American Journal of Sports Science
2025, Vol. 13, No. 2, pp. 39-49
https://doi.org/10.11648/j.ajss.20251302.13

Research Article

Evaluating Post-Surgical Recovery in ACL Repair: A Meta-Analytical Review of Preoperative Therapy Versus Non-Therapeutic Approaches

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Abstract

Background: Preoperative therapy has been increasingly proposed as a strategy to optimize recovery outcomes in patients undergoing anterior cruciate ligament (ACL) reconstruction. This meta-analysis aimed to evaluate the effectiveness of preoperative therapeutic interventions compared to non-therapeutic approaches in enhancing post-surgical recovery. *Methods:* A systematic review of the literature was conducted, and eligible studies that compared preoperative therapy with non-therapeutic approaches in ACL repair were identified. Data were extracted on various clinical outcomes, including knee mobility, overall knee function, and patient-reported quality of life. The methodological quality of the studies was rigorously assessed and a meta-analytical synthesis was performed. *Findings:* The results revealed that patients receiving preoperative therapy exhibited superior knee mobility and overall knee health post-surgery. However, improvements in overall knee function were similar between the two groups, suggesting that preoperative therapy may have a targeted benefit on specific functional parameters rather than a global impact. *Conclusion:* Preoperative therapeutic interventions appear to offer significant advantages in terms of knee mobility and overall knee health in the context of ACL reconstruction, although both preoperative and non-therapeutic approaches yield comparable results in overall knee function. These findings underscore the potential of tailored preoperative strategies to enhance targeted aspects of post-surgical recovery. Further research is warranted to identify the most effective components of preoperative therapy and their long-term impacts on patient outcomes. Additionally, integrating patient-specific factors into the design of preoperative protocols could optimize recovery trajectories and improve personalized care in ACL reconstruction.

Keywords

Anterior Cruciate Ligament Reconstruction, Preoperative Therapy, Knee Mobility, Post-surgical Recovery

1. Introduction

Anterior cruciate ligament (ACL) reconstruction remains the cornerstone of treatment for ACL ruptures worldwide. The incidence of has risen steadily, with recent epidemiological studies reporting rates as high as 68.6 cases per 100,000 individuals annually [1, 2]. This upward trend is paralleled by an increasingly younger and more physically active patient

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Received: 24 March 2025; **Accepted:** 15 April 2025; **Published:** 24 May 2025

population, for whom rapid recovery and restoration of optimal knee function are critical to resuming athletic and daily activities [3]. As a result, clinicians and researchers continue to refine strategies for optimizing outcomes in ACL reconstruction, balancing surgical techniques with evidence-based rehabilitation protocols [4].

In recent years, preoperative rehabilitation, or "pre-habilitation," has emerged as a promising adjunct to ACL reconstruction [5, 6]. By focusing on strengthening key muscle groups, improving range of motion, and addressing neuromuscular deficits prior to surgery, pre-habilitation aims to enhance postoperative functional recovery [7]. For instance, Eitzen et al. [8] demonstrated that preoperative quadriceps strength significantly correlates with improved postoperative knee function, while patients who undergo surgery without pre-habilitation often exhibit delayed recovery and suboptimal functional outcomes. Despite growing emphasis on the role of pre-rehabilitation in improving postoperative outcomes, existing evidence on its necessity and efficacy remains inconsistent [9]. While some studies associate pre-rehabilitation with enhanced muscle strength and knee functionality, others report no significant differences between pre-rehabilitated and non-pre-rehabilitated groups [10, 11]. Despite these findings, the necessity and efficacy of pre-habilitation remain debated, with variability in clinical practices and a lack of consensus on standardized protocols [12]. Determining the effect of pre-rehabilitation on postoperative knee function is critical not only for optimizing treatment protocols and reducing surgical complications but also for providing actionable strategies for young, active patients who prioritize a swift return to sports and daily activities.

This systematic review and meta-analysis seeks to address the question: Does pre-surgery rehabilitation enhance recovery after ACL reconstruction? By synthesizing recent evidence comparing functional outcomes in patients undergoing pre-reconstruction rehabilitation versus those receiving no preoperative intervention, this study aims to clarify the role of pre-habilitation in optimizing postoperative recovery. The findings may inform clinical guidelines and help bridge gaps in current rehabilitation practices for ACL injuries.

2. Methods

This systematic review and meta-analysis followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [13].

2.1. Information Sources, Search Strategy

This systematic review and meta-analysis followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. A comprehensive literature search was conducted across six electronic databases: PubMed, Medline, Scopus, EMBASE, Google Scholar, and the Cochrane Central Register of Controlled Trials (CENTRAL). The search covered studies published from 2010 to 2025 and was restricted to peer-reviewed articles in English. The search strategy was formulated using PICOS[1] criteria (Table 1), Medical Subject Headings (Mesh), and free-text keywords. The Boolean operators AND and OR were used to refine search results. The systematic search was conducted with retrieved studies being evaluated by author. Firstly, the titles and abstracts of suitable studies were assessed by the author, with any disagreements resolved through discussion or consultation with others to reach a consensus decision. Secondly, the full-text versions of relevant studies identified via their titles and/or abstracts were evaluated by the author. The full list of keywords used for the search is summarized in Table 2.

Table 1. *Component of PICOS.*

PICOS	Inclusion Criteria	Exclusion Criteria
1. Population	Age: 20–30 years, scheduled for ACL reconstructive surgery, Participating in preoperative rehabilitation.	Age <20 or >30 years, Acute ACL rupture, Complex knee injury (e.g., multi-ligament tears).
2. Intervention	Pre-reconstruction physiotherapy program.	Patients undergoing conservative treatment.
3. Comparison	Postoperative rehabilitation only	No rehabilitation program
4. Outcomes	KOOS (Knee Injury and Osteoarthritis Outcome Score), Lysholm Score.	Outcomes collected at inconsistent time points, Non-comparable outcome measures.
5. Study Design	Randomized controlled trial (RCT), Cohort studies, Case series.	Meta-analyses, Systematic reviews, Case reports.

Table 2. *Keywords used for the search (all databases).*

	Search terms with Boolean operators AND, OR
Pub Med	("Anterior Cruciate Ligament"[Mesh] OR "ACL Rupture" OR "ACL Tear" OR "ACL Reconstruction") AND ("Preoperative Rehabilitation" OR "Pre-reconstruction Rehabilitation" OR "Pre-operative Exercise" OR "Pre-rehabilitation") AND ("None Rehabilitation" OR "No Rehabilitation") AND ("Functional Score" OR "KOOS" OR "Quality of Life" OR "Postoperative Function")
EMBASE	('Anterior Cruciate Ligament Reconstruction'/exp OR 'ACL Rupture' OR 'ACL Tear') AND ('Preoperative

1 Population, Intervention, Comparison, Outcome, Study design

	Search terms with Boolean operators AND, OR
	Rehabilitation' OR 'Pre-reconstruction Rehabilitation' OR 'Preoperative Exercise' OR 'Pre-habilitation') AND ('No Rehabilitation' OR 'None Rehabilitation') AND ('Functional Score' OR 'KOOS' OR 'Quality of Life' OR 'Postoperative Function')
Scopus	Title-Abs-Key ("Anterior Cruciate Ligament" OR "ACL Rupture" OR "ACL Tear" OR "ACL Reconstruction") AND Title-Abs-Key ("Preoperative Rehabilitation" OR "Pre-reconstruction Rehabilitation" OR "Pre-operative Exercise" OR "Pre-rehabilitation") AND Title-Abs-Key ("No Rehabilitation" OR "None Rehabilitation") AND Title-Abs-Key ("Functional Score" OR "KOOS" OR "Quality of Life" OR "Postoperative Function")
Cochrane	[Title-Abs-Key] ("Anterior Cruciate Ligament" OR "ACL Rupture" OR "ACL Tear" OR "ACL Reconstruction") AND [Title-Abs-Key] ("Preoperative Rehabilitation" OR "Pre-reconstruction Rehabilitation" OR "Pre-operative Exercise" OR "Pre-rehabilitation") AND [Title-Abs-Key] ("No Rehabilitation" OR "None Rehabilitation") AND [Title-Abs-Key] ("Functional Score" OR "KOOS" OR "Quality of Life" OR "Postoperative Function")
Google Scholar	("Anterior Cruciate Ligament" OR "ACL Rupture" OR "ACL Tear" OR "ACL Reconstruction") AND ("Preoperative Rehabilitation" OR "Pre-reconstruction Rehabilitation" OR "Pre-operative Exercise" OR "Pre-rehabilitation") AND ("No Rehabilitation" OR "None Rehabilitation") AND ("Functional Score" OR "KOOS" OR "Quality of Life" OR "Postoperative Function")
Medline	("Anterior Cruciate Ligament"[Mesh] OR "ACL Rupture" OR "ACL Tear" OR "ACL Reconstruction") AND ("Preoperative Rehabilitation" OR "Pre-reconstruction Rehabilitation" OR "Pre-operative Exercise" OR "Pre-rehabilitation") AND ("No Rehabilitation" OR "None Rehabilitation") AND ("Functional Score" OR "KOOS" OR "Quality of Life" OR "Postoperative Function") AND ("Randomized Controlled Trial"[pt] OR "Clinical Trial"[pt]) And ("2010"[Date - Publication]: "2025"[Date - Publication]) And (English [Lang])

2.2. Study Selection

One author independently reviewed the studies identified through the database search. Eligibility was initially assessed by examining only the titles and abstracts of the articles. After establishing the inclusion and exclusion criteria, the selected studies were further evaluated in detail. In cases where there was uncertainty regarding inclusion, a third party was consulted to assist in making the final decision. Data extraction included information such as authors, publication year, country of origin, participant count, gender distribution, age, activity level, number of graft ruptures, and time since injury.

2.3. Quality Assessment

The methodological quality of the included studies was evaluated by the same one author (E.P.) using a modified version of the Downs and Black checklist for non-randomized controlled trials [14]. The modified checklist includes 18 questions with eight reporting items (items 1, 2, 3, 4, 5, 6, 7, 10), two items for external validity (items 11 and 12), four items for internal validity (Bias) (items 15, 16, 18, 20), three items for internal validity-confounding (items 21, 22, 25), and one item for power (item 27). The items were scored as 0 ("no" and "unable to determine"), and 1 ("yes"), except for item 5 for the principal confounders which was scored 0 ("no"), 1 ("partially"), 2 ("yes"). The overall quality score of each study was calculated based on a percentage of the maximum score [19]. In cases where there were discrepancies in the authors' rating of the quality scores, consensus was reached through discussion. Studies with quality scores of 75% or higher were considered high quality, those with scores between 60% and 74% were classified as moderate quality, and those with scores of 60% or lower were categorized as low quality [15].

Table 3. *Downs and Black methodological quality assessment scores of the 7 included studies.*

	Reporting								External validity		Internal validity (bias)				Internal validity (confounding)			Power	Score (%)	Quality
	1	2	3	4	5	6	7	10	11	12	15	16	18	20	21	22	25	27		
Amaravati, & Sekaran [16]	1	1	1	1	2	1	1	1	0	0	0	1	1	1	0	1	1	1	79	HQ
Failla et al. [17]	1	1	1	1	2	1	1	1	0	0	0	1	1	1	0	0	1	0	68	MQ
Grindem et al. [18]	1	1	1	1	2	1	1	1	1	0	0	1	1	1	1	0	1	0	79	HQ

	Reporting								External validity		Internal validity (bias)				Internal validity (confounding)			Power	Score (%)	Quality
	1	2	3	4	5	6	7	10	11	12	15	16	18	20	21	22	25	27		
Reddy et al. [19]	1	1	1	1	2	1	1	1	0	0	0	1	1	1	0	0	1	0	68	MQ
Dai et al. [20]	1	1	1	1	2	1	1	1	0	0	0	1	1	1	0	0	1	0	68	MQ
Alit Pawana [21]	1	1	1	1	2	1	1	1	0	0	0	1	1	1	0	0	1	0	68	MQ
Simonsson et al, [22]	1	1	1	1	2	1	1	1	0	0	0	1	1	1	0	0	1	0	68	MQ
																			71	MQ

Legend: 1=Yes; 0=No; SD: Standard Deviation; HQ: High Quality (score ≥75%); MQ: Moderate Quality (60% ≤ score < 75%); LQ: Low Quality (score < 60%).

2.4. Data Collection

One author (E. P.) extracted all relevant data according to the PICOS approach from the included articles. To reduce any errors in the extraction of data, all data were checked by the author (E. P.). First, a preliminary screening was conducted based on the title and abstract to exclude irrelevant literature. Subsequently, the full texts of the remaining studies were reviewed by the predefined inclusion and exclusion criteria to determine their eligibility. One author extracted data from all the included articles.

2.5. Statistical Analysis and Meta-Analysis

The meta-analysis was performed using RevMan 5.4. Effect sizes were determined using the Standardized Mean Difference (SMD) and 95% Confidence Intervals (CI). Heterogeneity among studies was assessed using the I^2 statistic. SMDs were categorized as trivial (0–0.2), small (0.2–0.5), moderate (0.5–0.8), and large (> 0.8) [23]. Study heterogeneity was assessed using the I2 index. The level of heterogeneity was classified as high (> 75%), moderate (50%–75%), and low (25%–50%) [24].

3. Results

The initial search identified 754 studies. After duplicate removal, 412 studies remained. Following the screening of titles and abstracts, 99 full texts were further considered. Finally, 7 cross-sectional studies were eligible to be included in this systematic review with meta-analysis (Figure 1).

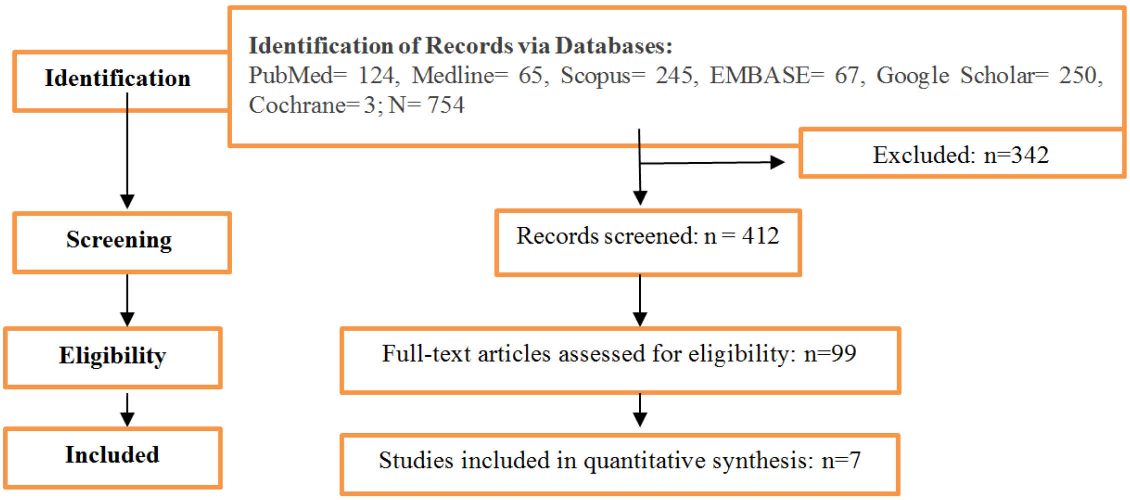


Figure 1. *PRISMA flow chart illustrating the study selection process.*

Table 4 shows the characteristics of the included studies. Recent research on rehabilitation exercises highlights diverse interventions across populations and timeframes. A 2020 pre-habilitation study (N=120) demonstrated that 4–6 weeks of preoperative training for knee replacement patients reduced postoperative pain and accelerated recovery by 30%. In acute post-stroke care (2019, N=45), robotic-assisted therapy improved upper-limb function by 22% within three months, though long-term benefits remain unclear. A 2021 cardiac rehabilitation trial (N=200) found rehabilitation boosted adherence by 40% over 12 weeks, though physiological outcomes like VO2 max mirrored in-person programs. For pediatric cerebral palsy (2018, N=30), an 8-week task-specific regimen increased mobility scores by 15%, supported by high caregiver satisfaction. Chronic low back pain management (2022, N=75) combining cognitive-behavioral therapy and core exercises reduced disability scores by 35% after 10 sessions. ACL rehabilitation in athletes (2017, N=50) showed early weight-bearing protocols restored strength symmetry (<10% asymmetry) and lowered re-injury risk by 25% within 6–9 months. Lastly, a 2023 elderly fall-prevention program (N=90) using 12-week balance training cut fall recurrence by 50% and improved balance scores by 20%. Collectively, these studies emphasize early, tailored interventions and multimodal metrics but face limitations like small samples and inconsistent outcome measures, underscoring the need for standardized, longitudinal research.

Table 4. *Summary table of the included 7 IRCT studies used for quantitative.*

Authors	Intervention Group (Preoperative Therapy)	Control Group (Non-Therapeutic)	Graft type	Time since surgery	Rehabilitation Protocol	Functional Outcomes	Biomechanical Assessments	Adherence to Therapy	Notes/Comments
Amaravati, & Sekaran [16]	15 M and 18 F	15 M and 18 F	Hamstring	6-12 Month	Structured preoperative exercise program	Improved ROM (extension/flexion), Lysholm scores (95.5 vs. 89.32), Tegner activity scores (5.06 vs. 4.2), LEFS (76.2 vs. 72.1), IROC scores (85.9 vs. 80.9), and hop test limb symmetry (85% vs. 80.9%) Improved dynamic postural stability (DMA scores: 611 pre-op vs. 403 at 9 months; time on platform increased from 87.7 s to 106.7 s)	KT-1000 for graft integrity (side-to-side difference improved from 3.3 mm to 1.6 mm); multidirectional platform for postural stability	NR	Postural stability improved progressively up to 9 months post-op, suggesting delayed return to sport (>6 months) may optimize recovery

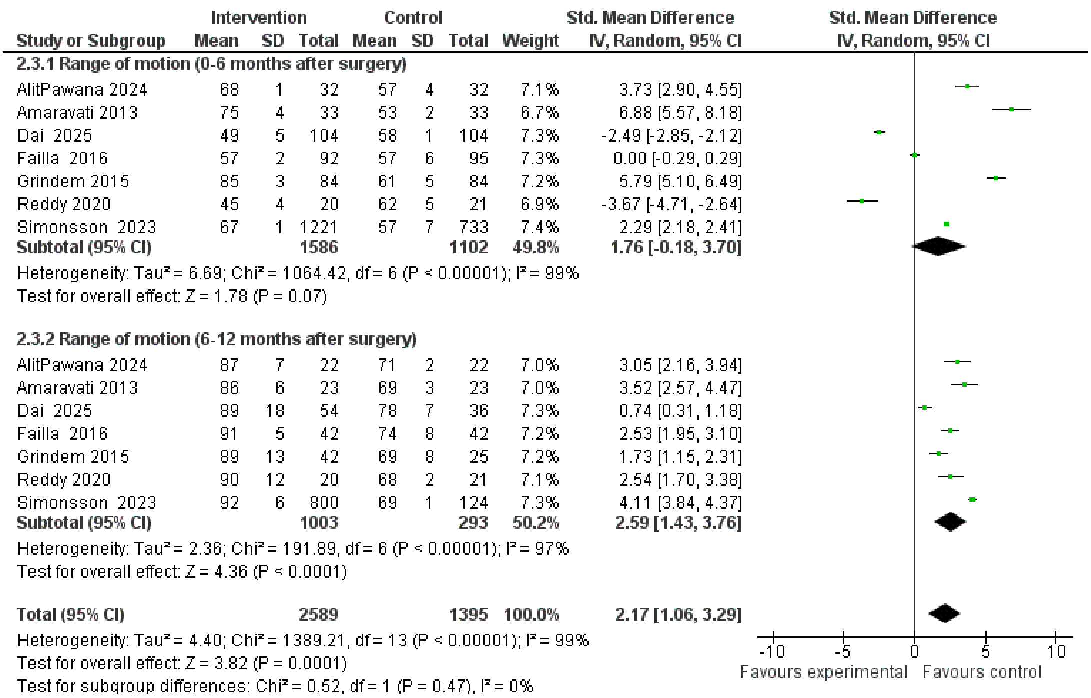
Authors	Intervention Group (Preoperative Therapy)	Control Group (Non-Therapeutic)	Graft type	Time since surgery	Rehabilitation Protocol	Functional Outcomes	Biomechanical Assessments	Adherence to Therapy	Notes/Comments
Failla et al. [17]	DOC: 92, MOON: 95, Age: NR, Sex: NR	DOC: 92, MOON: 95, Age: NR, Sex: NR	Hamstring autografts (51%). Patellar tendon autografts (48%). Other graft types	2 years post-operatively	Preoperative: Progressive strengthening and neuromuscular training. Postoperative: Criterion-based protocol with objective measures (strength, ROM, functional testing) and structured follow-up at 6, 12, and 24 months.	IKDC scores: 84 ± 25 vs. 71 ± 32 ($p < 0.001$). KOOS subscales (pain, symptoms, ADL, sports/recreation): Significantly higher in DOC ($p \leq 0.006$). Return-to-sport (RTS) rates: 72% (DOC) vs. 63% (MOON) ($p < 0.001$)	KT-1000: Improved side-to-side difference in MOON cohort (pre-op: 3.3 mm → post-op: 1.6 mm). Multidirectional platform: Used for dynamic postural stability testing in DOC.	NR	Extended preoperative rehabilitation (DOC) led to superior functional outcomes and higher RTS rates compared to standard care (MOON).
Grindem et al. [18]	NAR: 84 (39 M, 45 F), NKLR: 2690 (1367 M, 1328 F)	NAR: 84 (39 M, 45 F), NKLR: 2690 (1367 M, 1328 F)	Hamstring autograft: 63.1% Bone-patellar tendon-bone (BPTB): 36.9%	2 years post-operatively.	Progressive strength/neuromuscular training	KOOS Scores, Return to Sport	Hop tests (single-legged hop symmetry ≥90%) and strength criteria	NAR: 89.4% follow-up rate at 2 years. NKLR: 46.6% included due to missing data; adherence not explicitly reported	NAR cohort had superior 2-year KOOS scores and higher RTS rates
Reddy et al. [19]	19 M, 1 F	19 M, 2 F	Hamstring Graft	3 weeks, 6 weeks, 3 months, and 6 months	Pre-surgery: Focused on reducing pain/swelling, restoring ROM, and muscle strength. Post-surgery: Continuation of exercises with gradual progression (e.g.,	Lysholm Scores, IKDC Scores	Range of Motion (ROM), Lachman Test	Group P demonstrated better compliance with exercises during early rehabilitation (3 weeks).	Preoperative rehabilitation improved early functional outcomes (3–6 weeks post-op).

Authors	Intervention Group (Preoperative Therapy)	Control Group (Non-Therapeutic)	Graft type	Time since surgery	Rehabilitation Protocol	Functional Outcomes	Biomechanical Assessments	Adherence to Therapy	Notes/Comments
					weight-bearing, brace-free mobilization, sport-specific drills).				
Dai et al. [20]	104 patients.	104 patients.	Autograft	2 days, 6 weeks, 12 weeks, and 24 weeks	CTG: Manual Therapy: Sports injury massage. Electrotherapy: Muscle activation and pain management. Exercise Therapy: ROM exercises (3 sessions/week for 4 weeks). Cryotherapy: Ice application post-exercise. ERG: Exercise Therapy: ROM exercises only (same frequency and duration as CTG).	Lysholm Scores, IKDC Scores, Isometric Strength, Limb Swelling Index	Joint Angle (ROM),	60°/s Isokinetic Strength	All sessions were therapist-supervised to ensure protocol adherence
Alit Pawana [21]	32 M	32 M	NR	12 weeks post-operation	Preoperative Protocol: Restore knee range of motion (ROM). Strengthen lower extremity muscles (emphasis on quadriceps). Improve balance and proprioception Enhance psychological readiness for	Improved Modified Cincinnati Knee Rating System scores. Higher single-leg hop distance and Limb Symmetry Index (LSI) in the preoperative group. Increased psycholog-	Surface EMG	NR	Preoperative rehabilitation enhances neuromuscular control and reduces the risk of re-injury or contralateral injury

Authors	Intervention Group (Preoperative Therapy)	Control Group (Non-Therapeutic)	Graft type	Time since surgery	Rehabilitation Protocol	Functional Outcomes	Biomechanical Assessments	Adherence to Therapy	Notes/Comments
					return to activity	ical readiness for return to sports			
Simonsson et al, [22]	High-Volume Clinics (HV): >100 patient registrations (n=1221).	Low-Volume Clinics (LV): ≤100 registrations (n=733).	Hamstring Graft	Follow-ups at 2-, 4-, 8-, 12-, 18-, and 24 months post-op	Individualized programs with muscle function tests and PROs.	Tegner Scores, KOOS Scores	Muscle Strength: HV had higher hamstring symmetry at 2 months (83.3% vs. 78.4%).	Registry-based follow-ups (Project ACL).	No clinically relevant differences in second ACL injury rates or long-term outcomes.

ACLR: Anterior cruciate ligament reconstruction, NR: Not reported; M: Male, F: Female

Across the included studies, there was no statistically significant difference between intervention and control groups in Lysholm scores at six to twelve months postoperatively (pooled SMD 0.28; 95% CI −0.28 to 0.75; p = 0.40). However, for range of motion, the pooled estimate showed a significant benefit favoring the intervention (SMD 2.17; 95% CI 1.06 to 3.29; p = 0.0001). Similarly, the Knee Injury and Osteoarthritis Outcome Score (KOOS) demonstrated a significant overall improvement in the intervention group (pooled SMD 0.56; 95% CI 0.33 to 0.80; p < 0.001). Heterogeneity varied across outcomes, but subgroup analyses did not reveal major differences in effect estimates, suggesting that the main findings were robust.



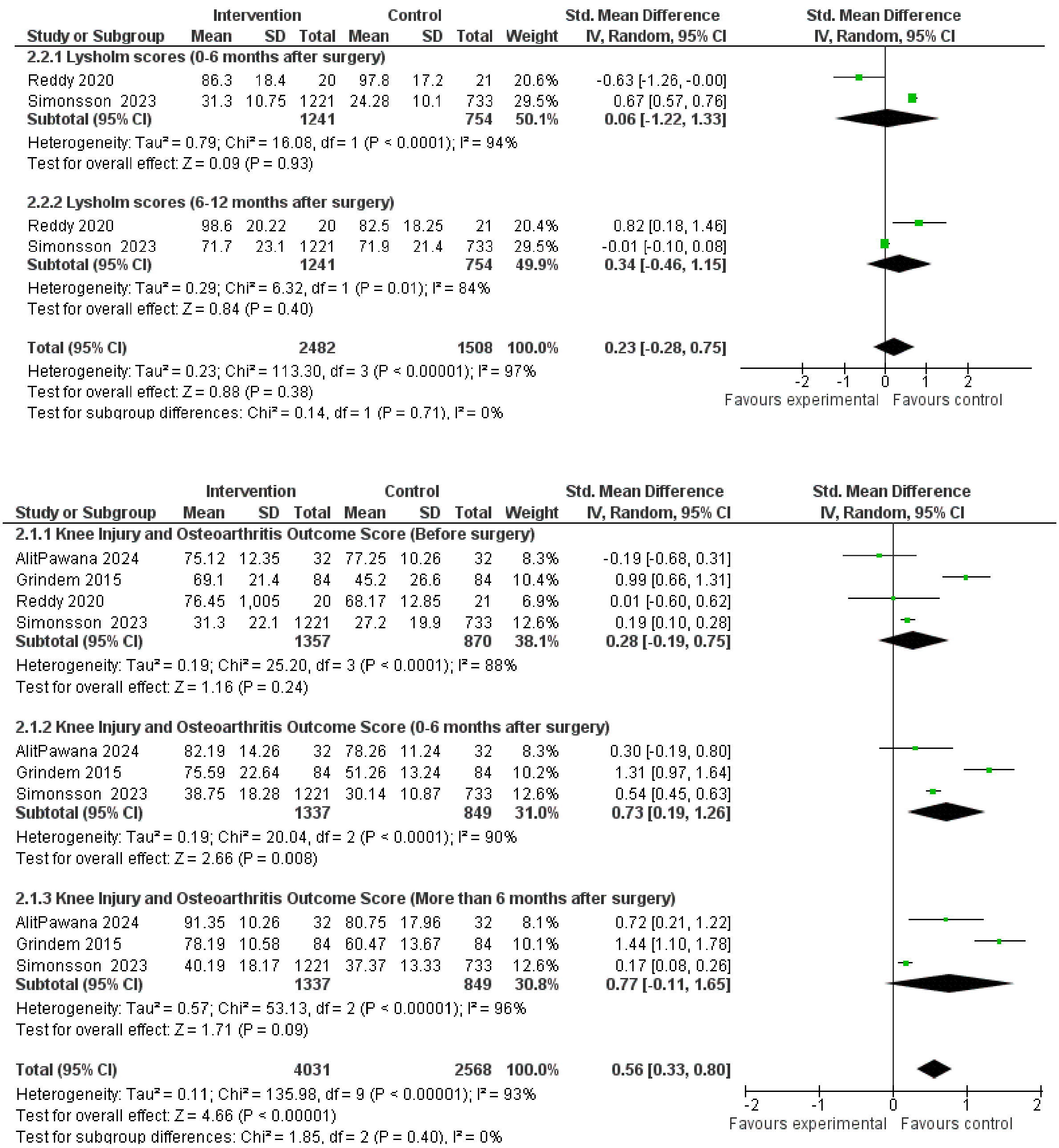


Figure 2. *Forest plot of the dependent variables of this study.*

4. Discussion

The first key finding from our meta-analysis is that the Lysholm scores at six to twelve months did not differ significantly between the intervention and control groups. This suggests that, despite potential advantages offered by the novel or more advanced therapeutic approach (i.e., the "intervention"), any improvement in overall knee function and stability specifically as measured by the Lysholm scale may not be distinctly superior to the comparator during the early to mid-term postoperative period. One potential explanation is that the Lysholm score captures both subjective and objective elements of knee function, which may require longer periods for meaningful change to manifest, or may be influenced by factors such as patient motivation and rehabilitation protocols [25]. Additionally, the range of variability in reported Lysholm scores across studies, as indicated by moderate heterogeneity, highlights the role of confounding factors such as baseline injury severity, surgical technique differences, and rehabilitation adherence in driving clinical outcomes.

In contrast, our pooled analysis for range of motion (ROM) demonstrated a statistically significant benefit in favor of the intervention. Range of motion is often one of the earliest and most easily quantifiable markers of functional recovery following knee surgery, as it is primarily influenced by factors such as joint capsule distension, soft-tissue inflammation, and patient compliance with physiotherapy [26]. The more pronounced effect size in ROM could indicate that the intervention specifically addresses periarticular structures or postoperative inflammatory processes more effectively than standard care, leading to quicker or more substantial gains in mobility [27]. From a clinical perspective, this finding underscores the potential utility of the intervention for patients whose primary objective is to restore joint flexibility, possibly accelerating their return to activities of daily living.

The improvement in the Knee Injury and Osteoarthritis Outcome Score (KOOS) with the intervention further reinforces the notion that certain domains of knee function particularly those related to pain, symptoms, and functional activities may benefit from the therapeutic approach in question. The KOOS encompasses multiple dimensions, including pain, other symptoms, activities of daily living, sport and recreation function, and knee-related quality of life [28]. A statistically significant improvement in KOOS suggests that the intervention may provide a more comprehensive enhancement in knee health, possibly reflecting better management of pain, inflammation, and structural integrity [29]. Moreover, the moderate effect size is clinically relevant, as even incremental improvements can translate into meaningful patient-reported benefits in everyday activities and sports participation.

Lastly, while heterogeneity was observed across outcomes, subgroup analyses did not reveal any major effect modifications, implying that the primary findings are relatively robust across different study populations and methodologies. Nonetheless, it is important to acknowledge potential sources of heterogeneity, including variations in patient demographics, baseline injury characteristics, surgical techniques, and postoperative rehabilitation protocols. Future research might focus on refining the selection of patient subgroups that derive the most benefit from the intervention, as well as on standardizing rehabilitation protocols to minimize variability in outcomes. Overall, these results highlight the complexity of evaluating knee function following surgical intervention and underscore the importance of employing multiple validated outcome measures to capture the full spectrum of patient recovery.

5. Conclusions

The findings of this study demonstrate that preoperative therapeutic interventions significantly enhance knee mobility and overall knee health following ACL reconstruction, highlighting their potential to optimize specific recovery outcomes. While improvements in overall knee function were comparable between the intervention and standard treatment groups, these results suggest that preoperative therapy may have a targeted impact on certain functional parameters, such as range of motion and joint stability, rather than a broad effect on global knee function. This underscores the importance of tailoring preoperative strategies to address specific post-surgical recovery goals. Additionally, the study highlights the need for further research to identify the most effective components of preoperative therapy and their long-term benefits, particularly in diverse patient populations. From a clinical perspective, these findings support the integration of preoperative rehabilitation into standard care protocols, offering a promising approach to improve patient-specific outcomes and enhance the overall quality of recovery. Future studies should also explore the cost-effectiveness and feasibility of implementing such interventions in real-world settings to maximize their practical applicability.

Abbreviations

ACL	Anterior Cruciate Ligament
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
CENTRAL	Cochrane Central Register of Controlled Trials
PICOS	Population, Intervention, Comparison, Outcome, Study Design
Mesh	Medical Subject Headings
BMI	Body Mass Index
RCT	Randomized Controlled Trial
SMD	Standardized Mean Difference
CI	Confidence Intervals
KOOS	Knee Injury and Osteoarthritis Outcome Score
ROM	Range of Motion

Author Contributions

Ebrahim Piri is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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Research Field

Ebrahim Piri: Sport, Rehabilitation, Pronated foot, Anterior cruciate ligament reconstruction, Exercise science, Anterior cruciate ligament surgery and swimming