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

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1. Round 1

1.1 Reviewer 1

Reviewer:

In the Introduction, the sentence *“Hydrotherapy, also known as aquatic therapy, refers to a set of therapeutic exercises and interventions performed in water”* oversimplifies several distinct intervention categories. The authors should provide a more precise conceptual distinction between hydrotherapy, aquatic exercise, aquatic physiotherapy, aquatic rehabilitation, and balneotherapy because these interventions may have different mechanisms and therapeutic effects, which directly impacts the validity of pooling them in a meta-analysis.

Within the Methods section, the authors state that the review followed PRISMA guidelines. However, there is no mention of prospective registration in PROSPERO or another systematic review registry. The absence of protocol registration raises concerns regarding selective methodological decisions. The authors should report registration details or explicitly justify why the review was not prospectively registered.

In the search strategy paragraph, the restriction to studies published between January 2015 and April 2026 requires justification. Since hydrotherapy has been extensively investigated before 2015, excluding earlier randomized trials may introduce selection bias and limit the comprehensiveness of the evidence base. The rationale for this temporal restriction should be clearly articulated.

The search methodology lacks sufficient reproducibility. Although the authors provide a generic Boolean expression, database-specific search strings, field restrictions, truncation operators, and search dates are not reported. According to PRISMA 2020 recommendations, complete search strategies for each database should be included as supplementary material.

The reported heterogeneity of $I^2 = 98.1\%$ is extremely high and suggests substantial inconsistency among studies. Although subgroup and sensitivity analyses were performed, the manuscript does not adequately investigate sources of heterogeneity. Additional analyses such as meta-regression, influence diagnostics, or stratification by outcome type, intervention duration, or risk-of-bias level should be considered if data permit.

Table 2 (Leave-one-out Sensitivity Analysis) reveals a substantial reduction in heterogeneity when Peng (2022) is excluded (I^2 decreasing from 98.1% to 82.8%). This finding suggests that Peng (2022) may exert disproportionate influence on the pooled estimate. The authors should discuss potential methodological or clinical characteristics of this study that explain its influence.

Authors revised the manuscript and uploaded the updated document.

1.2 Reviewer 2

Reviewer:

The eligibility criteria paragraph specifies inclusion of studies reporting *"sample size, mean, and standard deviation."* However, several modern trials report adjusted estimates, change scores, standardized coefficients, or other effect metrics. The authors should explain whether attempts were made to derive missing statistics from available data and how studies lacking direct means and standard deviations were handled.

The data extraction procedures are insufficiently described. The manuscript does not indicate how many reviewers independently extracted data, whether disagreements were resolved by consensus or a third reviewer, and whether inter-rater agreement was assessed. These methodological safeguards should be reported to enhance confidence in the review process.

A major methodological concern appears in the Meta-analysis section. The manuscript repeatedly refers to a *"composite effect estimate"* while simultaneously discussing pain and disability outcomes. Because pain intensity and functional disability represent distinct clinical constructs measured on different scales, combining them into a single pooled estimate may violate meta-analytic assumptions. The authors should provide a detailed justification for this decision or perform separate meta-analyses for pain and disability outcomes.

The paragraph beginning with *"For outcomes measured on different scales, standardized mean difference (SMD) is the appropriate pooled metric"* acknowledges the methodological requirement for SMDs; however, the manuscript does not clearly state whether SMD or MD was ultimately calculated. The exact effect-size metric, formula, and software package used for analysis must be explicitly reported.

Regarding the RoB 2 assessment section, the statement *"the included trials were generally judged as having some concerns"* is insufficiently informative. Readers need a detailed risk-of-bias table showing judgments for each domain and each study. A graphical summary of risk-of-bias assessments should also be included to improve transparency.

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In the Results section, the PRISMA flow diagram reports exclusion of 64 full-text studies, but specific reasons and frequencies for exclusion categories are not provided. PRISMA standards require detailed reporting of exclusion reasons at the full-text stage, preferably within the flow diagram or supplementary material.

Table 1 contains substantial heterogeneity in intervention characteristics, including aquatic exercise, aquatic therapy, aquatic physiotherapy, and hot-spring bathing. These interventions differ considerably in theoretical basis and clinical application. The authors should discuss whether pooling these interventions is clinically justified and consider more refined subgroup analyses.

The paragraph reporting the pooled effect size of *"-2.44 (95% CI: -5.88 to 1.00)"* raises concerns regarding interpretability. Because different outcome measures were combined, the reported value lacks a clinically meaningful unit. The authors should explain how clinicians should interpret this magnitude and whether it reflects SMD units or another standardized metric.

Authors revised the manuscript and uploaded the updated document.

2. Revised

Editor's decision after revisions: Accepted.

Editor in Chief's decision: Accepted.

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