–13], specifically with 2.8 times and 3.5 times increased incidence in soccer and basketball, respectively [14]. This is due to a complex interaction of multiple factors (anatomical, biomechanical, neuromuscular, environmental) [11,15].

The growth of women's sports is constant, and the number of sports licenses is increasing year after year. According to data from the National Sports Council, in the last decade, the number of female sports licenses has grown by 20.8 %, mainly in basketball and soccer [16], and with that, the number of ACL injuries in these athletes has increased.

With the increase in participation in youth athletics as well as the expansion of women's collegiate and professional programs over the last few decades [17], it has become increasingly important to better understand potential mechanisms underlying the gender difference in injury rates. In the last years, there has been an increase in the proportion of females undergoing ACLR compared to males in both ambulatory and inpatient settings [18], however, despite higher rates of primary injury in female athletes, males have been reported to undergo ACLR more frequently [19,20].

Return to sports (RTS) is considered an indicator of successful recovery after ACLR. In the current literature, male patients have superior functional outcomes following primary ACLR and significantly higher RTS rates compared to female athletes at 12 months after surgery [21,22]. Female athletes are less likely to return to preinjury sports [23]; they experience more instability and greater psychological distress after ACLR than male athletes [24].

Several studies have been performed on outcomes after ACLR [25–27]; however, little is known about the return-to-play and performance outcomes of female athletes after ACLR. Girls and women comprise <40 % of participants in clinical trials. To better prevent, diagnose, and treat ACL injuries, it is necessary to study and report sex differences [28].

The purpose of this study is to conduct a systematic review and meta-analysis to evaluate the RTS rate in female athletes after ACLR.

We hypothesize that most of the female athletes can RTS.

METHODS

This study was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. PROSPERO (international database of prospectively registered systematic reviews) was checked for similar systematic reviews before proceeding. Two authors independently performed the study selection. Electronic databases (PubMed, Embase, and Epistemonikos) were searched for articles reporting a RTS rates and contextual data in female athletes. Any discrepancies were resolved by the senior author as needed.

The following search terms were used: “anterior cruciate ligament reconstruction” OR “ACL reconstruction” OR “anterior cruciate ligament” OR “ACL” AND “female” OR “women” AND “return to sports” OR “return to play” to retrieve all relevant articles published between 2003 and 2023. The last research was made on May 29th, 2023.

Journals in all languages were included, with no limits in the search strategy. In the identification phase, the search was performed using keywords. In the screening phase, abstracts were screened for relevance. In the eligibility phase, the full text was reviewed to assess for inclusion.

The inclusion criteria for this review were as follows: (1) clinical studies published in the last 20 years; (2) the purpose of the research was to report RTS after ACLR on female athletes or both sexes and (3) the available data included gender differentiation and qualitative and quantitative results.

Exclusion criteria included letters, editorials, narrative reviews, and studies recognized as having a low level of evidence. The references of the selected full-text articles were reviewed for the inclusion of additional articles.

The outcomes sought included RTS rates, time to RTS, the level at which athletes returned, and reasons for not returning.

Other variables collected included participants' characteristics and demographic data, sports practice, and the level at which they played before injury.

All selected articles were critically appraised by the authors. A quality assessment of the included studies was conducted by the authors. The risk of bias was assessed by two independent reviewers via the Methodological Index for Non-Randomized Studies (MINORS) criteria [29]. All data were extracted and tabulated using Microsoft Excel 365 (Microsoft, Seattle, WA) and analysed using the STATA 16.1 program (Stata Corp LLC, College Station, Texas 77845, USA).

The heterogeneity of the studies was evaluated using the Higgins and Thompson I^2 statistic, and the meta-analysis was made to control heterogeneity by using a random effects model.

Subgroup analysis was conducted for studies that included only elite athletes.

RESULTS

Fifteen articles were included, reporting on 1456 female athletes participating in pivoting sports (Fig. 1).

The included studies consisted of 9 cohorts [21,22,30–36], 1 case-control study [37], 2 case series [38,39], 2 descriptive epidemiology studies [40,41], and 1 observational study [42]. Eight out of fifteen studies evaluated only elite-level athletes (Table 1). The elite level was defined as a professional level of sports or the highest national level of sports participation. The participants had a mean age of 23.13 years. The most practised sport among the participants was soccer, accounting for 49.7 % of all included athletes, followed by basketball (15.1 %) (Table 1).

All 15 studies reported a RTS rate, though RTS was defined in different ways in the studies. Listed definitions of RTS were: (1) any documented WNBA game play after ACLR [30], (2) yes or no questionnaire [31], (3) participation in sports for a minimum of 12 months after

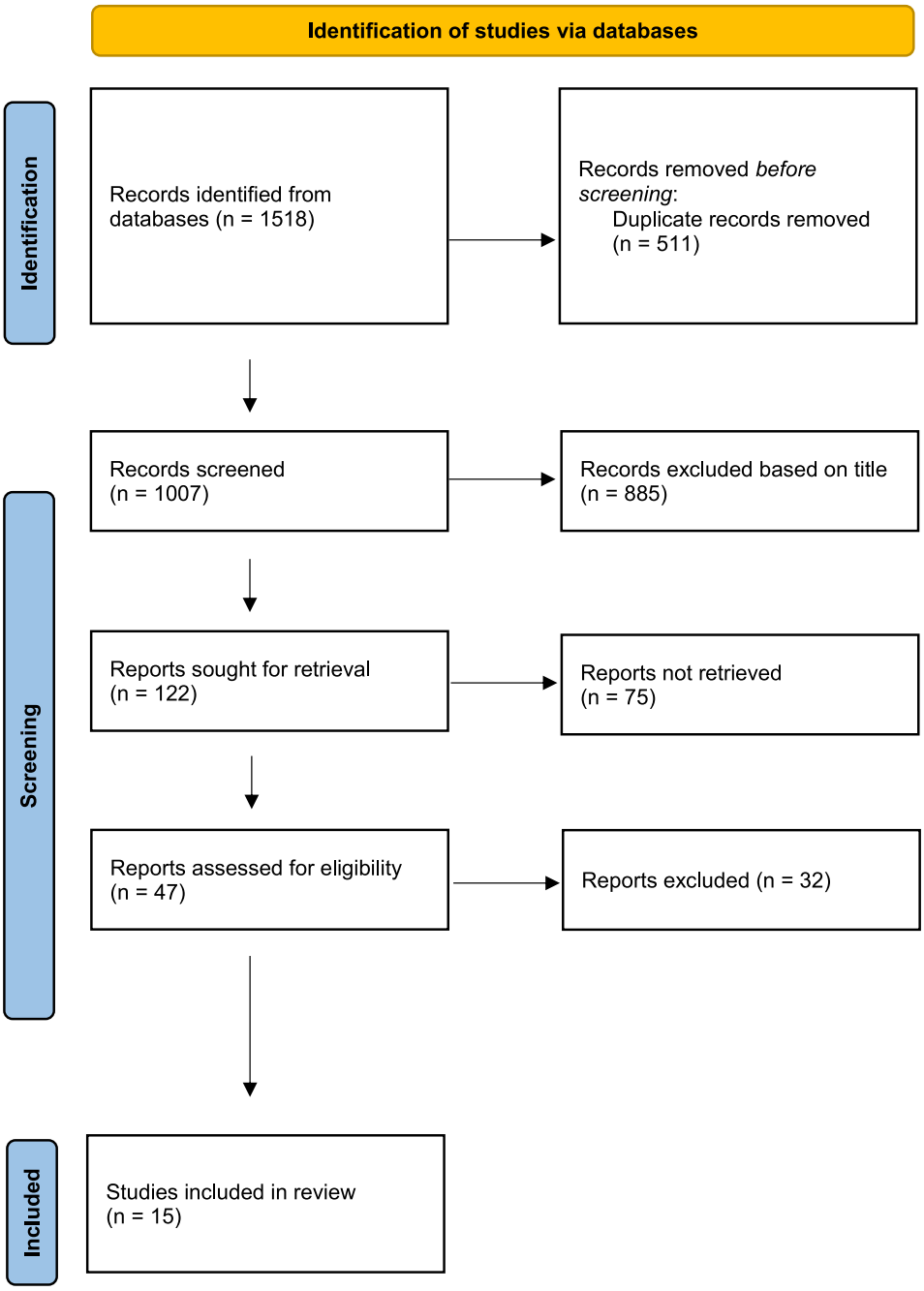

Fig. 1. Article selection.

surgery [32], (4) return to level I (jumping, hard pivoting, and cutting) sport competition [22], (5) any player who played at least 1 min in at least 1 NWSL game after ACLR [40], (6) Tegner activity scale ≥6 after ACLR [21], and (7) resuming playing soccer after ACLR and currently playing at any level [34,36].

The studies showed a meta-proportion of RTS of 69% [95% CI, 58–80%] (Fig. 2). When considering only the articles that describe the RTS rate in elite athletes, the proportion increases up to 79% [95% CI, 73–86%] (Fig. 3).

The studies tend to be heterogeneous, with an I^2 value of 94.38 % ($p < 0.001$). When comparing studies that include only elite athletes, the sample shows mild heterogeneity with an I^2 value of 37.7% ($p = 0.13$).

Nine articles reported the time to RTS, with an average of 10.8 months [95 % CI, 8.7–12.8 months]. When analysing only elite athletes, the time to RTS was 9.96 months [95 % CI, 4.8–15.1 months].

Twelve articles described at what level athletes returned to sports. Tramer [30], and Abed [40] et al. showed worse performance within the first year after surgery, achieving the same pre-injury level after the first year. Brophy [31], Walden [36], and Howard [41] et al. described 75–85 % of the athletes returning to sports at the same level or higher than their pre-injury level. Lindanger [32], Ezzat [33], Mardani-Kivi [42], Fältström [34], and Myklebust [35] et al. showed between 50 and 59 % of athletes returning to the same pre-injury level. Unlike the rest of the articles, Ardern [38] et al. showed a return to the same pre-injury level (full competition) in only 26 % of the participants in the study (Table 2).

Reasons for not returning to sports were described in only 4 studies, being mainly unrelated to knee function. The reasons listed include the ACL injury itself, lack of trust in the knee, fear of reinjury, poor knee function (pain, stiffness, instability), not being able to maintain

Table 1
Study characteristics and patients' demographics of articles included in the systematic review.

First Author (Year)	Female patients with ACLR (*n*)	Mean age (range)	Sports practice	Level of sport	Study design	MINORS
Tramer JS (2020) [30]	59	26.3 years (22.4–29.7)	Basketball	Elite	Retrospective cohort	17
Brophy RH (2012) [31]	45	19.8 years (11.1–53.0)	Soccer	Elite	Retrospective cohort	11
Lindanger L (2019) [32]	74 (early ACL-R)	22.0 years (14.0–47.0)	- Soccer - Basketball - Handball	- Elite - Highly competitive - Lower competitive - Recreational	Prospective cohort	11
Ezzat A (2021) [33]	51	17.8 years (14.9–22.6)	- Soccer - Basketball - Volleyball - Others	Not defined	Retrospective cohort	19
Webster K (2018) [22]	448	26.0 years (12.0–55.0)	- Soccer - Basketball - Australian football - Netball - Rugby - Volleyball	Level 1 sport (jumping, hard pivoting, cutting) on a weekly basis	Retrospective cohort	11
Abed V (2023) [40]	30	25.0 years (22.5–28.0)	Soccer	Elite	Descriptive epidemiology	12
Hamrin Senorski E (2018) [21]	138	25.0 years (15.8–34.2)	Soccer	Tegner 7–9	Prospective cohort	11
Mardani-Kivi M (2020) [42]	107	27.2 years (26.4–28.0)	- Soccer - Basketball - Volleyball - Martial arts/ Wrestling	Not defined	Observational	12
Fältström A (2016) [34]	182	18.2 years (15.2–21.4)	Soccer	- Elite - Sub elite - Recreational	Prospective cohort	9
Namdari S (2011) [37]	18	26.8 years (21.7–31.3)	Basketball	Elite	Case – control	21
Ardern C (2011) [38]	163	27.2 years (18.8–35.6)	- Soccer - Basketball - Australian football - Netball	Not defined	Case series	11
Myklebust G (2003) [35]	37	Missing data	Handball	Elite	Prospective cohort	13
Walden M (2011) [36]	14	20.6 years (18.4–22.8)	Soccer	Elite	Prospective cohort	12
Erickson B (2013) [39]	12	22.6 years (18.2–27.1)	- Snowboard - Ski	Elite	Case series	11
Howard J (2016) [41]	78	19.3 years (17.0–22.0)	Soccer	Elite	Descriptive epidemiology	12

ACLR: anterior cruciate ligament reconstruction; MINORS: Methodological Index for Non-Randomized Studies.

performance at preinjury level, changes in the team, and others not knee-related (Table 2).

Few studies reported the criteria for RTS clearance. These included completion of a full postoperative rehabilitation program, full knee range of motion, a stable knee, functional quadriceps control, and no effusion [38]. One study also included control of a single-legged squat, normal running and landing, and at least 4 weeks of unrestricted training, in addition to the previously described criteria [22].

DISCUSSION

This study summarizes the current evidence regarding the RTS following ACLR in female athletes. Our findings show that 69 % of female athletes can RTS participation, and this number rises to 79 % when considering only elite female athletes.

RTS rates after ACLR vary in the literature and between sports, ranging from 22 to 100 % [38]. A recent review article reported an overall return rate of 82 % for elite female athletes [43]. Similarly, Ardern et al. in a systematic review in 2014 showed an RTS rate of 75 % at any level for women [23]. However, the likelihood of returning to play following an ACL injury is challenging, with reported rates highly variable and often lower than expected, with nearly half of athletes returning to the same preinjury level following ACLR, as described in this study.

The rates of return to preinjury level in the reviewed studies span a wide range, with rates described from 26 to 100 %, with a mean rate of 73.6 % returning to the same or higher level. This is fairly similar to what has been reported in the literature, which typically ranges between 40 and 86 % [23,44,45]. A systematic review in 2014 showed an RTS rate of 52 % at the pre-injury level and 68 % at competitive level sports for women [23]. When evaluating only elite competitive athletes, our study shows that 87.7 % of women return to the same or a higher preinjury performance level. This higher percentage among elite athletes may be explained by a greater time invested in sports, higher performance expectations, and that they may derive financial benefits from playing sports as professional players. Also, elite athletes have access to intensive, highly structured support from rehabilitation professionals and exceptional medical care compared to non-elite athletes [46–48]. This explains why elite athletes are more likely to return to their preinjury level sport, and have higher odds of returning to competitive sport when compared to non-elite athletes, with literature describing twice and 6 times the odds, respectively [23,44].

One of the most important decisions is when to clear an athlete to return to play. This study describes a mean time to RTS of 10.8 months, with a range from 6.1 to 15 months. These results are aligned with the available literature. Mok et al. in a systematic review report an average time to RTS ranging from 8.3 months to 11.1 months [49]. Also in 2019, Capin et al. described an average time to RTS of 8.5 months in female athletes in the ACL-SPORTS trial [50]. While several factors can influence the timing of return to play, it appears that most female athletes can return within the first year following ACL reconstruction surgery, however, this decision should not be based on time alone, and the athletes should always complete a series of specific tests for sports discharge [51].

Reasons for not returning to sports are scarcely described in the literature. Only 4 out of 15 studies vaguely reported on the main reasons, with most of them not being knee related. However, these studies don't

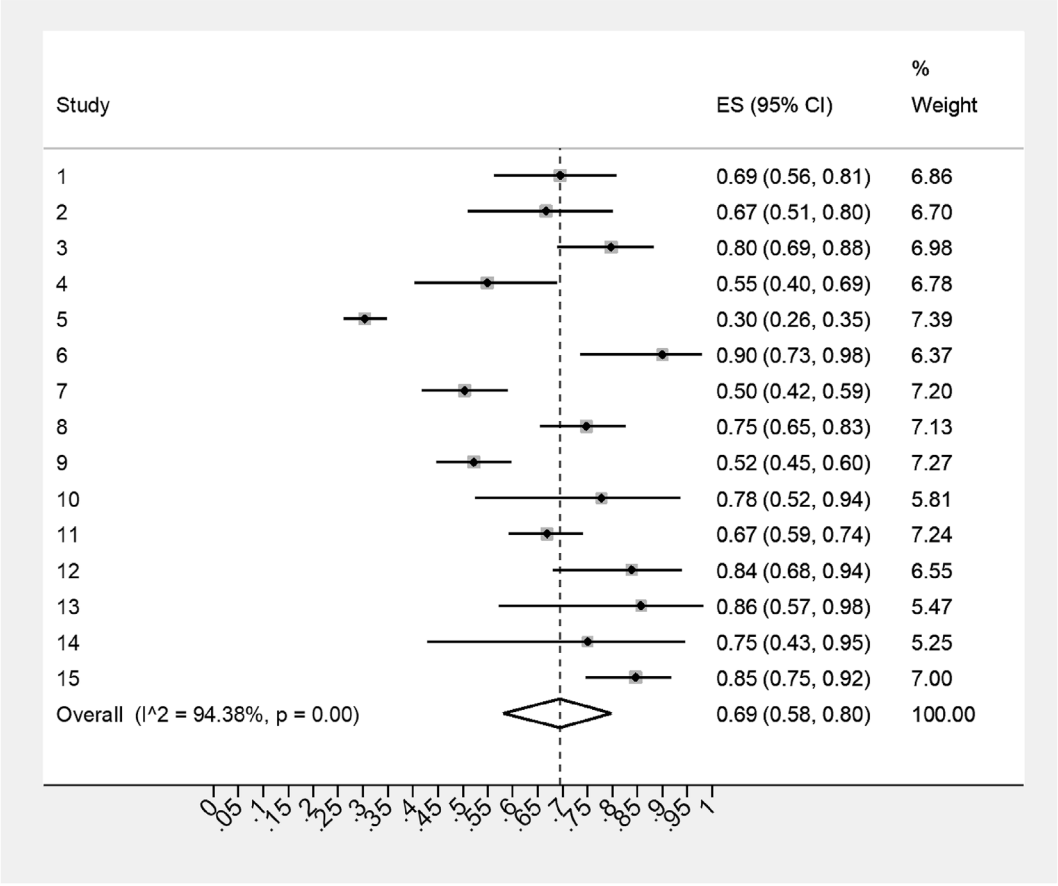

Fig. 2. Proportional meta-analysis showed an overall return to sport rate of 69 % [95 % CI, 58–80 %] in female athletes following ACLR (anterior cruciate ligament reconstruction).

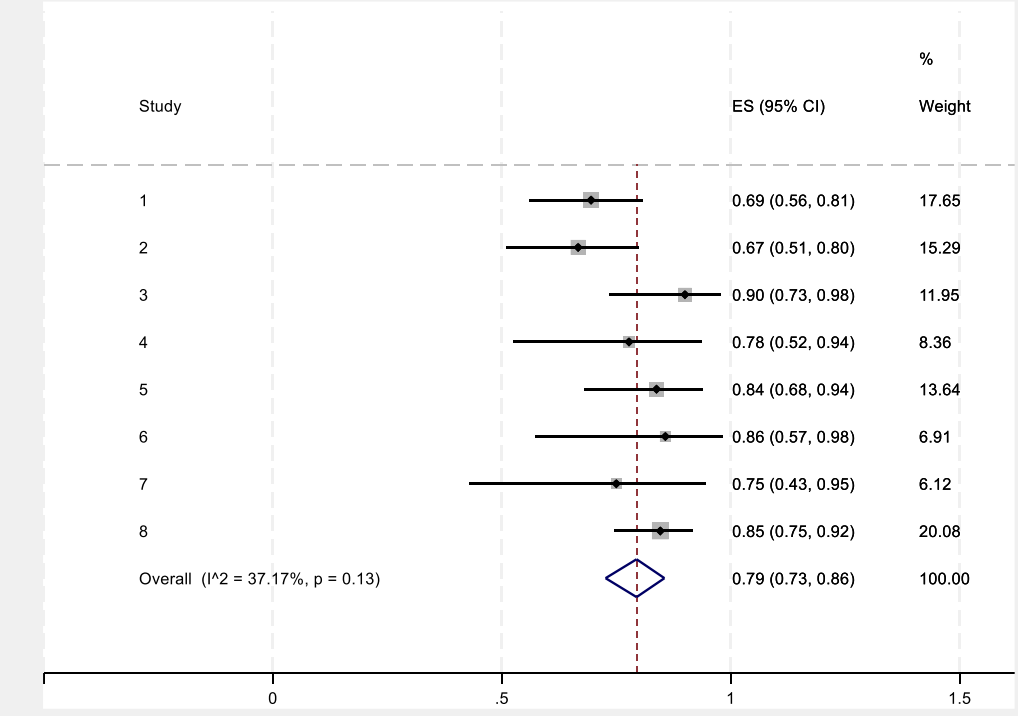

Fig. 3. Proportional meta-analysis showed an overall return to sport rate of 79 % [95 % CI, 73–86 %] in elite female athletes following ACLR (anterior cruciate ligament reconstruction).

Table 2
Details of studies which have reported return to sport rates after ACLR in female athletes.

First Author (Year)	Return to sports rate	Level of RTS	Time to RTS (months)	Reasons for not RTS
Tramer JS (2020) [30]	69.5 %	100 % preinjury level 3 years after return	–	Not reported
Brophy RH (2012) [31]	66.7 %	85 % preinjury level or higher	15	26 % knee related (ACL injury)
Lindanger L (2019) [32]	79.8 %	53 % preinjury level	–	52 % not knee related 17 % fear of reinjury 21 % knee-related issues
Ezzat A (2021) [33]	54.9 %	50 % preinjury level	12	Not reported
Webster K (2018) [22]	30.4 %	–	–	Not reported
Abed V (2023) [40]	90.0 %	100 % preinjury level after 2 seasons	12.1	Not reported
Hamrin Senorski E (2018) [21]	50.7 %	–	12	Not reported
Mardani-Kivi M (2020) [42]	74.8 %	58.9 % preinjury level	8	Not reported
Fältström A (2016) [34]	52.2 %	59 % preinjury level, 22 % higher level	–	28 % "lack of trust in the knee" 25 % fear or new injury 15 % "team has changed" 14 % poor knee function
Namdari S (2011) [37]	77.8 %	100 % preinjury level (only statistically significant decrease in shooting % and steals per 40 min of play)	11.8	Not reported
Ardern C (2011) [38]	66.9 %	26 % preinjury level	12	12 % not knee related 13 % poor knee function
Myklebust G (2003) [35]	83.8 %	54.1 % preinjury level	–	Not reported
Walden M (2011) [36]	85.7 %	–	8.3	Not reported
Erickson B (2013) [39]	75.0 %	100 % preinjury level or higher	–	Not reported
Howard J (2016) [41]	84.6 %	75 % preinjury level or higher	6.1	Not reported

ACLR: anterior cruciate ligament reconstruction; RTS: Return to sport.

delve into the reasons or other relevant factors such as physical and psychological considerations when returning to sports.

Not returning to sports or returning to a lower level could be due to physical, psychological, or motivational issues, or simply choosing to give up playing the same sport or at a high level. One relevant aspect to consider is kinesiophobia, which should be addressed as part of the psychological aspects of returning to sports. Patients who have a fear of reinjuring their surgically repaired knee tend to have stiffer jumping and landing mechanics. As a result, they put themselves at a greater risk of reinjury [52], therefore, the psychological aspects of returning to play should also be taken into consideration and addressed by qualified professionals with appropriate interventions when necessary [53].

This study does not evaluate the difference in RTS between male and female athletes. However, in most studies that reported RTS rates for both groups, male patients had a higher RTS rate compared to their female counterparts. They are also more likely than women to return to their preinjury level of sport [23,24,49,54,55]. One potential explanation seen in the literature is that male patients have been shown to have greater psychological readiness for RTS throughout the entire rehabilitation process compared to females [56–58]. Self-reported psychological readiness has been identified as the most important factor in predicting subsequent return to comparable athletic performance [59]. This implies a potential role for psychological treatment for female athletes as part of rehabilitation programs to successfully achieve RTS after ACLR.

The likelihood of returning to play should be considered and analysed based on a multitude of factors, including patient demographics (such as gender), concomitant injuries, specific sport played, graft selection, and psychological factors [60]. The effect of gender as an individual factor on return-to-play rates remains unclear, and empirical evidence is lacking to explain gender differences in returning to sport.

There are several limitations to this study. As mentioned, there is a high risk of bias in the included studies, as the majority are retrospective cohort studies. Another limitation is that most studies had different definitions of RTS, making it difficult to evaluate the results together. Many studies reported data as descriptive variables, such as reasons for not returning to sport, which makes them not comparable. All these factors make it difficult to analyse the data on a larger scale.

Future research on evaluation after ACLR should report sex-specific outcomes so that they can be analysed separately for male and female patients. This will allow for different rehabilitation strategies to be carried out for both men and women.

CONCLUSION

This systematic review demonstrates that the majority of female athletes (69 %) can RTS participation at an average of 10.8 months, however, the available information is insufficient, and quantitative data and reasons for not returning to play are lacking. Future studies should establish return-to-play criteria in this population and determine reasons for not returning to sport.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Mall NA, Chalmers PN, Moric M, Tanaka MJ, Cole BJ, Bach BR, et al. Incidence and trends of anterior cruciate ligament reconstruction in the United States. Am J Sports Med 2014;42(10):2363–70. https://doi.org/10.1177/0363546514542796.
[2] Zbrojkiewicz D, Vertullo C, Grayson JE. Increasing rates of anterior cruciate ligament reconstruction in young Australians, 2000–2015. Med J Aust 2018;208(8):354–8. https://doi.org/10.5694/mja17.00974.
[3] Sanders TL, Maradit Kremers H, Bryan AJ, Larson DR, Dahm DL, Levy BA, et al. Incidence of anterior cruciate ligament tears and reconstruction. Am J Sports Med 2016;44(6):1502–7. https://doi.org/10.1177/0363546516629944.
[4] Abram SGF, Price AJ, Judge A, Beard DJ. Anterior cruciate ligament (ACL) reconstruction and meniscal repair rates have both increased in the past 20 years in England: hospital statistics from 1997 to 2017. Br J Sports Med 2020;54(5):286–91. https://doi.org/10.1136/bjsports-2018-100195.
[5] Kaeding CC, Léger-St-Jean B, Magnussen RA. Epidemiology and diagnosis of anterior cruciate ligament injuries. Clin Sports Med 2017;36(1):1–8. https://doi.org/10.1016/j.csm.2016.08.001.
[6] Beynnon BD, Johnson RJ, Abate JA, Fleming BC, Nichols CE. Treatment of anterior cruciate ligament injuries, part I. Am J Sports Med 2005;33(10):1579–602. https://doi.org/10.1177/0363546505279913.
[7] Beynnon BD, Johnson RJ, Abate JA, Fleming BC, Nichols CE. Treatment of anterior cruciate ligament injuries, part 2. Am J Sports Med 2005;33(11):1751–67. https://doi.org/10.1177/0363546505279922.
[8] Hewett TE, Myer GD, Ford KR, Paterno MV, Quatman CE. Mechanisms, prediction, and prevention of ACL injuries: cut risk with three sharpened and validated tools. J Orthop Res 2016;34(11):1843–55. https://doi.org/10.1002/jor.23414.

[9] Prodromos CC, Han Y, Rogowski J, Joyce B, Shi K. A meta-analysis of the incidence of anterior cruciate ligament tears as a function of gender, sport, and a knee injury–reduction regimen. Arthrosc J Arthrosc Relat Surg 2007;23(12):1320–1325.e6. https://doi.org/10.1016/j.arthro.2007.07.003.

[10] Renstrom P, Ljungqvist A, Arendt E, Beynnon B, Fukubayashi T, Garrett W, et al. Non-contact ACL injuries in female athletes: an International Olympic Committee current concepts statement. Br J Sports Med 2008;42(6):394–412. https://doi.org/10.1136/bjsm.2008.048934.

[11] Hewett TE, Myer GD, Ford KR. Anterior cruciate ligament injuries in female athletes. Am J Sports Med 2006;34(2):299–311. https://doi.org/10.1177/0363546505284183.

[12] Agel J, Rockwood T, Klossner D. Collegiate ACL injury rates across 15 sports. Clin J Sport Med 2016;26(6):518–23. https://doi.org/10.1097/JSM.0000000000000290.

[13] Arendt E, Dick R. Knee injury patterns among men and women in collegiate basketball and soccer. Am J Sports Med 1995;23(6):694–701. https://doi.org/10.1177/036354659502300611.

[14] Ireland ML. The female ACL: why is it more prone to injury? Orthop Clin N Am 2002;33(4):637–51. https://doi.org/10.1016/S0030-5898(02)00028-7.

[15] Bruder AM, Donaldson A, Mosler AB, Patterson BE, Haberfield M, Mentiplay BF, et al. Creating Prep to Play PRO for women playing elite Australian football: a how-to guide for developing injury-prevention programs. J Sport Heal Sci 2023;12(1):130–8. https://doi.org/10.1016/j.jshs.2021.09.003.

[16] Anuario de Estadísticas Deportivas 2019. Madrid: División de Estadística y Estudios, Secretaría General Técnica M de C y D 2019; 2019. https://www.culturaydeporte.gob.es/dam/jcr:dc406096-a312-4b9d-bd73-2830d0affb2d/anuario-de-estadisticas-deportivas-2019.pdf.

[17] Stracciolini A, Amar-Dolan L, Howell DR, Alex T, Berkner P, Sandstrom NJ, et al. Female sport participation effect on long-term health-related quality of life. Clin J Sport Med 2020;30(6):526–32. https://doi.org/10.1097/JSM.0000000000000645.

[18] Buller LT, Best MJ, Baraga MG, Kaplan LD. Trends in anterior cruciate ligament reconstruction in the United States. Orthop J Sport Med 2015;3(1):232596711456366. https://doi.org/10.1177/2325967114563664.

[19] Herzog MM, Marshall SW, Lund JL, Pate V, Mack CD, Spang JT. Trends in incidence of ACL reconstruction and concomitant procedures among commercially insured individuals in the United States, 2002-2014. Sport Heal A Multidiscip Approach 2018;10(6):523–31. https://doi.org/10.1177/1941738118803616.

[20] 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;6(6):2325967118777823. https://doi.org/10.1177/2325967118777823.

[21] Hamrin Senorski E, Svantesson E, Beischer S, Thomeé C, Thomeé R, Karlsson J, et al. Low 1-year return-to-sport rate after anterior cruciate ligament reconstruction regardless of patient and surgical factors: a prospective cohort study of 272 patients. Am J Sports Med 2018;46(7):1551–8. https://doi.org/10.1177/0363546518765120.

[22] Webster KE, Feller JA. Return to level I sports after anterior cruciate ligament reconstruction: evaluation of age, sex, and readiness to return criteria. Orthop J Sport Med 2018;6(8):1–6. https://doi.org/10.1177/2325967118788045.

[23] Ardern CL, Taylor NF, Feller JA, Webster KE. Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. Br J Sports Med 2014;48(21):1543–52. https://doi.org/10.1136/bjsports-2013-093398.

[24] Tan SHS, Lau BPH, Khin LW, Lingaraj K. The importance of patient sex in the outcomes of anterior cruciate ligament reconstructions. Am J Sports Med 2016;44(1):242–54. https://doi.org/10.1177/0363546515573008.

[25] DeFroda SF, Patel DD, Milner J, Yang DS, Owens BD. Performance after anterior cruciate ligament reconstruction in national basketball association players. Orthop J Sport Med 2021;9(2):2325967120981649. https://doi.org/10.1177/2325967120981649.

[26] Mai HT, Chun DS, Schneider AD, Erickson BJ, Freshman RD, Kester B, et al. Performance-based outcomes after anterior cruciate ligament reconstruction in professional athletes differ between sports. Am J Sports Med 2017;45(10):2226–32. https://doi.org/10.1177/0363546517704834.

[27] Read CR, Aune KT, Cain EL, Fleisig GS. Return to play and decreased performance after anterior cruciate ligament reconstruction in national football league defensive players. Am J Sports Med 2017;45(8):1815–21. https://doi.org/10.1177/0363546517703361.

[28] Sex-specific reporting of scientific research. National Academies Press; 2012. https://doi.org/10.17226/13307.

[29] Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (MINORS): development and validation of a new instrument. ANZ J Surg 2003;73(9):712–6. https://doi.org/10.1046/j.1445-2197.2003.02748.x.

[30] Tramer JS, Khalil LS, Ziedas A, Mehran N, Okoroha KR. Return to play and performance in the women's national basketball association after anterior cruciate ligament reconstruction. Orthop J Sport Med 2020;8(9):1–8. https://doi.org/10.1177/2325967120947078.

[31] Brophy RH, Schmitz L, Wright RW, Dunn WR, Parker RD, Andrish JT, et al. Return to play and future ACL injury risk after ACL reconstruction in soccer athletes from the multicenter orthopaedic outcomes network (MOON) group. Am J Sports Med 2012;40(11):2517–22. https://doi.org/10.1177/0363546512459476.

[32] Lindanger L, Strand T, Mølster AO, Solheim E, Inderhaug E. Return to play and long-term participation in pivoting sports after anterior cruciate ligament reconstruction. Am J Sports Med 2019;47(14):3339–46. https://doi.org/10.1177/0363546519878159.

[33] Ezzat AM, Brussoni M, Mâsse LC, Emery CA. Effect of anterior cruciate ligament rupture on physical activity, sports participation, patient-reported health outcomes, and physical function in young female athletes. Am J Sports Med 2021;49(6):1460–9. https://doi.org/10.1177/03635465211002530.

[34] Fältström A, Hägglund M, Kvist J. Factors associated with playing football after anterior cruciate ligament reconstruction in female football players. Scand J Med Sci Sports 2016;26(11):1343–52. https://doi.org/10.1111/sms.12588.

[35] Myklebust G, Holm I, Mæhlum S, Engebretsen L, Bahr R. Clinical, functional, and radiologic outcome in team handball players 6 to 11 Years after anterior cruciate ligament injury. Am J Sports Med 2003;31(6):981–9. https://doi.org/10.1177/03635465030310063901.

[36] Waldén M, Hägglund M, Magnusson H, Ekstrand J. Anterior cruciate ligament injury in elite football: a prospective three-cohort study. Knee Surg Sports Traumatol Arthrosc 2011;19(1):11–9. https://doi.org/10.1007/s00167-010-1170-9.

[37] Namdari S, Scott K, Milby A, Baldwin K, Lee GC. Athletic performance after ACL reconstruction in the women's national basketball association. Physician Sportsmed 2011;39(1):36–41. https://doi.org/10.3810/psm.2011.02.1860.

[38] Ardern CL, Webster KE, Taylor NF, Feller JA. Return to the preinjury level of competitive sport after anterior cruciate ligament reconstruction surgery. Am J Sports Med 2011;39(3):538–43. https://doi.org/10.1177/0363546510384798.

[39] Erickson BJ, Harris JD, Fillingham YA, Cvetanovich GL, Bhatia S, Bach BR, et al. Performance and return to sport after anterior cruciate ligament reconstruction in X-games skiers and snowboarders. Orthop J Sport Med 2013;1(6). https://doi.org/10.1177/2325967113511196. 2325967113511196.

[40] Abed V, Dupati A, Hawk GS, Johnson D, Conley C, Stone AV. Return to play and performance after anterior cruciate ligament reconstruction in the national women's soccer league. Orthop J Sport Med 2023;11(5):23259671231164944. https://doi.org/10.1177/23259671231164944.

[41] Howard JS, Lembach ML, Metzler AV, Johnson DL. Rates and determinants of return to play after anterior cruciate ligament reconstruction in national collegiate athletic association division I soccer athletes. Am J Sports Med 2016;44(2):433–9. https://doi.org/10.1177/0363546515614315.

[42] Mardani-Kivi M, Azari Z, Hasannejad F. Return to sport activity after anterior cruciate ligament reconstruction: a 6–10 years follow-up. J Clin Orthop Trauma 2020;11:S319–25. https://doi.org/10.1016/j.jcot.2019.09.023.

[43] Webster KE. Return to sport and reinjury rates in elite female athletes after anterior cruciate ligament rupture. Sports Med 2021;51(4):653–60. https://doi.org/10.1007/s40279-020-01404-7.

[44] Drole K, Paravlic AH. Interventions for increasing return to sport rates after an anterior cruciate ligament reconstruction surgery: a systematic review. Front Psychol 2022;13:939209. https://doi.org/10.3389/fpsyg.2022.939209.

[45] Harris JD, Erickson BJ, Bach BR, Abrams GD, Cvetanovich GL, Forsythe B, et al. Return-to-Sport and performance after anterior cruciate ligament reconstruction in national basketball association players. Sport Heal A Multidiscip Approach 2013;5(6):562–8. https://doi.org/10.1177/1941738113495788.

[46] Lai CCH, Ardern CL, Feller JA, Webster KE. Eighty-three per cent of elite athletes return to preinjury sport after anterior cruciate ligament reconstruction: a systematic review with meta-analysis of return to sport rates, graft rupture rates and performance outcomes. Br J Sports Med 2018;52(2):128–38. https://doi.org/10.1136/bjsports-2016-096836.

[47] Kunnen M, Dionigi RA, Litchfield C, Moreland A. 'My desire to play was stronger than my fear of re-injury': athlete perspectives of psychological readiness to return to soccer following anterior cruciate ligament reconstruction surgery. Ann Leis Res 2020;23(3):447–61. https://doi.org/10.1080/11745398.2019.1647789.

[48] Kunnen M, Dionigi RA, Litchfield C, Moreland A. Psychological barriers negotiated by athletes returning to soccer (football) after anterior cruciate ligament reconstructive surgery. Ann Leis Res 2023;26(4):545–66. https://doi.org/10.1080/11745398.2021.2010224.

[49] Mok AC, Fancher AJ, Vopat ML, Baker J, Tarakemeh A, Mullen S, et al. Sex-specific outcomes after anterior cruciate ligament reconstruction: a systematic review and meta-analysis. Orthop J Sport Med 2022;10(2):1–11. https://doi.org/10.1177/23259671221076883.

[50] Capin JJ, Failla M, Zarzycki R, Dix C, Johnson JL, Smith AH, et al. Superior 2-year functional outcomes among young female athletes after ACL reconstruction in 10 return-to-sport training sessions: comparison of ACL-SPORTS randomized controlled trial with Delaware-Oslo and MOON cohorts. Orthop J Sport Med 2019;7(8):2325967119861311, https://doi.org/10.1177/2325967119861311.

[51] Figueroa D, Arce G, Espregueira-Mendes J, Maestu R, Mosquera M, Williams A, et al. Return to sport soccer after anterior cruciate ligament reconstruction: ISAKOS consensus. J ISAKOS 2022;7(6):150–61. https://doi.org/10.1016/j.jisako.2022.08.004.

[52] Trigsted SM, Post E, Schaefer D, Miller M, Green N, Bell DR. The effect of fear of reinjury on biomechanics during A jump landing following ACL reconstruction. Med Sci Sports Exerc 2017;49(5S):497. https://doi.org/10.1249/01.mss.0000518261.72162.e4.

[53] Burnham JM, Wright V. Update on anterior cruciate ligament rupture and care in the female athlete. Clin Sports Med 2017;36(4):703–15. https://doi.org/10.1016/j.csm.2017.05.004.
[54] King E, Richter C, Jackson M, Franklyn-Miller A, Falvey E, Myer GD, et al. Factors influencing return to play and second anterior cruciate ligament injury rates in level 1 athletes after primary anterior cruciate ligament reconstruction: 2-year follow-up on 1432 reconstructions at a single center. Am J Sports Med 2020;48(4):812–24. https://doi.org/10.1177/0363546519900170.
[55] Bruder AM, Culvenor AG, King MG, Haberfield M, Roughead EA, Mastwyk J, et al. Let's talk about sex (and gender) after ACL injury: a systematic review and meta-analysis of self-reported activity and knee-related outcomes. Br J Sports Med 2023;57(10):602–10. https://doi.org/10.1136/bjsports-2022-106099.
[56] Sims M, Mulcahey MK. Sex-specific differences in psychological response to injury and return to sport following ACL reconstruction. JBJS Rev 2018;6(7). https://doi.org/10.2106/JBJS.RVW.17.00170. e9-e9.
[57] Kostyun RO, Burland JP, Kostyun KJ, Milewski MD, Nissen CW. Male and female adolescent athletes' readiness to return to sport after anterior cruciate ligament injury and reconstruction. Clin J Sport Med 2021;31(4):383–7. https://doi.org/10.1097/JSM.0000000000000751.
[58] Webster KE, Nagelli CV, Hewett TE, Feller JA. Factors associated with psychological readiness to return to sport after anterior cruciate ligament reconstruction surgery. Am J Sports Med 2018;46(7):1545–50. https://doi.org/10.1177/0363546518773757.
[59] Webster KE, McPherson AL, Hewett TE, Feller JA. Factors associated with a return to preinjury level of sport performance after anterior cruciate ligament reconstruction surgery. Am J Sports Med 2019;47(11):2557–62. https://doi.org/10.1177/0363546519865537.
[60] Ellman MB, Sherman SL, Forsythe B, LaPrade RF, Cole BJ, Bach BR. Return to play following anterior cruciate ligament reconstruction. J Am Acad Orthop Surg 2015;23(5):283–96. https://doi.org/10.5435/JAAOS-D-13-00183.