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Effectiveness of Hydrotherapy on Low Back Pain: A Systematic Review and Meta-analysis

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A B S T R A C T

The aim of this study was to determine and compare the effects of hydrotherapy on pain and functional disability in patients with low back pain. This systematic review and meta-analysis was conducted based on randomized controlled trials. A comprehensive search was performed in PubMed, Cochrane Library, ScienceDirect, Scopus, and Google Scholar databases, yielding a total of 1,144 records. After removing duplicates, 920 studies remained for title and abstract screening, of which 850 were excluded due to irrelevance to the study objective. Ultimately, 6 eligible study reports, representing 5 independent randomized trial samples, were included in the systematic review. Six reports were included in the exploratory composite meta-analysis; however, two reports appeared to arise from the same parent trial sample and therefore the pooled estimate should not be interpreted as six fully independent trial effects. The results indicated that although several individual studies reported improvements in pain and functional outcomes following hydrotherapy, the pooled effect estimate from the random-effects model showed a non-significant effect in favor of hydrotherapy compared with control interventions (pooled effect size = -2.44; 95% CI: -5.88 to 1.00). Because the included studies used different pain and disability instruments, the pooled estimate should be interpreted as a composite effect estimate rather than a raw mean difference on a single clinical scale. Considerable heterogeneity was observed among the included studies (I^2 = 98.1%), indicating substantial variability in study populations, intervention protocols, treatment duration, and outcome measures. Egger's test (P = 0.07), Begg's test (P = 0.43), and visual inspection of the funnel plot did not show clear evidence of publication bias; however, because only 6 reports were included, these tests have limited power and cannot exclude undetected publication bias. Overall, although individual studies suggested potential improvements in pain and function among patients receiving hydrotherapy, the final meta-analysis did not demonstrate a statistically significant overall effect.

Keywords: *hydrotherapy; aquatic therapy; low back pain; systematic review; meta-analysis; randomized controlled trial*

1. Introduction

Low back pain is considered one of the most common musculoskeletal disorders worldwide and is recognized as a major cause of disability, reduced quality of life, and increased healthcare costs (1). This condition can negatively affect physical function, daily activities, psychological status, and occupational performance. According to global reports, the prevalence of low back pain has increased over recent decades and has become a major public health challenge in both developed and developing countries (2). The management of low back pain includes a wide range of pharmacological and non-pharmacological interventions. Despite the widespread use of anti-inflammatory medications and invasive procedures, concerns remain regarding their side effects, drug dependency, and limited long-term effectiveness. In recent years, increasing attention has been directed toward rehabilitation interventions and complementary approaches, including hydrotherapy (3). Hydrotherapy, also known as aquatic therapy, refers to a set of therapeutic exercises and interventions performed in water. By utilizing the physical properties of water, such as buoyancy, hydrostatic pressure, and uniform resistance, hydrotherapy may reduce stress on the spine and joints (4).

Several systematic reviews and clinical studies have suggested that aquatic exercise, hydrotherapy, swimming, or related water-based rehabilitation programs may reduce pain intensity, improve function, and support rehabilitation participation in patients with low back pain (1-6). However, swimming-related evidence is not uniformly favorable across all contexts; studies in elite swimming and fin-swimming populations suggest that aquatic exposure may also be associated with lumbar symptoms in specific sport settings (7, 8). Patient preferences, barriers, and enablers to swimming have also been reported among people with chronic low back pain (9). However, the existing evidence regarding the effectiveness of hydrotherapy remains inconsistent, with variations in intervention type, treatment duration, exercise intensity, and outcome assessment measures across studies. In addition, many previous studies have been limited by small sample sizes and methodological heterogeneity. Therefore, synthesizing the available evidence through a systematic review and meta-analysis may provide a more precise estimation of the effects of hydrotherapy on low back pain–related outcomes. Accordingly, the present study was conducted to evaluate the effectiveness of hydrotherapy on improving low back pain through a systematic review and meta-analysis of published studies.

2. Methods and Materials

This study was conducted as a systematic review and meta-analysis to investigate the effect of hydrotherapy on the improvement of low back pain. The study was designed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (10). The systematic search process covered English-language randomized controlled trials published from January 2015 to April 2026 and was last updated in April 2026. The databases searched were PubMed, Cochrane Library, ScienceDirect, Scopus, and Google Scholar. The same core search strategy was adapted to the syntax of each database using MeSH terms and free-text terms. The database yields were PubMed (n = 66), Cochrane Library (n = 11), ScienceDirect (n = 462), Scopus (n = 146), and Google Scholar (n = 459), giving 1,144 records before duplicate removal. After reviewing the keywords in the Medical Subject Headings (MeSH), the keywords were combined using Boolean operators as follows:

(("Hydrotherapy" OR "Aquatic Therapy" OR "Water Therapy" OR "Aquatic Exercise") AND ("Low Back Pain" OR "Chronic Low Back Pain" OR "Lumbar Pain" OR "Backache")) Filters: randomized controlled trials, English language, January 2015-April 2026. The Google Scholar records returned by the search were screened using the same eligibility criteria as the database records.

2.1. Eligibility criteria, study selection, and data extraction

After collecting the articles and documents, the study characteristics and abstracts were entered into reference management software, and duplicates were removed using the software as well as by manually screening the titles. Two-stage screening was performed: first by title and abstract, and then by full-text assessment. Irrelevant studies were excluded by reviewing the titles and abstracts. Then, the full texts of the remaining studies were assessed to ensure their eligibility for inclusion in the present study. In addition, the reference lists of the included studies were screened to

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identify further relevant articles. Moreover, for studies whose full texts were not accessible through databases, corresponding authors were contacted via email to obtain the full texts. The inclusion criteria were as follows: (1) randomized controlled trials (RCTs) published in English from January 2015 to April 2026, (2) studies conducted on patients with low back pain (acute, subacute, or chronic), (3) studies in which the intervention was hydrotherapy or aquatic exercise, and (4) studies reporting sufficient statistical data including sample size, mean, and standard deviation. Studies were excluded if they were non-randomized, observational, review articles, case reports, did not include a relevant aquatic intervention, did not report low back pain outcomes, or did not provide extractable quantitative data.

2.2. *Meta-analysis*

Meta-analysis was performed using a random-effects model (11). Continuous outcomes were extracted as post-intervention mean values, standard deviations, and sample sizes, or as change scores when reported consistently. Because the included trials used different measurement instruments, including VAS, ODI, and other disability scales, the pooled results were interpreted as standardized or composite effect estimates rather than as raw mean differences across non-identical scales. Pain and functional disability were extracted as separate clinical domains where possible. When a trial reported only one eligible outcome or when data were insufficient for two independent pooled analyses, the result was treated as a composite low-back-pain outcome and interpreted cautiously. For outcomes measured on different scales, standardized mean difference (SMD) is the appropriate pooled metric; mean difference (MD) should be retained only when outcomes are measured on the same scale. When multiple reports appeared to arise from the same parent randomized trial sample, they were treated as related reports rather than fully independent participant samples in the interpretation of the findings. Heterogeneity was assessed using Cochran's Q test ($P < 0.10$) and the I^2 statistic, with I^2 values greater than 50% considered substantial heterogeneity (12). Egger's regression test (13), Begg's rank correlation test (14), and visual inspection of funnel plots were used to explore potential publication bias, while recognizing the limited power of these tests when fewer than 10 studies are included.

2.3. *Quality assessment*

The Cochrane Risk of Bias 2 (RoB 2) tool was used to assess the methodological quality of the included randomized controlled trials (15). The assessment considered five domains: bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcome, and bias in selection of the reported result. Based on the available reporting, the included trials were generally judged as having some concerns rather than low certainty across all domains; no study was treated as definitively high risk of bias without sufficient information.

3. Findings and Results

A total of 1,144 records were identified through systematic searching in PubMed, Cochrane Library, ScienceDirect, Scopus, and Google Scholar. After removing 224 duplicate records, 920 studies remained for screening. Following title and abstract screening, 850 studies were excluded due to irrelevance to the study objective. The full texts of the remaining 70 studies were assessed for eligibility. Among these, 64 studies were excluded for the following reasons: non-randomized design, lack of relevant aquatic intervention, insufficient statistical data, or failure to meet the inclusion criteria. Finally, 6 eligible study reports, representing 5 independent randomized trial samples, were included in the systematic review and exploratory composite meta-analysis (Figure 1). Table 1 summarizes the characteristics of the included studies.

A total of 6 eligible study reports were included in the final exploratory composite meta-analysis evaluating the effectiveness of hydrotherapy on low back pain. These reports represented 5 independent randomized trial samples because the Montpetit (2026) and Vaillancourt (2026) reports appeared to arise from the same parent trial sample (16, 17). Therefore, the pooled estimate should be interpreted cautiously and should not be understood as a fully independent six-trial estimate. The pooled results from the random-effects model indicated a non-significant overall effect in favor of hydrotherapy compared with control

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interventions (pooled effect size = -2.44; 95% CI: -5.88 to 1.00). Because the included studies used different outcome instruments, the pooled result should be interpreted as a composite low-back-pain outcome rather than as a single raw mean difference on one clinical scale. Although the direction of the effect suggested a potential reduction in pain and disability in the hydrotherapy groups, the wide confidence interval crossing zero indicated that this difference was not statistically significant. Considerable heterogeneity was observed among the included studies (I^2 = 98.1%), reflecting substantial variability in study populations, intervention protocols, duration of treatment, control conditions, and outcome measures. The high level of heterogeneity suggests that the pooled estimate should be interpreted with caution. Overall, while several individual reports described improvements in pain and functional outcomes with hydrotherapy, the meta-analysis did not demonstrate a definitive statistically significant benefit (Figure 2).

Figure 1

PRISMA flow diagram of study identification, screening, eligibility assessment, and inclusion.

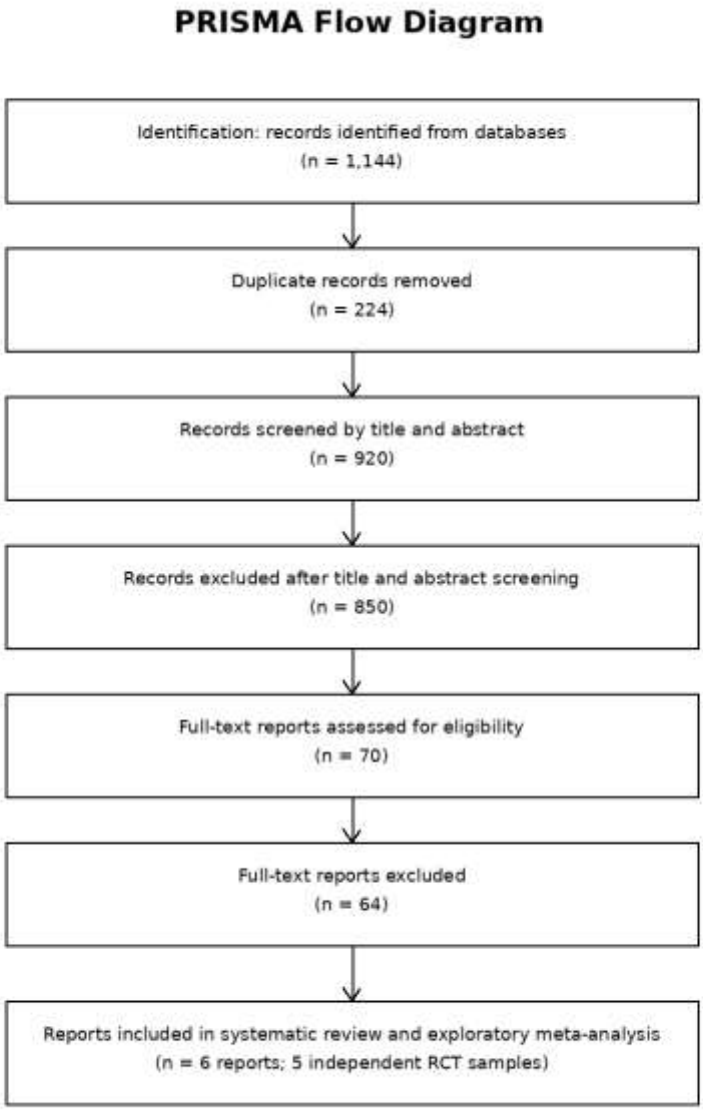

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Table 1

Characteristics and outcomes of included studies on hydrotherapy in low back pain

Study (Author, Year)	Country	Sample Size (n)	LBP type	Intervention	Outcome Measures	Control Group	Duration (weeks)	Findings
Qin (2026) (18)	China	36	CLBP	AE and hot spring bathing	VAS/ODI	AE	4 weeks	Greater improvement in combined therapy
Montpetit (2026) (16)	Canada	34	CLBP	AT	Disability scale	SC	10 weeks	Improved pain and function vs control; related report from the same parent trial sample as Vaillancourt (2026)
Vaillancourt (2026) (17)	Canada	34	CLBP	AT	Pain, disability, psychological outcomes	SC	10 weeks	Improved pain and function vs control; related report from the same parent trial sample as Montpetit (2026)
Peretro (2024) (19)	Brazil	26	CLBP	APh	Disability scale	EG	8 weeks	Significant reduction in pain and disability
Peng (2022) (20)	China	113	CLBP	AE	VAS/ODI	Physical therapy modalities	54 weeks	Significant reduction in pain and disability
Pires (2015) (21)	Portugal	62	CLBP	AE and education	VAS, disability scale	AE	6 weeks	Reduced pain at follow-up

Note. CLBP = chronic low back pain; AE = aquatic exercise; AT = aquatic therapy; APh = aquatic physiotherapy; VAS = Visual Analog Scale; ODI = Oswestry Disability Index; SC = standard care; EG = exercise group. Montpetit (2026) and Vaillancourt (2026) appear to be related reports from the same parent trial sample and should not be treated as fully independent participant samples (16, 17).

Figure 2

Forest plot of the exploratory composite effect estimate; estimates should be interpreted cautiously because the included reports used different outcome scales and two reports were related to the same parent trial sample.

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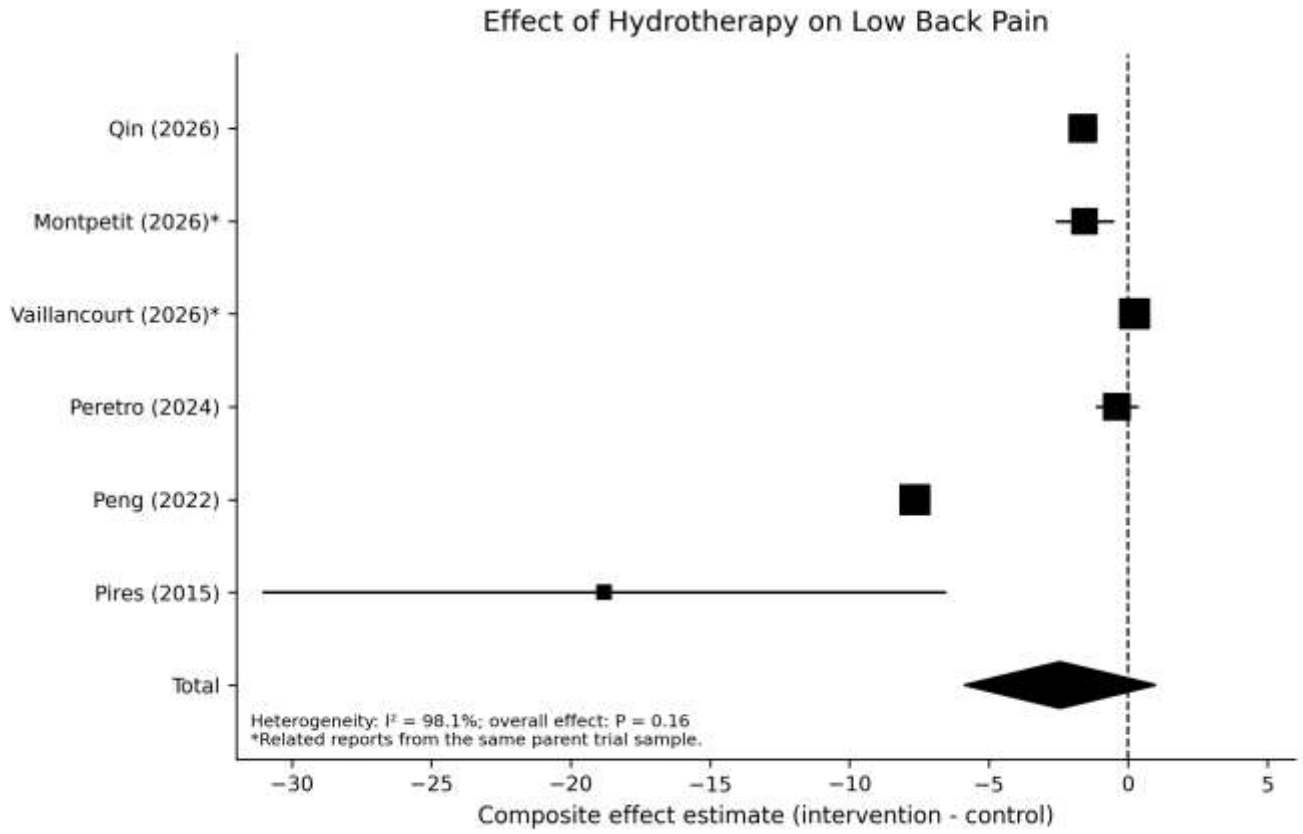

Table 2

Leave-one-out sensitivity analysis

Study excluded	Pooled composite effect estimate (95% CI)	I² (%)	Tau²
Qin (2026) (18)	-1.92(-4.10 to 0.27)	97.7	6.06
Montpetit (2026) (16)	-2.14(-4.43 to 0.15)	97.8	6.64
Vaillancourt (2026) (17)	-2.43(-4.57 to -0.30)	97.4	5.74
Peretro (2024) (19)	-2.25(-4.41 to -0.09)	97.7	5.89
Peng (2022) (20)	-0.729(-1.49-0.04)	82.8	0.63
Pires (2015) (21)	-2.22(-4.66 to 0.23)	97.7	7.57

Table 3

Subgroup analysis based on type of hydrotherapy and intervention duration

Subgroup	Studies	Pooled composite effect estimate (95% CI)	I² (%)	Interpretation
AE	Qin (2026), Peng (2022), Pires (2015) (18, 20, 21)	-1.74 (-3.41 to -0.70)	96.8	Favorable effect; high heterogeneity
AT	Montpetit (2026), Vaillancourt (2026) (16, 17)	-2.18 (-4.35 to -0.01)	96.8	Borderline favorable effect; high heterogeneity
APh	Peretro (2024) (19)	-2.30 (-4.42 to -0.18)	0	Favorable effect; single-study subgroup; no between-study heterogeneity estimable
<8 weeks (short-term)	Qin (2026), Peretro (2024), Pires (2015) (18, 19, 21)	-2.14 (-4.02 to -0.26)	96.4	Significant improvement; high heterogeneity
≥8 weeks (long-term)	Montpetit (2026), Vaillancourt (2026), Peng (2022) (16, 17, 20)	-1.21 (-3.02 to 0.60)	98.5	Non-significant; high heterogeneity

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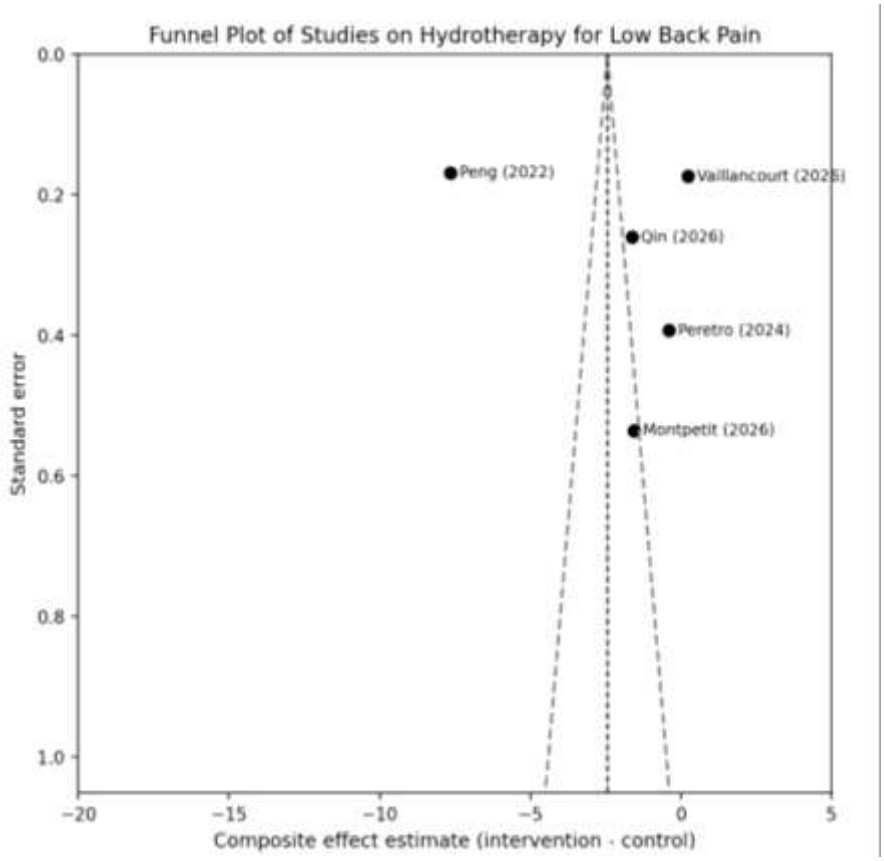
Figure 3

Funnel plot to detect possible publication bias; interpretation is limited because fewer than 10 reports were included.



4. Discussion and Conclusion

The present systematic review and meta-analysis investigated the effectiveness of hydrotherapy in patients with low back pain. The findings demonstrated that although several randomized controlled trial reports reported improvements in pain intensity and functional disability following aquatic interventions, the pooled analysis revealed no statistically significant overall effect compared with control interventions. Moreover, the extremely high heterogeneity (I^2 = 98.1%) highlights substantial variability among studies, limiting the certainty and generalizability of the results. These findings are generally consistent with previous low-back-pain evidence indicating that aquatic exercise may reduce pain and disability, while the certainty and consistency of the evidence remain limited (2, 22). Evidence from broader chronic musculoskeletal disorders also supports potential benefits of aquatic exercise, but such evidence should not be interpreted as direct proof of superiority for low back pain (23). Therefore, the present results suggest that hydrotherapy may be clinically useful for selected patients, particularly those who have difficulty tolerating land-based loading, but the current evidence does not justify concluding that hydrotherapy is superior to conventional exercise-based rehabilitation, which is consistent with current low-back-pain clinical guideline evidence (24)

A very high level of heterogeneity was observed among the included studies (I^2 = 98.1%). Such substantial heterogeneity is not uncommon in systematic reviews evaluating complex interventions such as hydrotherapy for chronic low back pain. This finding likely reflects important clinical and methodological differences across the included trials. In particular, variability in intervention protocols (e.g., hydrotherapy, aquatic exercise, hot water therapy), differences in treatment duration (ranging from 4 to 54 weeks), and heterogeneity in outcome measurement tools (including VAS, ODI, and other disability scales) may have significantly contributed to the observed inconsistency. Additionally, differences in patient characteristics, baseline

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pain severity, and types of control interventions further increase heterogeneity. According to the Cochrane Handbook for Systematic Reviews of Interventions, high statistical heterogeneity should lead to cautious interpretation of pooled estimates and encourage exploration of its potential sources through subgroup and sensitivity analyses, rather than relying solely on a single summary effect size (25). Therefore, in the present study, the pooled results were interpreted with caution, and additional analyses were performed to assess the robustness of the findings.

Despite the high heterogeneity, the direction of effect across most studies consistently favored hydrotherapy in terms of pain reduction and functional improvement, although statistical significance was not always achieved. In addition, because two included reports were related to the same parent trial sample, the effective number of independent trial samples was smaller than the number of eligible reports, which further limits certainty. Assessment of publication bias in the present study should be interpreted with caution due to the limited number of included studies. Although Egger's and Begg's tests were performed, it is well established that these statistical tests have low power when fewer than ten studies are available, and therefore their results may not reliably detect the presence of publication bias. In addition to these tests, a visual inspection of the funnel plot was conducted to further explore potential asymmetry (13, 14, 26). The funnel plot did not demonstrate clear evidence of asymmetry; however, given the small number of studies, this finding should be interpreted cautiously, and the possibility of undetected publication bias cannot be completely excluded (26). A further methodological limitation is the non-independence of two included reports derived from the same parent trial sample. This issue should be addressed in future updates by selecting one clinical effect per independent participant sample or by statistically combining correlated outcomes before pooling.

Overall, the available evidence suggests that hydrotherapy is a safe and potentially beneficial intervention for low back pain, particularly in patients who cannot tolerate weight-bearing exercises. However, its clinical effectiveness appears comparable, not clearly superior, to land-based exercise programs. Therefore, hydrotherapy should be considered an adjunct or alternative rehabilitation modality rather than a primary superior intervention. Future randomized controlled trials should use standardized protocols, prespecified pain and disability outcomes, transparent RoB 2 reporting, and long-term follow-up to clarify its precise clinical role.

Authors' Contributions

Masoumeh Sadat Mousavi and Fatemeh Naseri contributed to the conception and design of the study. Masoumeh Sadat Mousavi, Javad Salami, Marzieh Dowlatshahi, and Raziyeh Chabok contributed to screening, data extraction, and manuscript preparation. Fatemeh Naseri contributed to methodological revision, interpretation of findings, and final manuscript editing. All authors reviewed and approved the final manuscript.

Declaration

Language editing and formatting assistance were used during manuscript preparation. The authors reviewed, verified, and approved all scientific content and take full responsibility for the integrity and accuracy of the manuscript.

Transparency Statement

All data analyzed in this review were extracted from published studies included in the reference list. Additional extraction sheets or analysis files are available from the corresponding author upon reasonable request.

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None.

Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

This systematic review and meta-analysis used data from previously published studies and did not involve direct recruitment, intervention, or collection of new human

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participant data. The study was approved by the Ethics Committee of Shahrekord University of Medical Sciences (IR.SKUMS.REC.1401.164).

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