REVIEW

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The Effect of Hydrokinetic Therapy on Patients with Low Back Pain: A Systematic Review and Meta-Analysis

Giulia Serra[1], Ilaria Ruotolo[2], Anna Berardi[2], Alessandra Carlizza[1], Giovanni Galeoto[2,3]

[1] *Saint Camillus International University of Rome and Medical Sciences (UniCamillus), Rome, Italy*
[2] *Department of Human Neurosciences, Sapienza University of Rome, Rome, Italy*
[3] *IRCSS Neuromed, Isernia, Italy*

CORRESPONDING AUTHOR:
Giovanni Galeoto
Department of Human Neurosciences
Sapienza University of Rome
viale dell'Università 30
00185 Rome, Italy
E-mail: giovanni.galeoto@uniroma1.it

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SUMMARY

Background. Musculoskeletal disorders (MSDs) are a leading cause of disability internationally, particularly low back pain (LBP), which accounts for 60% of occupational diseases. Aquatic therapy has been used to treat various diseases. The aquatic setting has properties that can be used to obtain benefit through exercise. The primary aim of this systematic review was to evaluate physiotherapy qualitatively and quantitatively in a water environment in patients with LBP carrying out a meta-analysis to provide a guidance instrument about the efficacy of this kind of treatment.

Methods. This review was conducted in compliance with Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) protocol. We searched the PubMed, Scopus, Web of Science, CINAHL, and PEDro databases for studies to include. Only randomized controlled trials were included. To evaluate the risk of bias, the Jadad and PEDro scales were used.

Results. After removing duplicate articles, 19 articles remained. Of these, 10 studies were of high-quality, while the remaining 9 achieved a score indicative of a low qualitative level.

Conclusions. Aquatic therapy is beneficial to use in addition to conventional therapy in patients with LBP, with outcomes visible in the short-term.

Study registration. Review was registered in Prospero website http://www.crd.york.ac.uk/PROSPERO with registration number: CRD42021250750.

KEY WORDS

Aquatic therapy; musculoskeletal disorders; low back pain; aquatic exercise; hydrokinetic therapy.

BACKGROUND

Musculoskeletal disorders (MSDs) are a leading cause of disability internationally, particularly in industrialized countries, with poor quality healthcare being one of the causes (1, 2). These conditions are a major contributor to disability, accounting for 17.1% of years lived with disability (3) and can lead to chronic musculoskeletal pain (https://www.iasp-pain.org/advocacy/global-year/right-to-pain-relief/). Common healthcare problems may result from MSDs and a failure to educate patients, including the overuse of radiological imaging, surgery, and opioids (4).

The disability and reduced quality of life as a consequence of MSDs are reported to be much more severe than those associated with hypertension and high cholesterol (http://www.boneandjointburden.org/). Disabilities resulting from MSDs include low back pain (LBP), neck pain, hip and

knee osteoarthritis, complex shoulder conditions, and other joint conditions (1, 5).
LBP accounts for 60% of occupational diseases and is the most common of all non-communicable diseases (6). Current literature does not support a definitive cause for initial episodes of LBP (7). LBP is the leading cause of disability in the world and according to 2010 reports, 21.7 million people suffer from this disability each year (8, 9). The correlation between imaging examination findings and LBP is low. Psychosocial factors are involved in the onset of LBP and its progression to chronic pain. Activity improvement is more useful than rest (10, 11).
Over the past two decades, opioid prescriptions have been overutilized in chronic pain management, resulting in abuse and addiction (12). In recent years, conservative management of chronic pain, specifically exercise and cognitive behavioral therapy, has been recommended (13). To date, some of the most commonly used techniques to treat and prevent LBP are manual therapy, laser therapy, therapeutic exercise, blood flow restriction, videoconferencing, and transcutaneous electrical nerve stimulation (14-18).
Aquatic therapy (or aquatic physical therapy or hydrokinesitherapy) (19, 20) has been used to treat various diseases. The aquatic setting has properties such as buoyancy, turbulence, hydrostatic pressure, and resistance that can be used to obtain benefit through exercise (21, 22). There are specific physical laws that influence the immersed body's behavior in static and dynamic conditions. The intrinsic and dynamic characteristics of water facilitate movement and allow the human body to practice balanced and coordinated movements (23-25). Other benefits are due to buoyancy, which provides support and can reduce the probability of injury and joint degradation, the microgravity environment, which provides relief from body weight, the continuous movement of the body so that muscles are continuously activated to stabilize the body, hydrostatic pressure and viscosity, which provide proprioceptive and sensory feedback different from that provided with land exercise, and the constant water temperature and hydrostatic pressure that may facilitate blood circulation, ease soft-tissue contracture, and relieve muscle spasms and fatigue (26-29). Aquatic exercises are also a safe and enjoyable way to improve physical functioning in patients with and without MSDs or LBP and with other comorbidities (28, 30, 31).
Aquatic therapy refers to partial immersion movement therapy, which is based on exercising with the entire body or only some of its parts, while benefiting from the properties and characteristics of the aquatic environment (32).
The efficacy of this intervention is not clear in the current literature, though it has been used in various rehabilitation fields (21, 22, 27, 33). The primary aim of this systematic review was to qualitatively and quantitatively evaluate physiotherapy in a water environment in patients with LBP carrying out a meta-analysis; it could provide a valid guidance instrument about the efficacy of this kind of treatment, evaluating all the effects that water can produce in patients with LBP.

MATERIALS AND METHODS

Protocols and registration

This review was conducted in compliance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) protocol, which consists of 27 items based on Methodological Expectations of Cochrane Intervention Review (MECIR) Standards.

Eligibility criteria: types of studies, participants, and interventions

All studies in the published literature that included the keywords "aquatic therapy" OR "aquatic exercise" OR "hydrotherapy" OR "water exercise" OR "water therapy" AND "musculoskeletal disease" was considered.
We included only randomized controlled trials (RCTs). Studies that included the comparison between aquatic therapy and land therapy, no therapy, or other therapies were considered. All studies based on aquatic therapy or on the use of water (hot, cold, steam, or ice) to relieve discomfort and fatigue, restore range of motion (ROM), postural balance, muscle strength, cardio-respiratory response, endurance during exercise, and muscle and tendon length, relieve pain, and support joint mobility, quality of life, and a return to daily life activities in individuals with MSDs were included. No restrictions were applied to the type of intervention used. Inclusion criteria were: RCTs or clinical trials concerning MSDs, particularly LBP.
Studies on animals or other diseases were excluded. Articles in languages other than English were excluded.

Search methods

The databases used to identify studies for inclusion were the PubMed, Scopus, Web of Science, CINAHL, and PEDro databases. All included studies were identified by two reviewers.
The most recent study was conducted by Barker in 2014 (34). Research was conducted between May 2021 and August 2021. Papers concerning numerous aspects of rehabilitation, such as fatigue, ROM, postural balance, muscle strength, cardio-respiratory response, endurance during exercise, muscle and tendon length, pain relief, joint mobility support, quality of life, and the return to daily life activities, were considered.

Study selection

Titles, keywords, and abstracts identified through databases were screened independently by two physical therapists. In the first screening, the editors selected the relevant studies and removed duplicates. All articles that the editors agreed upon were included in the second screening.
During the second screening, the full text of the included studies was analyzed, and a final list of eligible studies was compiled.

Data extraction and risk of bias

Data extraction was performed according to the Cochrane method. The reviewers collected patient demographic information. The following data were extracted from selected studies: author, publication year, included sample characteristics, type of treatment and type of control, outcomes, and conclusions (**table I**). Regarding the intervention protocol, the type of exercise, duration of intervention, intensity, and conclusions of the study were considered.
To evaluate the risk of bias, Jadad and PEDro scales were used.

Meta-analysis

A quantitative analysis was conducted by comparing outcomes. Follow-up results were also considered and pooled as appropriate.

RESULTS

Search results

An initial keyword search retrieved a total of 1,409 articles, after the screening 19 articles remained and were included in the review, and 10 of these were included in the meta-analysis (35-44) (**figure 1**).

Study characteristics: types of design and participants

All the included studies were RCTs that included a hydrotherapy study group and a control group of another intervention. Participants included males and females of a broad range of ages (35-52).
The sample size in the studies varied from 19 to 262 participants. All the participants were adults and their ages varied from 18 to 80 years. It was found that the therapies used in the intervention group are: "Bad Ragaz Ring Method" (BRRM), hydrotherapy, aquatic exercise plus pain neurophysiology education, active groups, "AquaStretch", aquatic exercise together with deep water running, "Back school" program (stretching and selective muscle reinforcement techniques), bath in reduced sulphureous mineral water, water pilates and aquatic training with aerobic and resistance session. As regards the physiotherapy sessions, the duration was between 4 and 12 weeks, while the number of interventions varied from 8 to 45 sessions.
Different outcome measures were used in the studies: VAS (53), Roland Morris Disability Questionnaire (RMDQ) (54), Single locus sequence typing (SLST) (55), Modified-Modified Schober Test (MMST) (56), US images, Oswestry Disability Index (ODI) (54), McGill Pain Questionnaire (57), Passive Straight Leg Raise (SLR) (58), tendon reflex grading, strength grading, light touch sensation, Quebec Back Pain Disability Scale (QBPDS) (59), Tampa Scale of Kinesiophobia (TSK) (60), Quality Short-Form Health Survey 36 (SF-36) (61), body mass index (BMI), Sit-and-Reach Test (62), handgrip strength, Rockport 1 mile walking test (63), active range of motion (ROM), 6-Minute Walk Test (64), manual measure of spasms and tenderness, Biodex balance system, Short Form-12 (SF-12) (65), Biering-Sorensen test (66), electromyography, percentage of body fat (PBF), waist-hip ratio (WHR) (67), trunk muscle mass, EQ-5D-3 scale (68), Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F) (69), peak oxygen uptake.
The outcomes of studies varied: there was improvement in disability, endurance, function, pain intensity, quality of life and mobility in the experimental groups; the intervention groups also showed more benefits than control groups or the same benefits. The detailed characteristics of the included articles are summarized in **table I**.

Intra-study risk of bias

The Cochrane risk of bias tool was used for the qualitative analysis of the trials included in the systematic review. This evaluation revealed that 10 studies received a score of 3 and were of high quality. The remaining nine studies achieved a score indicative of a low level of quality (**figures 2, 3**).

Meta-analysis

A quantitative analysis was carried out by comparing outcomes and follow-ups. This pool was based on comparable outcomes. Ten studies had comparable follow-up times that were considered in the meta-analysis. These studies are as follows:
Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 1: visual analogue scale (VAS), follow-up at four weeks. Four studies were considered. Meta-analysis revealed statistically significant results ($p < 0.001$) in favor of the experimental group compared to the control group (mean difference = -1.22, 95% confidence interval (CI) = -1.45−-0.99) (**figure 4**).

Table I. Characteristics of the study.

Author	Details of participants	Intervention (study group)	Frequency of treatment	Control group	Instrument to measure outcomes	Follow up	Conclusions
Zoltan Balogh; Jòzsef Ordogh; Attila Gasz; Laslo Nemet; Tamas Bender (35)	Adults with LBP; n 60, of which 56 completed the study	Bath in reduced sulphurous mineral water, n 30 (20 females and 10 males aged 52.6 years)	15 days	Bath in modified tap water of matching odor, n 30 (22 females and 8 males aged 52.1 years)	VAS; Oswestry Low Back Pain Disability Questionnaire; manual measure of spasms and tenderness and vertebral ROM	3 months	No substantial differences between groups
Umit Dundar; MD; Ozlem Solak; Ilknur Ygit; Deniz Evcik; Vural Kavuncu (36)	Adults with chronic LBP, n 65	Aquatic therapy, n 32	4 weeks, 20 sessions, 5 per week	Land-based exercise, n 33 (60 minutes)	MMST (spinal mobility); active range of motion (ROM) (lumbar flex/ext and rotation); VAS (pain); Oswestry Low Back Disability Questionnaire; SF-36 (quality of life)	12 weeks	Improvement in all parameters in both groups, but disability and quality of life were more improved in the aquatic group
Billy C.L. So; Joseph K; F. Ng, and Ken C.K. Au (37)	Adults with chronic LBP, n 44 (45/65 years) 37 women	Bad Ragaz Ring Method (BRRM), n 21	4 weeks, twice weekly	Ai Chi, n 23	VAS; RMDQ; SLST; MMST; US images; PBM; SBM	4 weeks	Potential improvements in disability and global core muscle endurance
Diogo Pires; Eduardo Brazete Cruz; Carmen Caeiro (38)	Adults with chronic LBP, n 62, of which 55 completed the study	Aquatic exercise plus pain neurophysiology education, n 30	12 sessions in 6 weeks	Acquatic exercise alone, n 32	VAS; Quebec Back Pain Disability Scale (functional disability); Tampa Scale of Kinesiophobia (TSK)	3 months	mprovement in pain intensity, perceived functional benefits
Tracey Sjogren; Nerida Long; Ian Story; Jenni Smith (39)	Patients with chronic LBP, n 60	Hydrotherapy, n 30: 9 males and 21 females (26-78 years)	6 weeks	Land-based exercise, n 30: 8 males and 22 females (29-80 years)	MMST; VAS; Oswestry Low Back Pain Disability Questionnaire; walking test	6 weeks	Did not find that hydrotherapy treatment was more beneficial than land exercise
Kaynoosh Homayouni; Mahshid Naseri; Foroozandeh Zaravar; Leila Zaravar; Hajar Karimian (40)	Adults with LBP and a diagnosis of lumbar spinal stenosis, n 50; age 50-80 years; of which 47 completed the study	Aquatic therapy, n 24	First group: 24 sessions, 10-15 min; Second group: 10 sessions, home exercise and transcutaneous electrical nerve stimulation (TENS)	Conventional physical therapy, n 23	VAS; 6-Minute Walk Test	3 months	Aquatic therapy provided better short-term improvement in pain and function than conventional physical therapy
Ali Yalfani; Zahra Raeisi; Zohreh Koumasian (41)	Adults with chronic non-specific LBP, n 24	Water pilates, n 12	8 weeks: 3 sessions per week, 75 minutes	Mat pliates, n 12	VAS; Oswestry Low Back Pain Disability Questionnaire; Biodex Balance System	8 weeks	No significant changes
Rodrigo G.S. Carvalho; Mariana F. Silva; Josilainne M. Dias; Mabel M. Olkoski; Laìs F. Dela Bela; Alexandre R.M. Pelegrinelli; Maria S.T. Barreto; Renata R. Campos; Leandro C. Guenka; Ligia M. Facci; Jefferson R. Cardoso (42)	Adults with chronic LBP, n 54	Aquatic exercise + deep water running, n 27; lost n 3: tot 24	9 weeks; 18 sessions (2 sessions a week). 40 minutes for control group and 1 h for experimental group	Only aquatic exercise, n 27; lost, n 4: tot 23	RMDQ; VAS; 6-Minute Walk Test	3 months	Only relieved pain in the short term in the experimental group. At the 3-month follow-up there were no differences in outcomes.

Author	Details of participants	Intervention (study group)	Frequency of treatment	Control group	Instrument to measure outcomes	Follow up	Conclusions
Cosimo Costantino; Davide Romiti (43)	Adults with non-specific LBP; aged 65-80 years; n 56	Back school program (stretching and selective muscle reinforcement techniques), n 28 but lost 1: tot 27	12 weeks; 1h, 2 sessions per week	Hydrotherapy, n 28 but lost 1: tot 27	RMDQ; SF-36	3 months	Both therapies were effective
Erdal Dilekci; Kagan Ozkuk; Baris Kaki (44)	Adults with chronic LBP, n 262	Only physiotherapy, n 129	3 weeks: 15 sessions, 5 days per week.	Physiotherapy + balneotherapy, n 133	VAS; EQ-5D-3 scale; EQ-VAS; Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F); RMDQ; Quebec Back Pain Disability Scale	3 weeks	Balneotherapy was more effective than physical therapy in reducing pain, fatigue, and disability status and improving functionality and quality of life
Bronwyn McIlveen; Valma J Robertson (45)	Adults with LBP or back and leg pain (more than 3 months), n 109, of which 95 completed the study	Hydrotherapy, n 45 (17 men; 28 women)	4 weekes (60 minutes twice weekly)	Delayed hydrotherapy, n 50 (21 men; 29 women)	Oswestry Low Back Pain Disability Questionnaire; McGill Pain Questionnaire; MMST; passive straight leg raise (SLR); tendon reflex grading (quadriceps-hamstrings-calf); strength grading (hip flexors-knee extensors-ankle); light touch sensation (lower limb)	4 weeks	Significant improvement in function (in experimental group)
Pedro Angel Baena-Beato; Enrique G Artero; Manuel Arroyo-Morales; Alejandro Robles-Fuentes; Maria Claudia Gatto-Cardia; Manuel Delgrado-Fernandez (46)	Adults sedentary with chronic LBP, n 49	Active group, n 24	2 months, 40 sessions, 5 days per week	Waiting list, n 25 (no therapy)	VAS; Oswestry Disability Index; Quality Short-Form Health Survey 36 (SF-36); body mass index (BMI); sit and reach; handgrip strength; Rockport 1-mile test	2 months	Decreased pain and disability, increased quality of life and improved body composition and health-related fitness
Cuesta Vargas; Garcia Romero; Arrojo Morales; Diego Acosta (47)	Adults with chronic non-specific LBP, n 46	Physical therapy + deep water running, n 23	15 weeks; 3 times a week for 60 minutes (experimental group +20 minutes)	Only physical therapy, n 23	VAS; RMDQ; Short Form-12; maximum isometric strength of lumbar and hip extensor test (MISL); lumbosacral mobility in flexion in the sagittal plane; Biering-Sorensen Test	15 weeks	Better results in reducing pain, physical function, and mobility.
S. Ansari; A. Elmieh; A. Alipour (48)	Women with chronic non-specific LBP (age 50-63 years), n 20	Water-based exercise, n 10	8 weeks: 3 sessions per week, 1 h	No intervention, n 10	Functional disability; flexibility; electromyography (trunk muscles: rectus, external oblique, longissimus thoracic, and lumbar multifidus muscles)	8 weeks	aquatic exercise could be used to improve health. Positive effects.
Khadjeh Irandoust; Morteza Taheri (49)	Males with LBP (65 years), n 32	Aquatic training, n 16 (2 aerobic sessions and 1 resistance session)	12 weeks: 3 sessions per week	Did not participate in any kind of exercise program, n 16	BMI; percentage of body fat (PBF); waist-hip ratio (WHR); trunk muscle mass (using InBody 230); Simple 9-Item Questionnaire (Keele STarT Back Screening Tool)	12 weeks	Improvement in aquatic group, decreased pain

Author	Details of participants	Intervention (study group)	Frequency of treatment	Control group	Instrument to measure outcomes	Follow up	Conclusions
Gunsoo Han; Minhaeng Cho; Gitaek Nam; Taeyoung Moon; Jeehee Kim; Seonrye Kim; Sungyoup Hong; Byungjun Cho (50)	Patients with LBP (aged around 60 years), n 19	Aquatic exercise, n 9: 50 minutes, 5 times a week (warm-up 10 minutes; main exercise 30 minutes; cool-down 10 minutes)	10 weeks	Non-exercise control group, n 10	VAS; maximum peak torque of the flexors and extensors	10 weeks	Water exercise is beneficial for LBP: increases lower back muscle strength and decreases pain
Kanitz, A.C., Machado, B., Rodrigues, D., Zambelli, G., Ivaniski, A., Carvalho, N., Reichert, T., Pereira, E., Rocha, R., Sudatti, R., Martins, L.F. (51)	Adults with chronic LBP (13 women, 9 men), n 22	Deep-water walking/ running training at moderate intensity (MIT), n 11	12 weeks: twice a week for 45 minutes	Deep-water walking/ running training at high intensity (HIT), n 11	Oswestry Low Back Pain Disability Questionnaire; peak oxygen uptake (VO2peak); and quality of life	12 weeks	Decreases in pain and disability were observed in both groups, with no differences in these parameters between training groups. Deep-water aerobic exercise training seemed to be effective in improving pain symptoms and reducing the disability of people with chronic LBP
Sawant Rakhi Sadanand; Shinde Sandeep Babasaheb (52)	Adults with chronic non-specific LBP, n 30	Conventional therapy, n 15	pre-post	Hydrotherapy, n 15	VAS; ROM; MMT; MODI	pre-post	There was significant improvement in subjects who underwent conventional therapy and hydrotherapy
Lynda G Keane; Sarah Burns (75)	Adults with chronic LBP, n 29; age 18-70 years	AquaStretch, n 10 (2 males and 8 females)	12 weeks, 2 sessions, 30 minutes	Land-based stretching, n 10 (2 males, 8 females); control, n 9 (no treatment; 1 male and 8 females)	Modified Oswestry Low Back Pain Disability Questionnaire; VAS (pain); TSK	12 weeks	Improvement in pain, AquaStretch recommended in combination with land-based stretching

VAS: Visual Analogical Scale; RMDQ: Roland-Morris Disability Questionnaire; SLST: single-leg stand test; MMST: Modified-Modified Schober Test; US images; PBM: prone bridge maneuver; SBM: supine bridge maneuver; TSK: Tampa Scale of Kinesiophobia; SF-36: Quality Short-Form Health Survey 36; MODI: Modified Oswestry Disability Index.

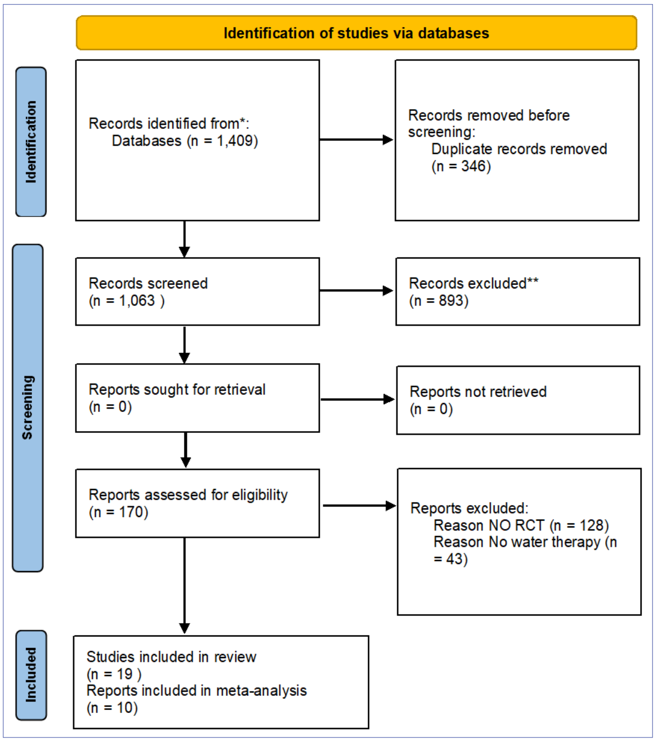

Figure 1. Flow chart of the 19 included randomized controlled trials.

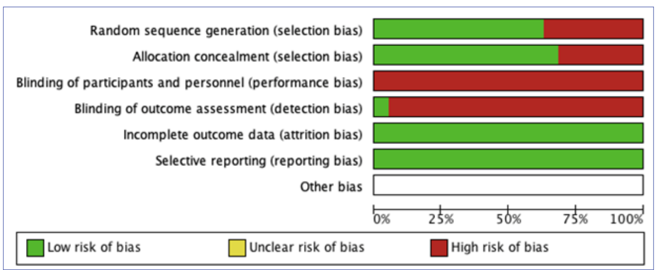

Figure 2. Risk of bias graph: investigators' judgements about each risk of bias item presented as a percentage across all included studies.

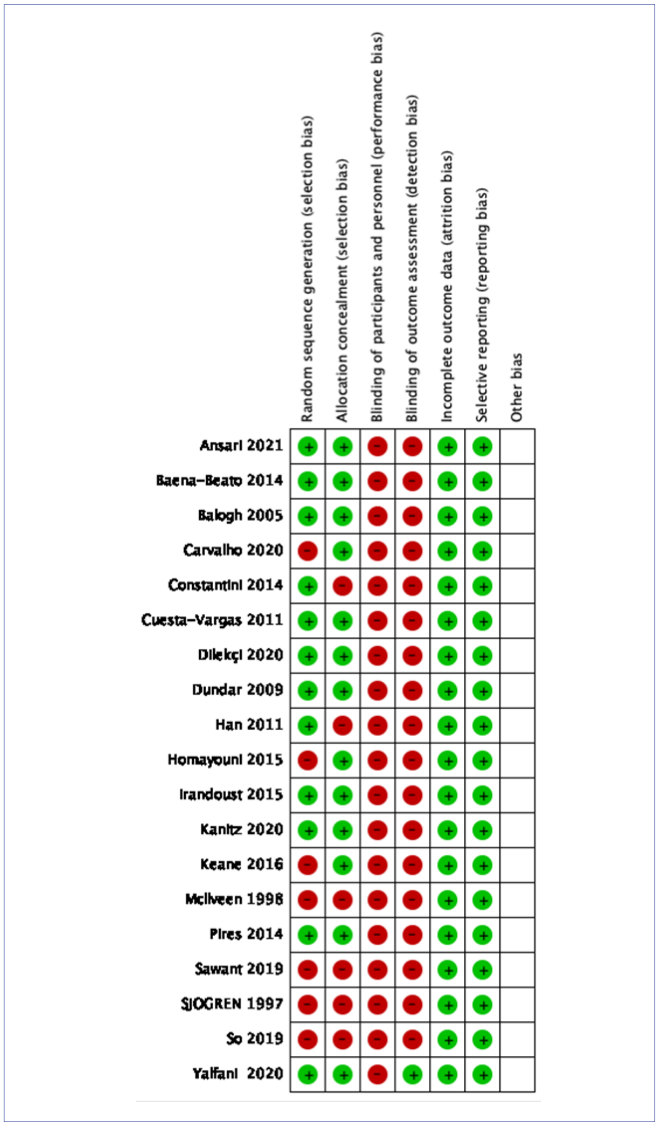

Figure 3. Risk of bias summary: investigators' judgements about each risk of bias item for each included study.

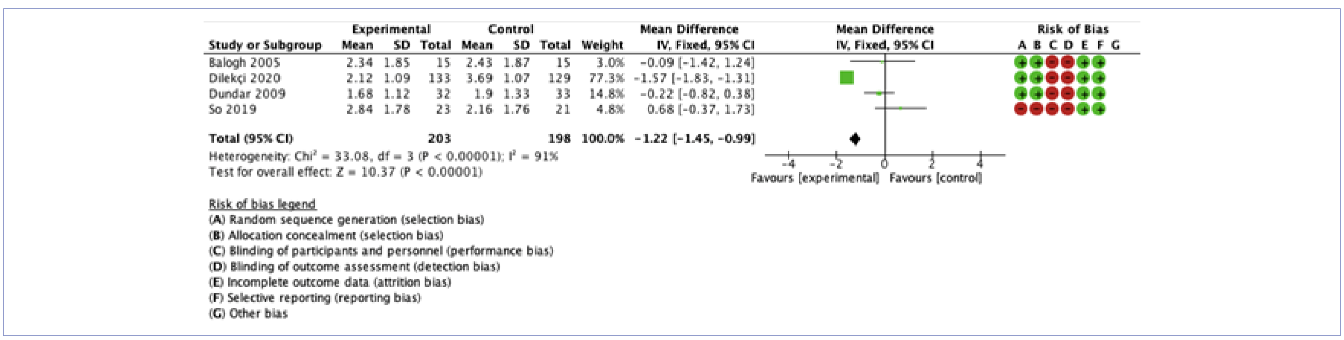

Figure 4. Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 1: VAS, follow-up at four weeks.

Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 1: VAS at six weeks. Two studies were considered. Meta-analysis revealed non-statistically significant results (p = 0.20) (mean difference = -0.48, 95%CI = -1.22–-0.26) (**figure 5**).
Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 1: VAS at eight weeks. Two studies were considered. Meta-analysis revealed statistically significant results (p = 0.001) in favor of the experimental group compared to the control group (mean difference = -1.37, 95%CI = -2.18–-0.55) (**figure 6**).
Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 1: VAS at 12 weeks. Four studies were considered. Meta-analysis revealed statistically significant results (p = 0.02) in favor of the experimental group compared to the control group (mean difference = -0.66, 95%CI = -1.2–-0.12) (**figure 7**).
Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 2: Roland-Morris Disability Questionnaire at 12 weeks. Two studies were considered. Meta-analysis revealed statistically significant results (p = 0.05) in favor of the experimental group compared to the control group (mean difference = -1.12, 95%CI = -2.22–0.01) (**figure 8**).
Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 1: VAS at 20 weeks. Two studies were considered. Meta-analysis revealed statistically significant results (p = 0.01) in favor of the experimental group compared to the control group (mean difference = -1.13, 95%CI = -2.03–-0.23) (**figure 9**).
Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 3: 6-Minute Walk Test at 20 weeks. Two studies were considered. Meta-analysis revealed statistically significant results (p = 0.04) in favor of the experimental group compared to the control group (mean difference = 26.33, 95%CI = 1.80–50.86) (**figure 10**).

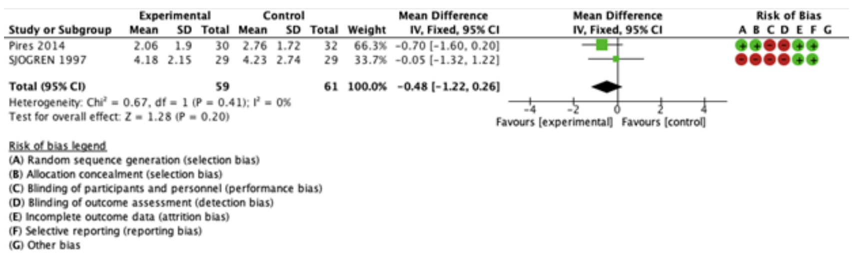

Figure 5. Comparison between aquatic physical therapy *vs* conventional physical therapy concerning outcome 1: VAS at six weeks.

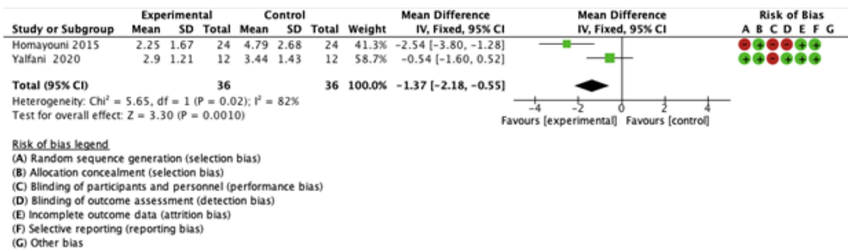

Figure 6. Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 1: VAS at eight weeks.

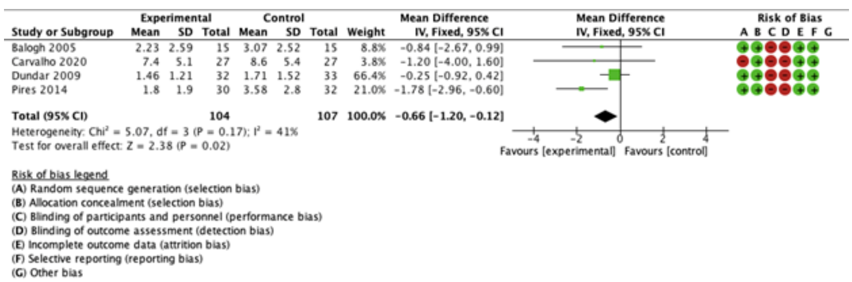

Figure 7. Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 1: VAS at 12 weeks.

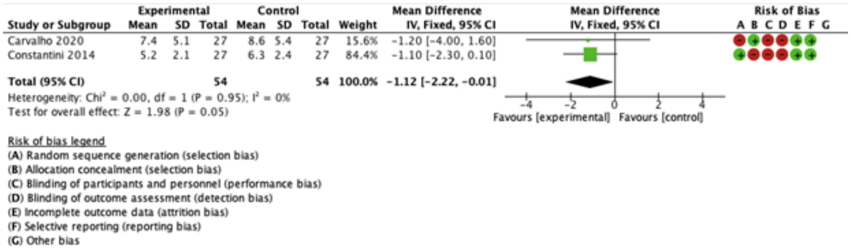

Figure 8. Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 2: Roland-Morris Disability Questionnaire at 12 weeks.

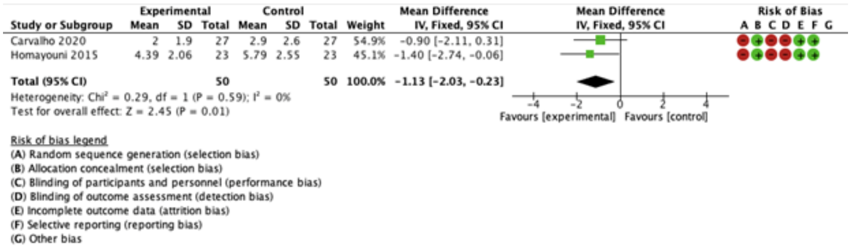

Figure 9. Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 1: VAS at 20 weeks.

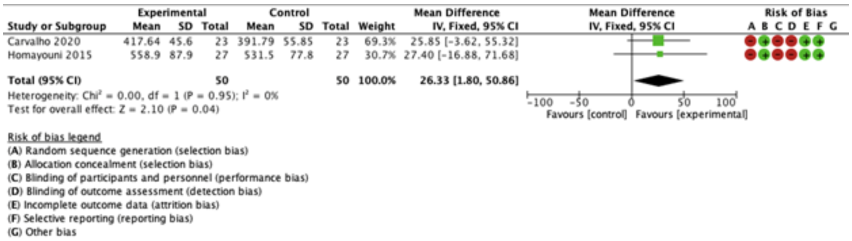

Figure 10. Comparison between aquatic physical therapy *vs* conventional physical therapy for outcome 3: 6-Minute Walk Test at 20 weeks.

DISCUSSION

The purpose of our study was to analyze the effectiveness, methods, and parameters, such as intensity, type of intervention, and duration, of rehabilitation programs for patients with LBP. Results were statistically significant ($p < 0.001$) concerning pain (VAS), disability (Roland-Morris Disability Questionnaire), and walking (6-Minute Walk Test). The study shows that aquatic therapy may be a valid alternative to conventional therapy in the treatment of LBP.

The water environment is useful to facilitate therapeutic exercise and to put patients in different positions (supine, prone, lateral, standing, or kneeling) where the operator can access them from all three dimensions of space. Physical exercise in water refers to the use of water to simplify the application of various interventions, such as stretching, muscle strengthening, articular mobilization (ROM), balance improvement, deambulation, and resistance training. The physical properties of water are the key to this method (70). All studies included were RCTs that included a hydrokinesitherapy study group and a control group of another therapeutic intervention (land-based exercise, Ai Chi, delayed therapy, or conventional therapy). Results indicate that hydrokinesitherapy is more efficient for relieving pain in the short term, but is equivalent in terms of outcome (disability, mobility). These results are in line with current literature (19, 34, 71). Therefore, patients may choose aquatic therapy as an alternative therapy if it appeals to them, and this factor can improve their adherence and participation in the treatment, which is an important element of rehabilitation (72). Many scales are used to measure outcomes, including the VAS (73), Roland-Morris Disability Questionnaire (50), Modified-Modified Schober Test (74), and Oswestry Low Back Pain Disability Questionnaire.

Billy *et al.* (37) compared the Bad Ragaz Ring Method (BRRM) to the Ai Chi technique in water for pain and disability after 4 weeks of follow-up. The authors found that the two techniques were equivalent, though the BRRM resulted in slightly quicker benefits, mostly in pain improvement concluded that it made potential improvements in disability and global core muscle endurance; also other 3 works showed an improvement of disability through aquatic exercise (40, 46, 51).

Pires *et al.* (38) introduced pain neurophysiology education as a variant to the hydrotherapy-based intervention. The findings support the provision of pain neurophysiology education as a clinically effective addition to aquatic exercise. In many studies a positive effect was found on pain in the intervention group (30, 31, 44, 46, 47, 49-51). Carvalho *et al.* observed relieved pain only in the short term, after 9 weeks of aquatic exercise and deep water running (42).

Costantino *et al.* (43). compared the hydrotherapy group with a control group that performed land-based exercises and stretching (back school program). This study showed that both methods were effective for LBP and that back school programs should be favored for their simplicity and the small number of resources required. Aquatic therapy also seemed to have benefits on function and quality of life (36, 45). Keane *et al.* used the technique of AquaStretch compared with land-based stretching and showed that a combination of these two is recommended (75); however, many studies recommend adding water therapy to conventional therapies to obtain an improvement on all fronts of rehabilitation.

Study limitations

A limit of this study was the lack of comparable outcomes. We could thus only consider the VAS scale for pain, the Roland-Morris Disability Questionnaire, and the 6-Minute Walk test.

CONCLUSIONS

The results of our meta-analysis showed that hydrokinesitherapy is a good therapy to use in addition to conventional therapy in the conservative treatment of LBP, with outcomes visible in the short-term.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

GS, GG: conceptualization. GG: formal analysis. AB, IR: methodology. IR, AB: writing – original draft. AC, GG: writing – review & editing.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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