

Return-To-Sport Decision Criteria For Athletes Following Sports-Related Injuries: A Systematic Review.

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ABSTRACT

Background: Sports-related injuries pose significant challenges for athletes, impacting performance and long-term health. Establishing clear, evidence-based return-to-sport (RTS) decision criteria is necessary to ensure safe and timely reintegration into athletic activities while minimizing the risk of re-injury. This systematic review synthesizes current RTS criteria used across different sports and injury types.

Methodology: Following PRISMA 2020 guidelines and PROSPERO registration (CRD420250637241), we searched PubMed, Embase, Web of Science, Scopus, Cochrane Library, and Google Scholar for English-language studies (2015–2025) on athletes with sports injuries assessing return-to-play criteria. Two reviewers independently screened and extracted data. Study quality was assessed using JBI critical appraisal checklists and PEDro scale, and findings were narratively synthesised by injury type and RTP criteria due to between-study heterogeneity.

Results: A total of 14 studies were included after qualitative screening. These studies comprised randomized controlled trials (n=7), prospective cohort studies (n=4), and cross-sectional studies (n=3) involving athletes aged 17 to 40 years (n = 1,430), primarily focused on ACL injuries, hamstring strains, lateral ankle sprain, and arthroscopic partial meniscectomy. Key findings highlighted the importance of strength recovery, psychological readiness, biomechanical movement quality, and tailored rehabilitation in safe return-to-sport. Methodological quality was generally high, though blinding and allocation concealment were variably reported. Risk of bias assessments indicated most studies had low to moderate bias.

Conclusion: Current evidence highlights that effective return-to-sport decision-making requires integrating objective physical measures (strength and functional tests), psychological readiness assessments (ACL-RSI, Tampa Scale), and biomechanical movement quality evaluation within a criterion-based framework. Time-based minimum thresholds complement but do not replace criterion-based assessment. Standardised, sport-specific RTS guidelines supported by high-quality prospective research are needed...

Keywords: Rehabilitation; Return to Sport; Exercise Therapy; Psychological Readiness; Sports Medicine; Decision Making; Limb Symmetry Index; ACL Reconstruction

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INTRODUCTION

Sports-related injuries are a significant public health concern, with an increasing global burden due to rising

participation in both competitive and recreational sports. Athletes at all levels are frequently exposed to musculoskeletal trauma, especially involving the knee, ankle, and shoulder joints, which may lead to prolonged

absence from training and competition [1,2]. These injuries can broadly be classified as contact or non-contact in nature. Contact injuries often arise from direct physical interactions between players, such as collisions or tackles, commonly observed in football, rugby, and hockey. Non-contact injuries occur without external force and are frequently associated with sudden directional changes, acceleration, or deceleration, as seen in basketball, volleyball, and track events [3,4].

A recent meta-analysis by Yang T et al. [5] highlighted a sports injury prevalence of 30.9% among athletes with disabilities, while Sreekaarini I et al. [6] reported a substantially higher overall injury prevalence of 65% among general athlete populations. These figures underscore the scale of the problem. A meta-analysis of 3,744 patients reported that only 61.8% returned to sport after primary ACL reconstruction, and fewer returned to their pre-injury competitive level [7]. Athletes who resume sport before meeting adequate recovery benchmarks face elevated reinjury rates. Beischer et al. [8] demonstrated that young athletes returning to pivoting sport before nine months post-ACLR had a seven-fold increase in second ACL injury risk compared to those who delayed return.

The return-to-sport (RTS) process is now understood as a continuum rather than a single decision point. The Panther Symposium Consensus Group proposed three phases: return to participation, return to sport, and return to performance [9]. Each phase involves different demands and assessment criteria. However, there is considerable heterogeneity in the criteria employed across different sports disciplines and healthcare settings to determine RTS readiness [10]. Many decisions are based on subjective clinical judgment or outdated benchmarks, with limited use of standardised, evidence-based protocols [11]. Marom et al. [12] documented wide inconsistency in how RTS is defined, measured, and reported across studies, making cross-study comparison difficult.

Most current RTS literature focuses on physical parameters such as isokinetic strength ratios and hop test performance, with limb symmetry index (LSI) thresholds of 90% applied as clearance benchmarks [13]. Yet mounting evidence suggests these criteria are incomplete. Paterno et al. [14] found that standard RTS test batteries incorporating quadriceps strength, hop tests, and IKDC scores failed to discriminate between athletes who sustained a second ACL injury and those who did not. Psychological factors, particularly fear of

reinjury and self-efficacy, have been identified as independent predictors of whether athletes actually return to pre-injury sport [7,15]. Despite this, psychological assessments remain inconsistently integrated into clinical RTS protocols [16]. Furthermore, there is a notable gap in consensus regarding which specific clinical, functional, and psychological parameters should guide RTS decisions and how these criteria are validated and implemented in practice [9,17]. This systematic review aims to critically examine and summarise the current evidence on return-to-sport decision-making after sports-related injuries. It focuses on identifying the key components and optimal timing for RTS assessments to support a safe and effective return to sports. By addressing gaps and variations in the available literature, this review was performed to develop a more consistent, evidence-based approach to RTS decisions, with the goal of enhancing athlete safety, improving performance, and reducing the risk of reinjury.

MATERIAL AND METHODS

Protocol and Registration

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [18]. The PERSiST guidance for implementing PRISMA 2020 in sport and exercise medicine was followed for field-specific reporting [19]. The review protocol was registered prospectively with the International Prospective Register of Systematic Reviews (PROSPERO; Registration No: CRD420250637241).

Inclusion Criteria

Articles published in English only were considered eligible. Study designs included randomized controlled trials (RCTs), cohort studies, case-control studies, and cross-sectional studies. The target population consisted of athletes with sports-related injuries (contact and non-contact sports), encompassing both acute and chronic injury types. Eligible studies evaluated return-to-play (RTP) protocols, rehabilitation programmes, or associated outcomes. Outcome measures of interest included re-injury rates and patient-reported outcomes.

Exclusion Criteria

Studies were excluded if they were published in non-English languages, represented duplicate publications, or constituted grey literature. Case reports, expert opinions, and review articles were also excluded. Studies focusing

solely on prevention or treatment of injuries without RTP criteria, non-sports-related injuries, and studies with incomplete or missing data were similarly excluded.

Information Sources and Search Strategy

A comprehensive search of electronic databases including PubMed, Embase, Web of Science, Scopus, Cochrane Library, and Google Scholar was conducted for evidence published between 2015 and 2025. The search strategy combined MeSH terms and keywords such as "return to sport," "return to play," "injury," "criteria," "readiness," "rehabilitation," "athletes," "decision-making," "functional testing," and "psychological readiness." Boolean operators (AND, OR) were applied to maximise retrieval sensitivity and specificity. Reference lists of included studies and relevant reviews were hand-searched to identify additional eligible studies.

Study Selection and Data Extraction

Two independent reviewers (Reviewer A and Reviewer B) screened all titles and abstracts for relevance. Full texts were retrieved for studies fulfilling inclusion criteria or if eligibility could not be determined from the abstract alone. Disagreements between reviewers were resolved through structured discussion or consultation with a third reviewer (Reviewer C). Data were extracted using a standardised extraction form that captured study characteristics, population details, type of injury, RTS criteria used, outcome measures, and key findings.

Quality Assessment

Methodological quality and risk of bias were assessed using multiple validated tools appropriate to study design. Randomized controlled trials were evaluated using the Joanna Briggs Institute (JBI) critical appraisal checklist for RCTs (13-item scale) and additionally

scored using the Physiotherapy Evidence Database (PEDro) scale, an 11-item tool with demonstrated fair-to-excellent inter-rater reliability (ICC 0.53–0.91) [20]. Observational studies (cohort and cross-sectional) were assessed using the corresponding JBI analytical cross-sectional and cohort study checklists. The AMSTAR-2 tool [21] informed the critical appraisal approach for contextualising findings from systematic reviews cited in the discussion. Each study was rated independently by two reviewers, with differences resolved by consensus.

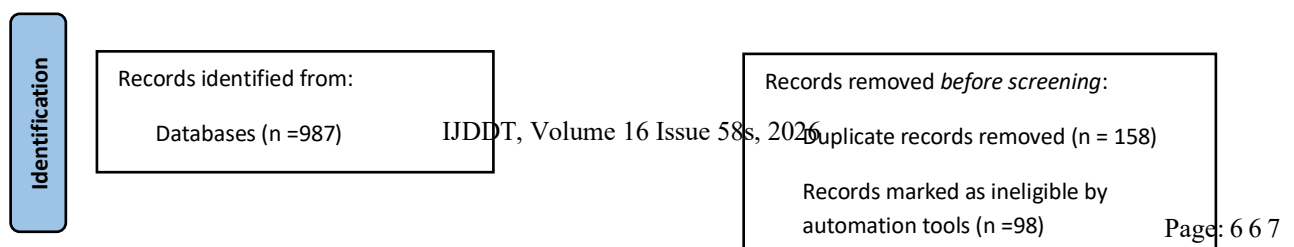
Data Synthesis

Due to the heterogeneity in RTS criteria and study designs, a narrative synthesis approach was adopted. Studies were grouped by injury type (e.g., ACL rupture, hamstring strain, ankle sprain, meniscectomy), sport, and type of RTS criteria used (e.g., strength tests, functional tests, psychological assessments, biomechanical analysis). The frequency of reported criteria, supporting evidence, and outcomes were analysed descriptively.

RESULTS

In this systematic review, a total of 1,045 records were identified through database searches (n = 987) and study registers (n = 58). Prior to screening, 158 duplicate records were removed, along with 98 records that were marked as ineligible by automation tools. This resulted in 789 records being screened, of which 439 were excluded based on titles and abstracts. The full texts of 350 reports were sought for retrieval, but 93 could not be retrieved. A total of 257 reports were assessed for eligibility. Among these, 193 were excluded due to irrelevance, 44 were conference abstracts, and 11 were previously published systematic reviews, among other reasons. Ultimately, 14 studies met the inclusion criteria and were included in the final qualitative synthesis.

Figure 1: PRISMA flow diagram for new systematic reviews which included searches of databases.



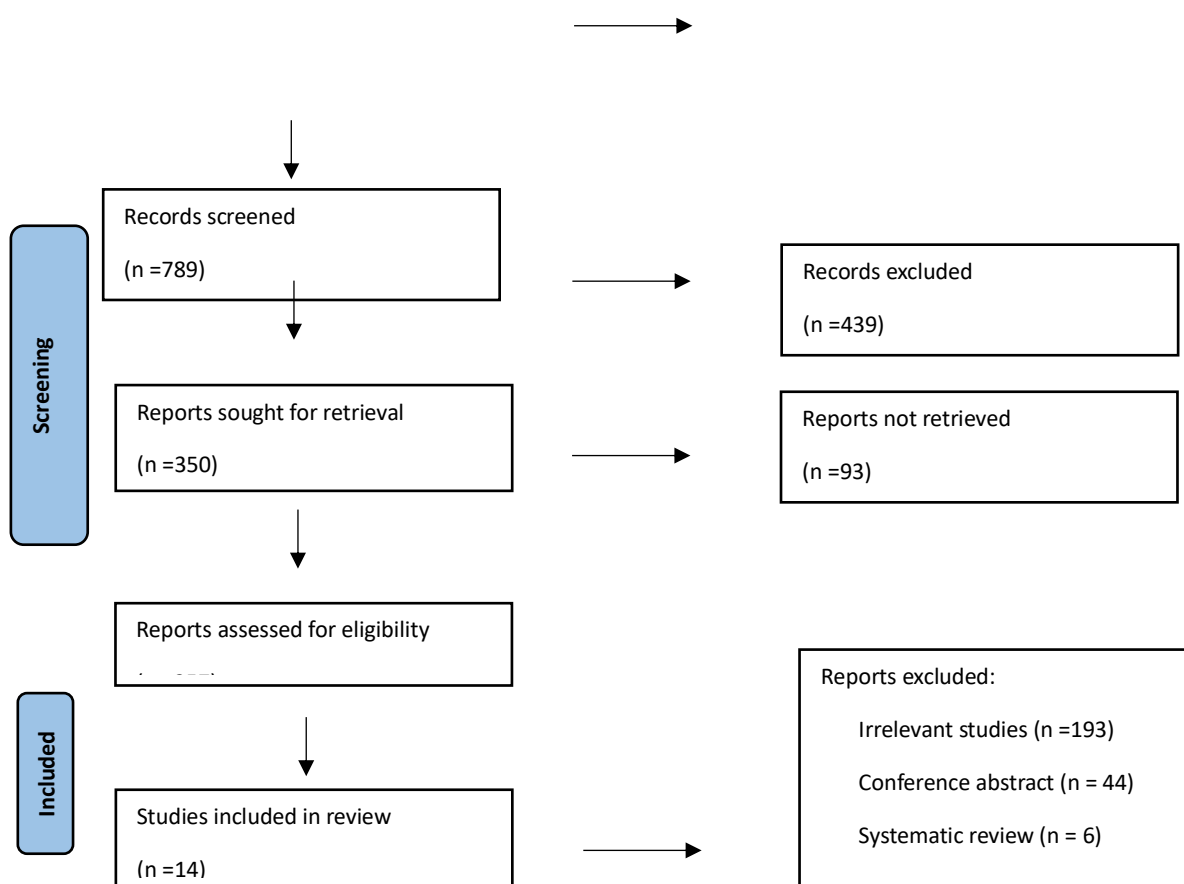


Table 1. Study Characteristics of Included Studies (n=14)

Sr. No.	Author (Year)	Study Design	n	Age (mean±SD)	Gender	Injury/Surgery	Key Outcomes
1	Jacobsen P, et al. [22] (2016)	Double-blind RCT	90	25.8±5.8	NR	Hamstring injury	Clinical assessments at first physiotherapy visit explained 50% of RTP time variance; 7-day follow-up explained 97% (±5 days). Key predictors: strength changes, pain levels, time to walk pain-free, sport type, treatment delay. MRI contributed only 8.6% and was not clinically useful.

Sr. No.	Author (Year)	Study Design	n	Age (mean±SD)	Gender	Injury/Surgery	Key Outcomes
2	Ithurburn MP et al. [23] (2018)	Prospective cohort	76	17.4±2.8	F:52 M:20	Unilateral ACLR	HQ group showed better hop test performance and higher knee function scores (KOOS-Sport/Rec, IKDC) than LQ group at 1 year. Restoring symmetric quadriceps strength at RTS supported better long-term knee function.
3	Swart NM et al. [24] (2019)	RCT	282	26–39	F:104 M:178	Mixed knee ligament (MCL, LCL, ACL, PCL)	At 3 months, 74% returned to sport. Non-return predicted with AUC up to 0.86 using patient/trauma/complaint data; MRI findings did not improve prediction.
4	Albano TR et al. [25] (2020)	Cross-sectional	150	29.57±9.12	NR	ACLR	57.3% returned at any level, 12% at pre-injury level. Higher quadriceps strength aided return; pre-injury level return was primarily influenced by psychological readiness, muscle balance, and postural stability.
5	Hickey JT et al. [26] (2020)	Double-blind RCT	43	26±5	Male	Hamstring strain	Pain-threshold rehabilitation produced 15% greater isometric knee flexor strength and 0.91 cm greater biceps femoris fascicle length at RTP vs. pain-free rehab. No significant difference in time to clearance or 6-month reinjury rate.
6	Johnson JL et al. [27] (2020)	Single-blind RCT	39	20.4±9.8	Female	ACLR	Adding perturbation training to standard ACL prevention programme did not reduce risk of second ACL injury in female athletes.

Sr. No.	Author (Year)	Study Design	n	Age (mean±SD)	Gender	Injury/Surgery	Key Outcomes
7	Faleide AGH et al. [28] (2021)	Prospective cohort	129	28.7±10	F:47% M:53%	Primary ACLR	ACL-RSI and age were the only significant multivariate predictors of returning to pre-injury sport at 2 years (OR 1.03, p=.005). ACL-RSI cutoff <47 identified at-risk patients (AUC=0.69). Functional tests did not independently predict sport return.
8	King E et al. [29] (2021)	Prospective cohort (matched)	88	21.7–22.9	Male	ACLR	Standard strength and hop tests did not differentiate reinjury from no-reinjury. 3D biomechanical analysis revealed medium-effect differences in knee flexion asymmetry, ground contact time, and frontal-plane asymmetry during change of direction (AUC=0.75).
9	van Melick N et al. [30] (2022)	Prospective cohort	176	16–50	Mixed	ACLR	Hop test battery LSI ≥90% associated with 11% absolute reduction in 2nd ACL injury. Hop-and-hold quality test showed 15% risk reduction. Combined quantitative-plus-qualitative composite was not significantly predictive.
10	Stojanovic MDM et al. [31] (2023)	Interventional	22	19.9±4.4	F:8 M:14	ACL (BTB graft)	Eccentric-oriented flywheel training 2–3x/week for 6 weeks significantly improved leg strength, vertical jump, and hop performance versus traditional training in late-stage ACLR recovery.

Sr. No.	Author (Year)	Study Design	n	Age (mean±SD)	Gender	Injury/Surgery	Key Outcomes
11	Cronström A et al. [15] (2023)	Cross-sectional	143	25.0±5.7	F:72 M:73	ACLR	Lower knee strength, lower preinjury activity, more knee pain, earlier surgery, and higher fear of reinjury explained ~70% of variation in sports function at 12 months. Psychological readiness showed only weak association with physical function.
12	Ebert JR et al. [32] (2024)	RCT	112	30±5.7	F:52 M:52	ACLR (graft type)	HT and QT autograft groups showed similar PROMs, ROM, and joint stability. HT group had better ACL-RSI and quadriceps strength; QT group had greater hamstring strength. Hop test performance favored HT group.
13	Picot B et al. [33] (2024)	Prospective cohort	54	34.7±13	F:31 M:23	Lateral ankle sprain	Ankle-GO composite score <8 at 2 months predicted 9-fold increased recurrence risk (OR=8.6; 95% CI: 2–37.2). 33.3% experienced recurrent sprain within 2 years. AUC=0.75.
14	Lo Presti M et al. [34] (2024)	RCT	75	40.4±8.2	F:16 M:59	Arthroscopic partial meniscectomy	Both groups improved significantly. A single postoperative PRP injection did not significantly enhance recovery, pain relief, function, or return to sport at short-term follow-up.

Study Characteristics

The 14 included studies comprised seven randomized controlled trials, four prospective cohort studies, and three cross-sectional or interventional studies. Participants were young to middle-aged, ranging from 17.4 to 40.4 years, with a mean age of approximately 26 years. The pooled sample included approximately 1,430 athletes; more males than females were represented overall, though several studies enrolled exclusively female or male participants. Nine

studies examined recovery after ACL reconstruction, two addressed hamstring strain injuries, one evaluated lateral ankle sprain outcomes, one investigated arthroscopic partial meniscectomy, and one examined mixed traumatic knee injuries.

Quality Evaluation of the Included Studies

Methodological quality and risk of bias were assessed using the JBI critical appraisal checklists. RCTs were evaluated across 13 domains, while observational studies were assessed using the JBI checklist for analytical cross-sectional and cohort studies (8–11 items depending on design)

Table 2. Risk of Bias Assessment for RCTs Using Joanna Briggs Institute Criteria (1 = Yes/Met; 0 = No/Not Met)

Criteria	Jacobsen P et al. [22] (2016)	Swart NM et al. [24] (2019)	Hickey JT et al. [26] (2020)	Johnson JL et al. [27] (2020)	Stojanovic MDM et al. [31] (2023)	Ebert JR et al. [32] (2024)	Lo Presti M et al. [34] (2024)
True randomization used	1	1	1	1	1	1	1
Allocation concealed	1	1	1	1	1	1	1
Treatment groups similar at baseline	1	1	1	1	1	1	1
Blinding of participants	1	0	1	0	1	1	0
Blinding of person delivering treatment	0	0	1	0	0	0	0
Treatment groups treated identically	1	0	1	1	1	1	1
Blinding of outcome assessor	1	0	1	1	1	1	1
Outcome measured in same way	1	1	1	1	1	1	1
Outcome measured in reliable way	1	1	1	1	1	1	1
Follow-up complete	1	1	1	1	1	1	1
Participants analyzed in randomized group	1	1	1	1	1	1	1
Appropriate statistical analysis used	1	1	1	1	1	1	1

Criteria	Jacobsen P et al. [22] (2016)	Swart NM et al. [24] (2019)	Hickey JT et al. [26] (2020)	Johnson JL et al. [27] (2020)	Stojanovic MDM et al. [31] (2023)	Ebert JR et al. [32] (2024)	Lo Presti M et al. [34] (2024)
Appropriate trial design used	1	1	1	1	1	1	1
Total	12/13	8/13	13/13	11/13	12/13	12/13	11/13

Table 2 presents the risk of bias assessment for seven RCTs using JBI criteria. Scores ranged from 8/13 (Swart et al.) to 13/13 (Hickey et al.). Hickey et al. [26] achieved the highest methodological quality among included studies, with successful double-blinding of both participants and outcome assessors -an uncommon achievement in rehabilitation research. This study also achieved a PEDro score of 8/10. Blinding of the person delivering treatment was not achieved in any study except Hickey et al., a recognised limitation in exercise-based interventions where the nature of treatment is typically apparent to the treating therapist. All RCTs demonstrated strong methodological quality in randomisation, reliable outcome measurement, follow-up completeness, and statistical analysis.

Table 3. Risk of Bias Assessment for Observational Studies Using JBI Analytical Cross-Sectional/Cohort Checklists (+ = Yes/Met; - = No/Not Met; NA = Not Applicable)

Criteria	Ithurburn MP et al. [23] (2018)	Albano TR et al. [25] (2020)	Faleide AGH et al. [28] (2021)	King E et al. [29] (2021)	van Melick N et al. [30] (2022)	Cronström A et al. [15] (2023)	Picot B et al. [33] (2024)
Clear inclusion criteria defined	+	+	+	+	+	+	+
Study subjects and setting described in detail	+	+	+	+	+	+	+
Exposure measured in valid and reliable way	+	+	+	+	+	+	+
Objective, standard criteria used for measurement	+	+	+	+	+	+	+
Confounding factors identified	+	-	+	+	+	+	+
Strategies to deal with confounding factors stated	+	-	+	+	+	-	+

Criteria	Ithurburn MP et al. [23] (2018)	Albano TR et al. [25] (2020)	Faleide AGH et al. [28] (2021)	King E et al. [29] (2021)	van Melick N et al. [30] (2022)	Cronström A et al. [15] (2023)	Picot B et al. [33] (2024)
Outcomes measured in valid and reliable way	+	+	+	+	+	+	+
Appropriate statistical analysis used	+	+	+	+	+	+	+
Follow-up time sufficient (cohort only)	+	NA	+	+	+	NA	+
Follow-up complete / reasons for loss described	+	NA	+	+	+	NA	+
Strategies to address incomplete follow-up	-	NA	+	+	+	NA	-
Total	9/11	7/8	11/11	11/11	11/11	7/8	10/11

Table 3 presents the risk of bias assessment for seven observational studies using JBI analytical checklists. The prospective cohort studies by Faleide et al. [28], King et al. [29], and van Melick et al. [30] achieved perfect scores (11/11), reflecting well-defined cohorts, objective outcome measurement, adequate follow-up duration (two years each), high retention rates (80–85%), and appropriate strategies to address confounding. Picot et al. [33] scored 10/11, with the only limitation being incomplete reporting of strategies to address loss to follow-up. The cross-sectional studies by Albano et al. [25] and Cronström et al. [15] scored 7/8, with limitations in identifying and addressing confounding factors -a recognised design-inherent limitation of cross-sectional studies that cannot establish temporal causality. Ithurburn et al. [23] scored 9/11 as a prospective cohort with one weakness in strategies for incomplete follow-

up. Overall, the observational studies demonstrated strong methodological quality.

DISCUSSION

This systematic review of 14 studies evaluating RTS decision criteria after sports-related injuries highlights the effectiveness of different rehabilitation strategies and assessment approaches in promoting functional recovery and safe return to sport following ACL reconstruction and other lower limb injuries. The findings converge on three themes with direct clinical implications: the limitations of current strength-based and hop-based clearance criteria, the independent role of psychological readiness, and the emerging value of biomechanical movement quality assessment.

Stojanovic et al. [31] (2023) demonstrated that eccentric training using flywheel devices significantly enhanced leg strength, jump ability, and hop performance in professional athletes recovering from ACL injury. These

findings align with recent literature suggesting that eccentric loading enhances neuromuscular adaptation during late-stage ACLR rehabilitation. Ithurburn et al. [23] (2018) highlighted the importance of restoring quadriceps symmetry before return to sport, as it was associated with better hop performance and subjective knee scores one year after surgery -underscoring the value of objective strength benchmarks prior to clearance.

However, evidence from more recent studies challenges the sufficiency of standard strength and hop criteria. Van Melick et al. [30] found that passing the hop test battery (LSI $\geq 90\%$) was associated with an 11% absolute reduction in second ACL injury, and that a qualitative hop-and-hold assessment reduced risk by 15%. Critically, the combined quantitative-plus-qualitative composite was not significantly predictive, suggesting individual tests may carry more discriminatory information than aggregate pass/fail scores. Both Paterno et al. [14] and King et al. [29] demonstrated that athletes meeting conventional strength and hop criteria reinjured at rates comparable to those who did not meet them. A longitudinal meta-analysis of 23,360 participants has additionally shown that LSI based on hop distance may overestimate recovery because the contralateral limb itself changes during rehabilitation [35].

Psychological readiness emerged as a critical and largely independent factor in RTS outcomes. Albano et al. [25] (2020) and Cronström et al. [15] (2023) reported that fear of reinjury, lower preinjury activity levels, and early surgical intervention were associated with poorer functional outcomes at 12 months. Faleide et al. [28] provided the strongest evidence that ACL-RSI scores independently predicted actual return to pre-injury sport at two years, while conventional functional tests did not. This supports findings from Sonesson et al. [36] and a meta-analysis of 26 studies confirming that Kinesio

phobia is consistently associated with failure to return to pre-injury sport [37]. Despite this evidence, a review of clinical practice guidelines for RTS after ACL injury found that body function measures dominated (37.8% of criteria) while psychological readiness accounted for only 8.9% [16], indicating a substantial gap between evidence and practice.

King et al. [29] provided novel evidence that three-dimensional biomechanical analysis during unplanned change-of-direction tasks identified reinjury risk (AUC = 0.75), whereas strength and hop performance did not differentiate between reinjured and non-reinjured groups. The relevant biomechanical variables-greater knee flexion asymmetry, longer ground contact times, and frontal-plane asymmetry are not captured by standard clinical RTS batteries. While 3D motion capture is unavailable in most clinical settings, the Landing Error Scoring System (LESS), administrable using standard video recording, has demonstrated good reliability and may serve as a feasible clinical alternative [38].

The role of graft type was investigated by Ebert et al. [32] (2024), who found that both hamstring tendon and quadriceps tendon autografts offered similar outcomes in terms of joint stability and patient-reported measures, though strength imbalances persisted between groups. The value of perturbation training was evaluated by Johnson et al. [27], who found it did not significantly reduce second ACL injury risk in female athletes. Swart et al. [24] (2019) explored predictors of non-return to sport after various knee ligament injuries, demonstrating that clinical features predicted non-return with high accuracy (AUC 0.86) while MRI added no value echoing recommendations by Logerstedt et al. [39] who advocate for functional testing over imaging in RTS decisions.

Three studies addressed injuries beyond ACL reconstruction. Jacobsen et al. [22] demonstrated that clinical assessment predicted RTP time for hamstring injuries with high accuracy, while MRI contributed

minimally (8.6%). Hickey et al. [26] showed that allowing mild pain during hamstring rehabilitation produced more robust musculotendinous recovery (15% greater isometric strength, longer fascicle length) at the point of RTP clearance without increasing reinjury rates. Picot et al. [33] validated the Ankle-GO composite criterion for lateral ankle sprain, showing that scores below 8 at two months predicted a nine-fold increase in recurrence. Lo Presti et al. [34] found no benefit of adjunctive platelet-rich plasma injection for recovery after arthroscopic partial meniscectomy.

The Panther Symposium Consensus Group reached 100% agreement that purely time-based RTS decisions should be abandoned [9]. This review supports that position. However, time still matters: Beischer et al. [8] showed a seven-fold reinjury increase for return before nine months, and Piussi et al. [40] quantified that athletes who reinjured returned an average of 25 days earlier. The Aspetar clinical practice guideline [41] incorporates this dual perspective, recommending criterion-based progression with time-based minimum thresholds.

A clinician-friendly decision framework proposed by Yung et al. [42] offers a structured approach integrating physical, psychological, and contextual domains while accounting for cognitive biases that affect RTS decision quality.

Based on the synthesised evidence, RTS assessment should incorporate four domains: (1) physical performance, including strength symmetry, hop tests, and sport-specific capacity; (2) psychological readiness, assessed using validated instruments (ACL-RSI, Tampa Scale) at defined milestones; (3) movement quality, evaluated through landing assessment, hop-and-hold testing, or biomechanical screening where available; and (4) time-based thresholds, particularly the nine-month minimum following ACLR. Future research should prioritise long-term outcomes with minimum two-year follow-up, sex-stratified and sport-stratified analyses,

prospective validation of multidimensional test batteries against reinjury outcomes, and development of feasible clinical alternatives to three-dimensional biomechanical analysis.

CONCLUSIONS

This systematic review of 14 studies demonstrates that return-to-sport decisions after sports-related injuries should be based on a combination of physical performance, strength symmetry, neuromuscular control, psychological readiness, and biomechanical movement quality. Eccentric strength training and functional tests such as hop performance are effective in assessing recovery, while psychological factors including confidence and fear of reinjury independently influence outcomes. Clinical assessments are more informative than imaging for predicting safe RTS. Standard pass/fail RTS batteries using LSI thresholds alone have limited ability to discriminate reinjury risk and should be supplemented by psychological screening (ACL-RSI, Tampa Scale for Kinesiophobia) and movement quality evaluation.

A criterion-based, individualised approach combined with time-based minimum thresholds (nine months post-ACLR) is necessary to reduce reinjury risk and ensure successful return to sport. Standardised, sport-specific RTS protocols that integrate physical, psychological, and biomechanical domains require prospective validation in future research.

LIMITATIONS

Variability in study designs, sample sizes, injury types, and rehabilitation protocols introduced heterogeneity that limited direct comparisons and precluded meta-analysis. Lack of long-term follow-up (beyond two years) in several studies made it difficult to assess sustained return-to-sport outcomes and reinjury risk. Inconsistent assessment and reporting of psychological

readiness across studies reduced the ability to draw uniform conclusions about optimal psychological screening thresholds. Many studies focused on specific groups (e.g., elite or young male athletes), limiting generalisability to recreational, female, or older athletic populations. The predominance of ACL-focused studies limits applicability to other common sports injuries. Potential publication bias and English language restrictions may have excluded relevant unpublished or non-English studies..

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