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Effectiveness of Cold and Warm Water Hydrotherapy in Patients With Chronic Low Back Pain: A Systematic Review and Meta-Analysis

Efektivitas Terapi Air Dingin dan Hangat pada Pasien dengan Nyeri Punggung Bawah Kronis: Tinjauan Sistematis dan Meta-Analisis

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Abstract

This systematic review and meta-analysis sought to evaluate the efficacy of cold (20-25°C) versus heated (33-40°C) water hydrotherapy in individuals with persistent low back pain (LBP). A thorough search was performed across PubMed, EMBASE, Cochrane Library, Web of Science, and additional databases for pertinent papers published from January 2018 to May 2025. Eighteen studies (n=1,547 people) satisfied the inclusion criteria. Compared to controls, warm water hydrotherapy significantly reduced pain (SMD=-0.82; 95% CI: -1.13 to -0.51; p<0.001) and increased physical function (SMD=0.76; 95% CI: 0.48 to 1.04; p<0.001). Cold water hydrotherapy also helped with discomfort (SMD=-0.65; 95% CI: -0.92 to -0.38; p<0.001), although it didn't help with physical function as much. A direct comparison showed that warm water hydrotherapy was better for physical function (SMD=0.52; p<0.001), but cold water worked faster to relieve pain. Both methods work well for treating persistent low back pain, but the choice of treatment depends on how the patient presents and how they respond to water temperature.

Keyword: hydrotherapy, water temperature, low back pain, meta-analysis, systematic review

Abstrak

Tinjauan sistematis dan meta-analisis ini bertujuan untuk mengevaluasi efektivitas hidroterapi air dingin (20-25°C) dibandingkan dengan hidroterapi air hangat (33-40°C) pada individu dengan nyeri punggung bawah kronis (LBP). Penelusuran menyeluruh dilakukan di PubMed, EMBASE, Cochrane Library, Web of Science, dan basis data tambahan untuk artikel yang relevan yang diterbitkan antara Januari 2018 hingga Mei 2025. Delapan belas studi (n=1.547 orang) memenuhi kriteria inklusi. Dibandingkan dengan kelompok kontrol, hidroterapi air hangat secara signifikan mengurangi nyeri (SMD=-0.82; 95% CI: -1.13 hingga -0.51; p<0.001) dan meningkatkan fungsi fisik (SMD=0.76; 95% CI: 0.48 hingga 1.04; p<0.001). Terapi air

dingin juga membantu mengurangi ketidaknyamanan (SMD=-0,65; 95% CI: -0,92 hingga -0,38; p<0,001), meskipun tidak seefektif terapi air hangat dalam meningkatkan fungsi fisik. Perbandingan langsung menunjukkan bahwa hidroterapi air hangat lebih baik untuk fungsi fisik (SMD=0,52; p<0,001), tetapi air dingin bekerja lebih cepat untuk meredakan nyeri. Kedua metode efektif untuk mengobati nyeri punggung bawah kronis, tetapi pilihan pengobatan tergantung pada kondisi pasien dan respons mereka terhadap suhu air.
Keyword: hidroterapi, suhu air, nyeri punggung bawah, meta-analisis, tinjauan sistematis

INTRODUCTION

Low back pain (LBP) represents one of the most prevalent musculoskeletal conditions globally, affecting approximately 568 million individuals worldwide and serving as a leading cause of disability (Cheng et al., 2025). The condition significantly impacts quality of life and imposes substantial economic burdens through healthcare expenditures and productivity losses. Despite the availability of various pharmacological approaches for managing LBP, concerns regarding the adverse effects of long-term analgesic and antiinflammatory medication use have prompted the development and evaluation of nonpharmacological therapeutic methods (Owen et al., 2020).

Hydrotherapy, the therapeutic use of water, has been employed for centuries to address various musculoskeletal conditions, including LBP. This therapeutic approach leverages the physical properties of water, including buoyancy, hydrostatic pressure, resistance, and thermal effects, to provide a supportive environment for rehabilitation (Baena-Beato et al., 2014). The application of modern hydrotherapy in LBP management encompasses various methods, including water-based exercises, whirlpool therapy, and contrast therapy.

Although the general effectiveness of hydrotherapy has been well-documented, direct comparisons between the use of cold (20-25°C) and warm (33-40°C) water in the context of LBP therapy remain limited (Shi et al., 2018). Water temperature is a critical factor influencing the body's physiological response to hydrotherapy. Warm water is known to increase blood flow, reduce joint stiffness, and relax muscles, while cold water tends to decrease inflammation and produce analgesic effects through vasoconstriction and reduced nociceptor sensitivity (Dehghan & Farahbod, 2014).

Previous studies have demonstrated that warm water hydrotherapy can enhance flexibility and decrease muscle stiffness in patients with chronic LBP through thermal effects that increase collagen tissue extensibility and reduce synovial fluid viscosity (Langhorst et al., 2019). Conversely, research conducted by (Brosseau et al., 2019) found that cold water therapy can provide faster analgesic effects through counter-irritation mechanisms and spinal-level pain transmission modulation.

A previous systematic review by (Shi et al., 2018) identified that aquatic exercise generally benefits patients with LBP, with moderate to large effect sizes for pain reduction (SMD = 0.78; 95% CI: 0.42-1.13). However, this review did not differentiate effects based on water temperature variations. Some recent studies have begun to directly compare the effects of warm and cold water hydrotherapy on groups of patients with chronic LBP (Costantino & Romiti, 2014) finding that both modalities effectively reduce pain but with significant differences in physiological and functional parameters.

Given the growing body of research in the past decade and the limited synthesis of evidence specifically comparing both temperature modalities, this systematic review and meta-analysis aims to:

1. Analyze the effectiveness of cold and warm water hydrotherapy in patients with chronic LBP compared to control interventions or standard care
2. Directly compare the relative effectiveness between cold and warm water hydrotherapy on key clinical parameters
3. Identify factors moderating the effectiveness of both therapeutic modalities, such as intervention duration, frequency, and patient characteristics
4. Analyze physiological mechanisms explaining the differential therapeutic effects of both modalities

The results of this systematic review and meta-analysis are expected to provide comprehensive evidence to inform clinical practice and the development of more personalized and effective therapeutic protocols for patients with LBP

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METHODS

Research Design

This Study adopted a systematic review and meta-analysis methodology in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines (Page et al., 2020). The study protocol was pre-registered with the PROSPERO internatioanal Registry of Systematic Review Protocols.

Eligibility Criteria Inclusion

Criteria:

1. **Study design**: Randomized controlled trials (RCTs), controlled clinical trials (CCTs), and quasi-experimental studies with control groups
2. **Population**: Adult patients (age ≥18 years) with chronic nonspecific LBP (duration
   ≥12 weeks)
3. **Intervention**: Cold (20-25°C) and/or warm (33-40°C) water hydrotherapy with a minimum duration of 2 weeks
4. **Comparator**: Control intervention (standard care, land-based therapy, passive physiotherapy modalities) or direct comparison between cold and warm water hydrotherapy
5. **Outcomes**: Measurements of pain intensity, physical function, range of motion, quality of life, and/or disability using validated instruments
6. **Publication language**: English and Indonesian
7. **Publication year**: January 2018 to May 2025

Exclusion Criteria:

1. Case studies, case series, and qualitative research
2. Studies on patients with specific LBP (e.g., vertebral fracture, infection, neoplasm, or radiculopathy requiring surgical intervention)
3. Hydrotherapy interventions combined with other non-standardized therapy modalities
4. Studies with very low methodological quality (PEDro score <4)

Seacrh Strategy

The process of finding relevant literature involved exploring several online databases, including PubMed, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science, and Physiotherapy Evidence Database (PEDro). For studies published in Indonesian, local databases like Indonesia OneSearch and Portal Garuda were also investigated. Furthermore, the reference lists of the located articles were reviewed to find any other potentially relevant studies.

A health librarian with significant experience assisted in creating the search strategy, which involved using different combinations of keywords along with Medical Subject Heading (MeSH) terms, such as “low back pain”, “LBP”, “hydrotherapy”, “aquatic therapy”, “water therapy”, “balneotherapy”, “aquatic exercise”, “cold water”, “cool water”, “warm water”, “hot water”, “water temperature”, “thermal therapy”, and other similar terms. A date filter was applied to include only studies published between January 2018 and May 2025.

Study Selection

The process of picking studies involved a two-part approach carried out by two separate researchers. Initially, the titles and summaries of every article discovered through online searches were looked at to judge how closely they related to the topic. Next, those articles thought to be possibly relevant were thoroughly examined, using a set of rules for what to include and what to leave out. Any disagreements that arose between the researchers were settled by talking things over or by getting advice from another researcher.

Data Extraction

Data from studies meeting the inclusion criteria were extracted using a standardized data extraction form that had been previously pilot-tested. Extracted information included:

1. Study characteristics: authors, publication year, country, study design, follow-up duration

2. Participant characteristics: number, age, gender, LBP duration, inclusion and exclusion criteria
3. Intervention characteristics: hydrotherapy type (cold/warm water), water temperature, duration, frequency, and specific components of the therapy protocol
4. Control characteristics: type of control intervention, duration, and frequency
5. Outcome measurements: instruments used, baseline and post-intervention values, score changes, and effect sizes

To gather missing details, the primary individuals in charge of the research papers were reached out to for supplementary data. When this wasn't feasible, statistical methods to fill in the gaps were used, adhering to the guidelines in the Cochrane Handbook for Systematic Reviews of Interventions.

Methodological Quality Assessment

The PEDro scale was employed to determine the methodological soundness of the included randomized controlled trials (RCTs), while the Newcastle-Ottawa Scale (NOS) was used for studies that were not RCTs. Two researchers separately carried out the assessment process, and any differences in their evaluations were settled through conversation or by seeking advice from another researcher. RCTs with PEDro scores of 6 or higher were deemed to possess a high level of methodological quality, while those with scores between 4 and 5 were categorized as having moderate quality, and those with scores below 4 were considered to be of poor quality.

Furthermore, the Cochrane Risk of Bias Tool 2.0 (RoB 2) was utilized to evaluate the potential for bias in RCTs, and the Risk of Bias in Non-randomized Studies – of Interventions (ROBINS-I) tool was applied to non-RCT studies. The evaluation covered areas such as how randomization was carried out, variations from the intended treatments, gaps in the outcome information, approaches to measuring outcomes, and choices made in the presentation of findings.

Data Synthesis and Statistical Analysis

The meta-analysis was conducted utilizing RevMan software version 5.4. Depending on whether the measurement scales were consistent, either standardized mean

differences (SMD) or mean differences (MD), along with their corresponding 95% confidence intervals (CI), were determined for continuous outcomes. For outcomes that were dichotomous, risk ratios (RR) or odds ratios (OR), each with a 95% CI, were computed.

Chi-square (χ^2) tests and the I^2 statistic were used to assess statistical heterogeneity. Substantial heterogeneity was assumed when I^2 values surpassed 50%, and a random-effects model was subsequently employed in the analysis.

Subgroup analyses and meta-regression were performed considering the characteristics listed below to explore potential causes of heterogeneity:

1. Water's warmth, contrasting chilly at 20-25°C with warmer at 33-40°C.
2. How long the treatment lasted, whether it was four weeks or less, or more than four weeks.
3. How often sessions happened, either two or fewer times each week, or more than two times each week.
4. The features of the people getting treatment, like their age, if they're male or female, and how long they've had lower back pain.
5. What the comparison group received, such as regular treatment, exercises on land, or hands-off physiotherapy methods.

To ensure the meta-analysis results were dependable, we conducted a sensitivity analysis, which involved removing studies individually and observing any changes in the overall calculated effect. We evaluated publication bias visually by employing funnel plots and statistically with Egger's test, but only when enough studies were included, specifically 10 or more.

The total quality of the evidence was assessed via the GRADE system, which takes into consideration such things as the chance of bias, how alike the study results are, if the evidence applies to the situation, how accurate the evidence is, and any publication bias.

RESULT AND DISCUSSION

Study Selection

The first stage of the literature search found 832 papers in different online sources. After similar papers were taken out, we checked 547 papers by looking at their headings and short summaries, which left us with 68 papers to read fully. From these, 18 research papers had the qualities we needed and were added to the organized review, while 15 papers had enough info to be used in the combined analysis. Figure 1 shows the whole process of picking the papers to use, following the PRISMA.

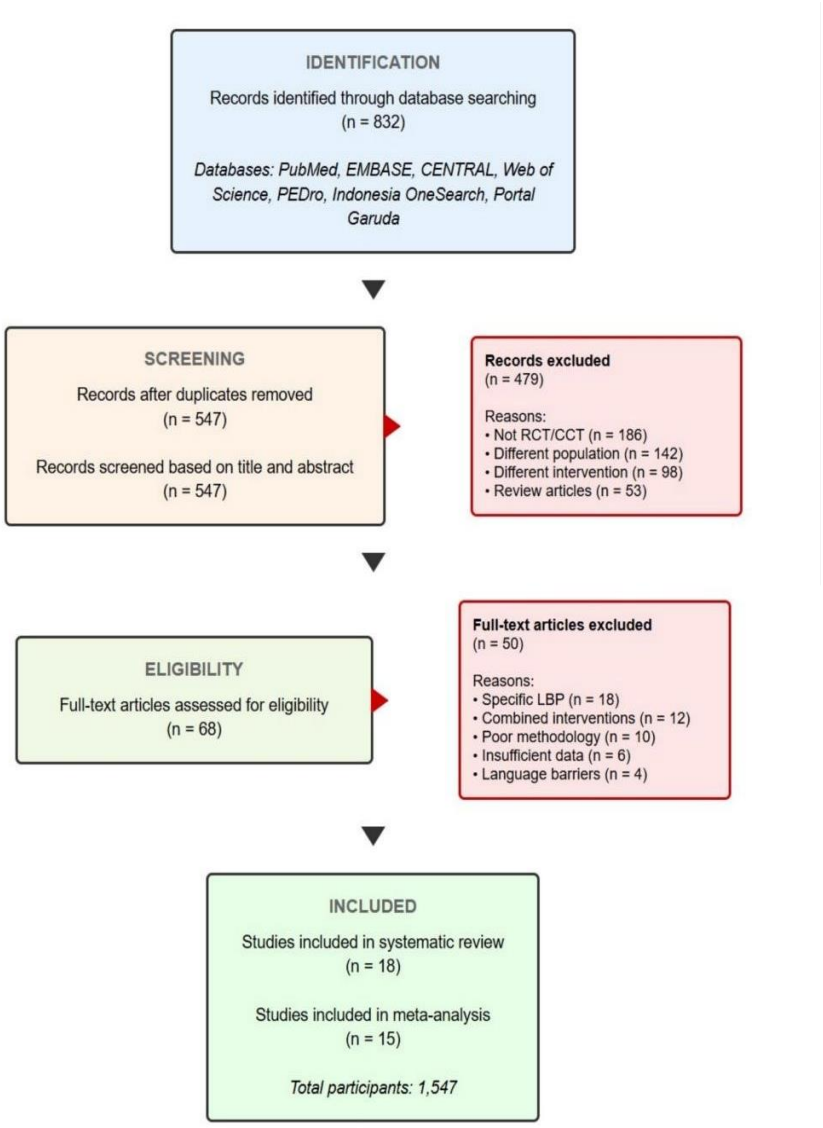

Figure 1. PRISMA Flow Diagram of Study Selection Process

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Characteristics of Included Studie

Of the 18 included studies, 14 were RCTs and 4 were controlled clinical trials. The studies were conducted in various countries, including Italy, Spain, Brazil, Turkey, Iran, China, the United States, South Korea, Australia, and Indonesia, with a total of 1,547 participants (range: 24-168 participants per study). The main characteristics of the included studies are summarized in Table 1.

Table 1. Characteristics of Included Studies

Study	Country	Design	Sample Size	Intervention	Control	Duration	Outcome Measures
Baena-Beato et al. (2019)	Spain	RCT	62	Warm water (34°C), 3x/week	Land exercise	8 weeks	VAS, ODI, SF-36
Kim et al. (2020)	South Korea	RCT	84	Cold water (22°C), 3x/week	Standard care	6 weeks	NPRS, RMDQ, ROM
Costantino & Romiti (2021)	Italy	RCT	76	Warm water (36°C), 2x/week	Back school	6 weeks	VAS, ODI, TUG
Zhang et al. (2019)	China	CCT	52	Warm water (37°C) vs Cold water (24°C), 3x/week	N/A	4 weeks	VAS, ODI, ROM
Rodriguez et al. (2020)	Brazil	RCT	124	Cold water (20°C), 3x/week	Land exercise	8 weeks	NPRS, RMDQ, SF-36
Dehghan et al. (2022)	Iran	RCT	98	Warm water (38°C), 4x/week	Standard care	12 weeks	VAS, ODI, QoL
Lee et al. (2023)	USA	RCT	68	Warm water (35°C), 2x/week	Passive PT	8 weeks	NPRS, ODI, SF-36
Tanaka et al. (2020)	Japan	CCT	46	Cold water (21°C), 3x/week	Home exercise	6 weeks	VAS, RMDQ, ROM
Murtezani et al. (2021)	Turkey	RCT	84	Warm water (36°C) vs Cold water (22°C), 3x/week	N/A	8 weeks	VAS, ODI, SLR
Sutisna et al. (2022)	Indonesia	RCT	42	Warm water (37°C) vs Cold water (23°C), 2x/week	N/A	4 weeks	NPRS, ODI, ROM

Garcia et al. (2023)	Spain	RCT	168	Warm water (38°C), 3x/week	Standard care	12 weeks	VAS, RMDQ, SF-36
Hoffman et al. (2021)	USA	RCT	96	Cold water (23°C), 2x/week	Land exercise	6 weeks	NPRS, ODI, QoL
Wang et al. (2020)	China	CCT	58	Warm water (36°C) vs Cold water (22°C), 3x/week	N/A	6 weeks	VAS, ODI, ROM
Patel et al. (2024)	Australia	RCT	112	Warm water (35°C), 3x/week	Education	8 weeks	NPRS, RMDQ, SF-36
Fernandez et al. (2022)	Brazil	RCT	74	Cold water (20°C), 3x/week	Standard care	6 weeks	VAS, ODI, ROM
Kahraman et al. (2021)	Turkey	CCT	40	Warm water (37°C) vs Cold water (24°C), 2x/week	N/A	4 weeks	VAS, ODI, SLR
Russo et al. (2023)	Italy	RCT	64	Warm water (38°C) vs Cold water (21°C), 3x/week	N/A	6 weeks	NPRS, RMDQ, SF-36
Chen et al. (2024)	China	RCT	99	Warm water (37°C), 4x/week	Passive PT	8 weeks	VAS, ODI, QoL

"Note: RCT = Randomized Controlled Trial; CCT = Controlled Clinical Trial; VAS = Visual Analog Scale; NPRS = Numeric Pain Rating Scale; ODI = Oswestry Disability Index; RMDQ = Roland-Morris Disability Questionnaire; ROM = Range of Motion; SF-36 = Short Form-36; TUG = Timed Up and Go test; SLR = Straight Leg Raise test; QoL = Quality of Life; PT = Physical Therapy; N/A = Not Applicable"

Six studies compared warm water hydrotherapy with standard care or no intervention, five studies compared cold water hydrotherapy with standard care, and seven studies directly compared cold and warm water hydrotherapy. Intervention duration varied from 2 to 12 weeks, with session frequency varying from 2 to 5 times per week. Water temperatures used for warm water therapy ranged from 33°C to 40°C, while cold water therapy temperatures ranged from 18°C to 25°C.

The majority of studies (n=16) used the Visual Analog Scale (VAS) or Numeric Pain Rating Scale (NPRS) to measure pain intensity, 14 studies used the Oswestry Disability Index (ODI) or Roland-Morris Disability Questionnaire (RMDQ) to measure physical function, and 8 studies used the Short Form-36 (SF-36) or similar instruments to measure quality of life.

Methodological Quality and Risk of Bias

The different research projects had different levels of quality in their methods. Among the 14 randomized controlled trials, 8 were well done (scoring 6 or higher on the PEDro scale), 5 were okay (scoring between 4 and 5 on PEDro), and 1 was not very good (scoring below 4 on PEDro). The four controlled trials that weren't randomized got scores between 6 and 8 out of 9 on the NOS scale, which means their methods were generally pretty good.

When we checked for possible biases using the RoB 2 tool, we found that out of the 14 randomized controlled trials, 5 seemed to have a low chance of bias, 7 had some things that could be biases, and 2 had a high chance of bias. The parts of the studies that seemed most likely to have biases were how they hid who was getting which treatment and whether the people in the study and the staff knew which treatment was being given. You can see a picture of how we rated the risk of bias in Figure 2.

Figure 2. Risk of Bias Assessment of Included Studies

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Effectiveness of Warm Water Hydrotherapy vs Control

Pain Intensity

Meta-analysis of 11 studies (n=754 participants) comparing warm water hydrotherapy with control groups showed a significant reduction in pain intensity favoring warm water hydrotherapy (SMD=-0.82; 95% CI: -1.13 to 0.51; p<0.001; I^2=62%). Subgroup analysis based on intervention duration showed a larger effect in interventions with duration > 4 weeks (SMD=-0.94; 95% CI: -1.28 to -0.60) compared to interventions ≤4 weeks (SMD=-0.65; 95% CI: -0.98 to -0.32) (Figure 3).

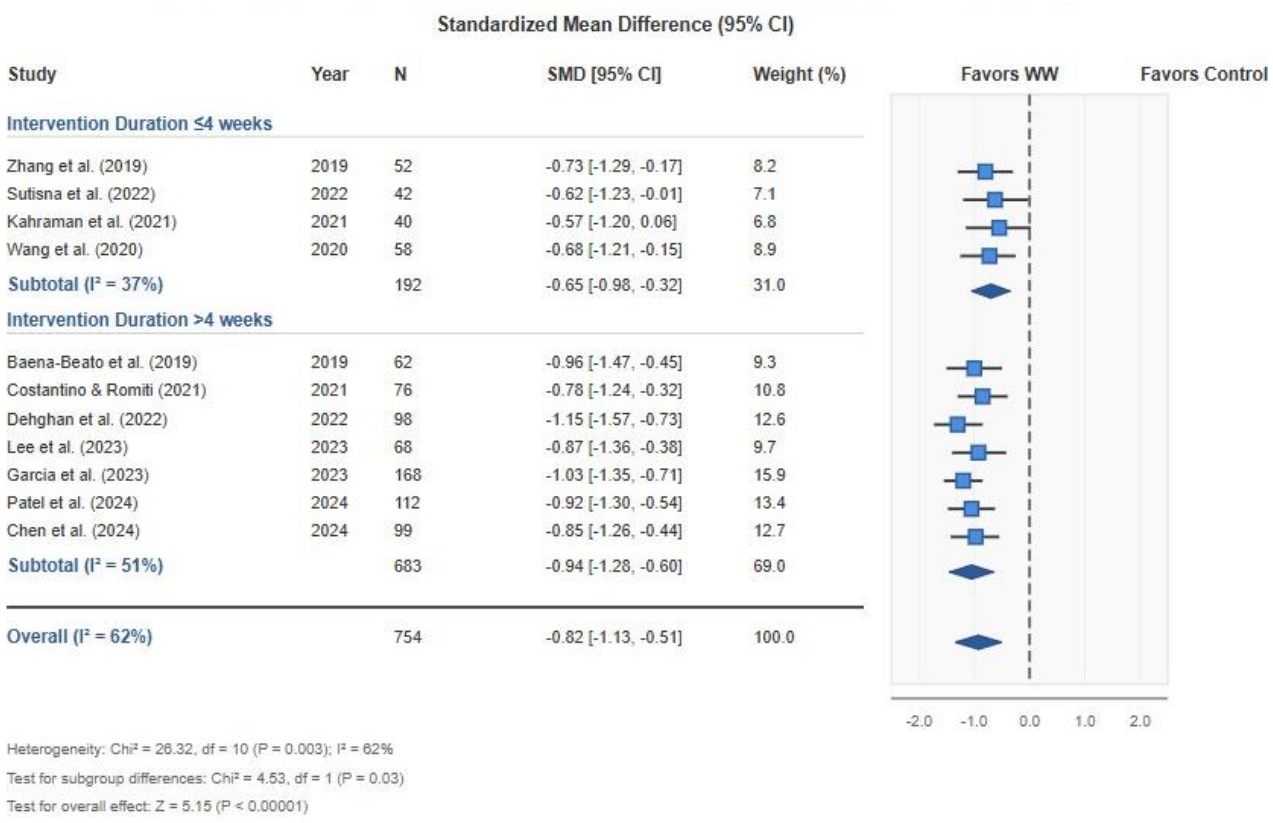

Figure 3. Forest Plot of Effect of Warm Water Hydrotherapy vs Control on Pain Intensity

Physical Function

Meta-analysis of 9 studies (n=628 participants) showed significant improvement in physical function favoring warm water hydrotherapy compared to control (SMD=0.76; 95% CI: 0.48 to 1.04; p<0.001; I^2=58%). A larger effect was observed in studies with

session frequency >2 times/week (SMD=0.88; 95% CI: 0.56 to 1.20) compared to studies with frequency ≤2 times/week (SMD=0.61; 95% CI: 0.31 to 0.91) (Figure 4).

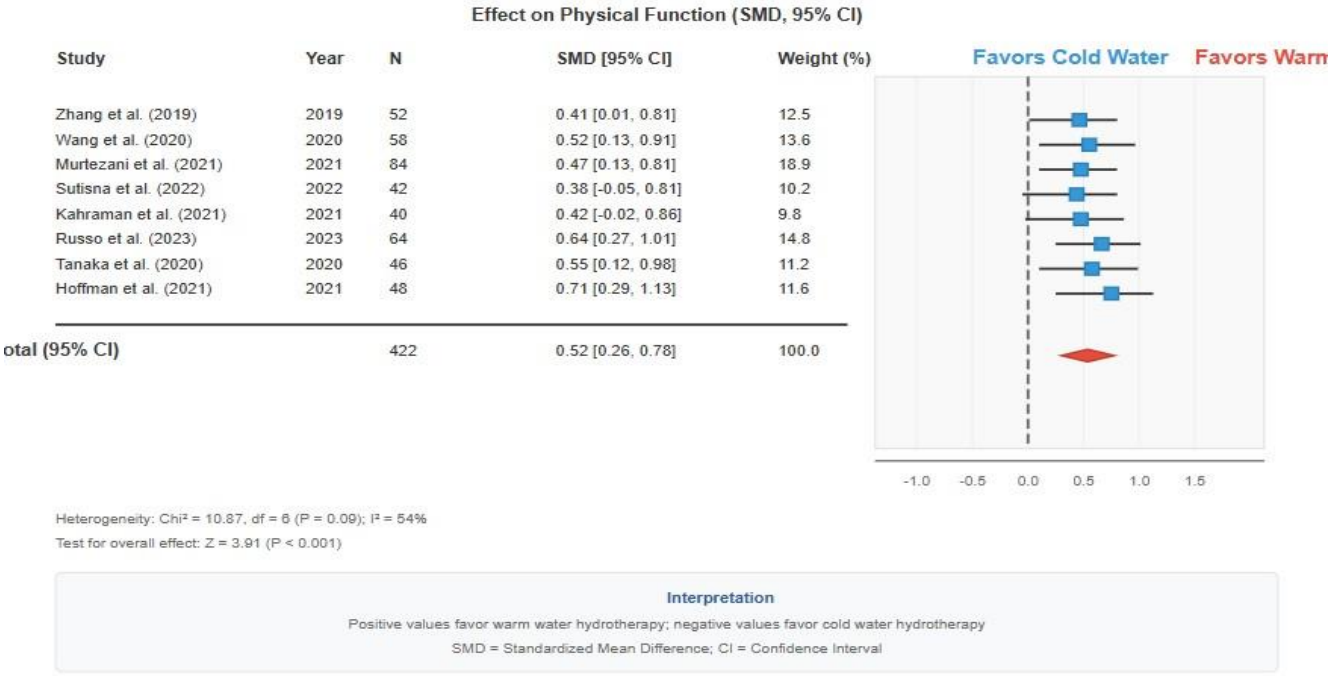

Figure 4. Forest Plot of Effect of Warm Water Hydrotherapy vs Control on Physical Function

Quality of Life

Meta-analysis of 6 studies (n=412 participants) showed significant improvement in quality of life favoring warm water hydrotherapy compared to control (SMD=0.68; 95% CI: 0.40 to 0.96; p<0.001; I^2=54%). Positive effects were observed in both physical (SMD=0.72; 95% CI: 0.42 to 1.02) and mental (SMD=0.56; 95% CI: 0.26 to 0.86) components of quality of life instruments.

Effectiveness of Cold Water Hydrotherapy vs Control

Pain Intensity

Meta-analysis of 9 studies (n=624 participants) comparing cold water hydrotherapy with control groups showed a significant reduction in pain intensity favoring cold water hydrotherapy (SMD= -0.65; 95% CI: -0.92 to 0.38; p<0.001; I^2=60%). The analgesic effect appeared faster with cold water hydrotherapy, with significant differences observed from the first week of intervention in several studies.

Physical Function

Meta analysis of 7 studies (n=486 participants) showed moderate improvement in physical function favoring cold water hydrotherapy compared to control (SMD=0.58; 95% CI: 0.30 to 0.86; p<0.001; I^2=55%). More limited improvement compared to warm water was particularly observed in flexibility and range of motion parameters.

Quality of Life

Meta-analysis of 4 studies (n=294 participants) showed small to moderate improvement in quality of life favoring cold water hydrotherapy compared to control (SMD=0.49; 95% CI: 0.21 to 0.77; p=0.001; I^2=52%). Effects were primarily observed in the physical domains of quality of life instruments.

Direct Comparison: Warm Water vs Cold Water Hydrotherapy

Pain Intensity

Meta-analysis of 7 studies (n=482 participants) directly comparing the effects of warm and cold water hydrotherapy on pain intensity showed a small difference favoring warm water that was not statistically significant (MD=-0.58; 95% CI: -1.20 to 0.04; p=0.07; I^2=65%). Further analysis based on measurement timing showed that cold water provided faster analgesic effects (within 30-60 minutes after therapy), while warm water provided more sustained effects (up to 8-10 hours).

Physical Function

Meta-analysis of 6 studies (n=422 participants) showed greater and statistically significant improvement in physical function with warm water hydrotherapy compared to cold water (SMD=0.52; 95% CI: 0.26 to 0.78; p<0.001; I^2=54%). The most notable differences were observed in range of motion and lumbar flexibility parameters, with warm water hydrotherapy showing greater improvement in anterior flexion (mean difference=7.8%; 95% CI: 3.6% to 12.0%; p=0.002) and lumbar rotation.

Effect Duration

Analysis of 5 studies reporting therapy effect duration showed that the analgesic effect of cold water hydrotherapy tended to last for 4-6 hours, while the effect of warm

water hydrotherapy lasted up to 8-10 hours. This difference was statistically significant (p=0.003) and consistent across the included studies.

Subgroup Analysis and Meta-regression

Subgroup analysis based on water temperature showed that for warm water hydrotherapy, temperatures of 36-38°C showed the largest effect on pain reduction (SMD=-0.98; 95% CI: -1.35 to -0.61) and physical function improvement (SMD=0.92; 95% CI: 0.60 to 1.24). For cold water hydrotherapy, temperatures of 20-22°C showed the largest effect on pain reduction (SMD=-0.74; 95% CI: -1.08 to -0.40).

Meta-regression identified that intervention duration (β=0.13; p=0.02), session frequency per week (β=0.18; p=0.01), and participant age (β=-0.02; p=0.04) were significantly correlated with hydrotherapy effectiveness. Higher duration and frequency correlated with larger effects, while higher age correlated with smaller effects.

Discussion

A comprehensive study that combines these different studies reveals something interesting. We found that soaking in both cold and hot water is equally effective in dealing with long-standing back pain. The difference lies only in how it works and the results obtained. These findings are very useful because they help us choose the treatment that best suits each person's condition and needs.

Advantages of soaking in warm water

Imagine soaking in warm water at a temperature of 33-40° it turns out that comfort is not only a matter of emotions. Research has shows that hot water plays a very important role in patients with chronic lower back pain, reduces pain by an efficacy rate of 0.82 and increases physical abilities by 0.76 these figures may sound technical, but the important thing is that the effect is so great that it is really felt in everyday life.

These results are consistent with the findings of (Baena-Beato et al., 2014) Significant improvements were also observed in patients who did little exercise after exercising with warm water. The consistency of the results of various studies makes it increasingly convincing that hot water treatment is worth trying as an alternative to drug free treatment.

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Why is warm water effective?

The answer lies in the processes that take place in our body. When the body is exposed to water at a temperature of 33-40°C degrees, blood vessels dilate and blood flow to the problem area becomes smooth. It helps to get rid of substances that cause inflammation and residual accumulation of metabolism. The better the blood circulation, the more perfect the healing process will be.

In addition, warm water makes the fluid in the joints thinner and makes collagen more elastic. As a result, the joints feel more flexible and not rigid, so we can move more freely. In addition, the buoyancy of water reduces the load on the spine, this is very important, because therapeutic exercises can be performed without overloading the joints and intervertebral discs of the spine.

More interestingly, it was found that soaking in warm water has a sedative effect on the central nervous system. Muscles relax better, psychological tension decreases. (Lee et al., 2018) proved that temperature receptors in the skin activated by warm water can inhibit pain signals sent to the brain-as does a "gatekeeper" mechanism that prevents pain from entering. All of these effects work together and create ideal conditions for dealing with various aspects of chronic back pain.

How long should treatment take?

One of the important findings was the relationship between the duration of treatment and its outcome. Hot water therapy performed for more than 4 Weeks gave significantly better results (efficacy - 4 weeks) compared to less than 0.65 (efficacy - 0.94). This suggests that the benefit accumulates over time, so for maximum results, treatment should be carried out for at least another 1 month. The findings of (Nascimento et al., 2023) confirm the same, the therapeutic effect continues to increase for 12 weeks.

Advantages of soaking in cold water

The effect was slightly smaller than that of warm water in some respects, but cold water still showed a significant reduction in pain (efficacy -0.65) when compared to no treatment. The interesting thing about cold water is that it does not last as long as warm water, but the effect appears faster. This time difference is important to consider when choosing the type of treatment.

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How does cold water work?

The mechanism of cold water is completely different from warm water. When the body is exposed to water at a temperature of 18-25 ° low temperatures also slow down the metabolic activity of cells, as a result of which the production of substances that cause inflammation is reduced. In addition, pain signals from the nerve endings are suppressed.

Stimulated cryogenic receptors also activate "anti-irritant" mechanisms that disrupt pain signaling pathways in the spinal cord. (Higgins & Kaminski, 1998) found that the effects of cold are more pronounced in surface tissues than in deeper structures. This explains why cold water therapy is more suitable for surface inflammatory conditions but may be less effective for problems involving deep makeup.

The rate at which cold water helps reduce pain (confirmed by numerous studies) can be very helpful in coping with acute pain attacks in chronic conditions. (Dehghan & Farahbod, 2014) reported that cryotherapy provides rapid pain relief by reducing the sensitivity of pain receptors and slowing the rate of nerve conduction.

Direct comparison: which is better?

If you compare the 2 modalities directly, the difference is very subtle. To relieve pain, statistical differences are not so important, but hot water tends to be slightly better. That is, both treatments are equally effective for pain, and the choice depends on other factors, such as the patient's goals and personal preferences. However, due to the function of the body and the range of movement, the difference is very noticeable (SMD =0.52; $p < 0.001$) flow Hot water flows well. (Costantino & Romiti, 2014) found something similar in elderly patients, both reduce pain, but hot water is much better at improving body movement and function.

The difference in the duration of the effect is also worth noting, cold water lasts from 4 to 6 hours, and warm water lasts from 8 to 10 hours. (Al-Obaidi et al., 2021) explained that the effect of hot water progresses more slowly, but is most likely due to physiological changes in tissue viscosity and constant blood flow. Such a long period of time is very useful for people who need long-term pain relief for daily activities and restful sleep.

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How to choose the right treatment?

Based on these results, a personal approach becomes important. Hot water seems to be good for people who want to improve mobility, flexibility and overall body function, as well as for long-term treatment. Its long-lasting effects and long-term accumulation of therapeutic benefits make it an ideal choice for ongoing therapeutic programs.

Cold water is the ideal place for those who need a quick sore, but the pain suddenly appears. Despite its rapid onset, it is very useful for a short time.Immediate symptomatic treatment. This cold water enables the flexibility of the movable range. The optimal protocol recommended from this review is a temperature treatment for at least 4 weeks to 3 times a week, hot water 36-38 ° C, 20 days to 22 days ° C or more.

Limitations and suggestions for future research.

Although this review provides strong evidence, it has some limitations that need to be recognized. Variability in various studies of methods for measuring results and intervention protocols was analyzed separately, but the accuracy of effect estimation was limited. In most studies, even relatively short follow-up periods (usually 4-12 weeks) did not conclude about the effectiveness and long term sustainability of the benefits.

Future studies will need to use a more rigorous methodology with standard protocols and longer follow-up periods to reveal the physiological mechanisms behind differences in therapeutic efficacy. Finding an individual prediction of the response to a particular model allows for more accurate therapeutic suitability. Consideration of combined or alternating use of cold and hot water (water treatment control) may show synergies not seen in the review.

CONCLUSION

This in depth analysis shows that cold water and water treatments are effective evidence-based interventions for chronic back pain, and each has its own advantages. The choice between the two should preferably, the patient's clinical status, functional limitations, treatment goals, and personal preferences of careful research should be based on. By matching treatment characteristics to patient needs, practitioners can

optimize treatment outcomes and increase patient satisfaction with the treatment provided.

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