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Best Practice & Research Clinical Rheumatology

journal homepage: www.elsevier.com/locate/berh



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Aquatic exercise & balneotherapy in musculoskeletal conditions

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Keywords:

Best-evidence synthesis
Aquatic exercises
Balneotherapy
Systematic review

This is a best-evidence synthesis providing an evidence-based summary on the effectiveness of aquatic exercises and balneotherapy in the treatment of musculoskeletal conditions. The most prevalent musculoskeletal conditions addressed in this review include: low back pain, osteoarthritis, fibromyalgia and rheumatoid arthritis. Over 30 years of research demonstrates that exercises in general, and specifically aquatic exercises, are beneficial for reducing pain and disability in many musculoskeletal conditions demonstrating small to moderate effect sizes ranging between 0.19 and 0.32. Balneotherapy might be beneficial, but the evidence is yet insufficient to make a definitive statement about its use. High-quality trials are needed on balneotherapy and aquatic exercises research especially in specific patient categories that might benefit most.

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Introduction

Musculoskeletal conditions

Musculoskeletal conditions, also called musculoskeletal disorders, consist of conditions where a part of the musculoskeletal system is injured or affected over time. Symptoms include pain, dysfunction or discomfort in the bones, joints, muscles, or surrounding structures, which can be acute

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or chronic, focal, or diffuse. These musculoskeletal disorders can occur either through sport (e.g. tennis elbow), work, hobby (e.g. dancers' splint) or as a result of a systemic disease (e.g. rheumatoid arthritis). They can also result from fractures, contusions sustained in an accident or degenerative diseases (e.g. osteoarthritis). The most frequent musculoskeletal disorders are osteoarthritis, fibromyalgia, rheumatoid arthritis and low back pain [1]. Some of these conditions are regarded as work-related. These work-related musculoskeletal conditions are frequently defined as: conditions which develop over time and are caused either by the work itself or by the employees' working environment [2]. These conditions are not specifically addressed in this review.

Musculoskeletal disorders are among the most common complaints when visiting the general practitioner. They frequently cause problems in body functions, activity and participations. On average the prevalence of musculoskeletal pain is between 13.5% and 47% of the general population [3]. Osteoarthritis is the most common musculoskeletal disorder; radiographic evidence of OA (osteoarthritis) occurs in the majority of older adults (65 years and over) [4]. In a Dutch study the top three of self-reported musculoskeletal conditions causing pain were: low back pain (26.9%), shoulder pain (20.9%) and neck pain (20.6%) [5]. Fibromyalgia is less common in the population with an estimated prevalence in the general population varying between 1 and 3% [6]. Because there appears to be an association with ageing, musculoskeletal disorders are likely to become more prevalent as the population ages throughout the world [1]. Interventions for musculoskeletal disorders are predominantly conservative and can be pharmacological or non-pharmacological. Both aquatic exercises and balneotherapy are regarded non-pharmacological interventions for musculoskeletal disorders.

Aquatic exercise

Aquatic exercises (water-based exercises, aquatic therapy or hydrotherapy), are exercises that are performed in the water. The Chartered Society of Physiotherapists defined aquatic exercises as a therapy program using the properties of water, designed by a suitably qualified physiotherapist, to improve function, ideally in a purpose-built and suitably heated pool [7]. If the clinical decision is to use aquatic exercise as the treatment modality, certain aspects of the intervention should be considered such as: fluid mechanics, temperature, type of exercise (with intensity, frequency and duration), the professional's experience and costs.

Aquatic exercises are frequently used to maintain or improve function for people with musculoskeletal disorders, especially arthritis [8]. Exercise in water is a popular treatment for many patients with musculoskeletal conditions [9]. Aquatic exercise is growing in popularity within the fitness industry and has been a popular way of keeping fit for years, particularly for people with musculoskeletal disorders or those recovering from injury. Water offers natural resistance, which helps strengthen the muscles. The effects of water resistance, for instance drag forces, may increase energy expenditure and decrease mechanical loads on lower extremity joints [10]. The buoyancy of water reduces pressure on the bones, joints and muscles facilitating movement, and may block nociception by acting on thermal receptors and mechanoreceptors, thus influencing spinal segmental mechanisms [11]. Apart from various specific techniques, simple exercises such as general body movements and walking in water might be beneficial because water's natural buoyancy allows many body movements by providing a type of body weight support [12].

In addition to the standard benefits of any exercise such as increased muscle strength, improved aerobic and cardiovascular capacity, the use of water exercise may reduce the risk of muscle or joint injury [13]. The mitigation of gravity by flotation reduces joint stress when stretching, and can allow a greater range of motion and makes aquatic exercises safe for individuals who are able to keep their heads out of water, including the elderly. Aquatic exercise greatly reduces the risk of injury; when they are performed in a low impact manner however, not as many calories are burned as would be with some weight bearing activities. When aquatic activities performed at the same pace as many land-based activities they in general expend more energy due to the increased resistance of water, the speed with which movements can be performed is greatly reduced [13]. Due to the inherent resistance of water, to obtain a similar physiological response the travel or transportation speed of movement in water must be approximately half of the speed of movement of land-based exercises. To maintain a constant speed, it is necessary to generate a pulse to overcome the resistance provided in response to drag force on the body [14].

Balneotherapy

The term balneotherapy (seated immersion or spa-therapy) is classically used in (Eastern) European countries for bathing in water without exercise. Often natural mineral or thermal waters are used for bathing, drinking and inhalation. One of the core elements of balneotherapy is the use of (natural) mineral waters, gases and peloids (including packs = local application of peloids) often performed in health resorts (spa's). In most European countries balneotherapy often takes place at centres with thermal baths or sea water baths [15].

In Homeric times baths were applied primarily to cleanse and refresh. At the time of Hippocrates, bathing was regarded as more than a simple hygienic measure. It was considered beneficial to cure most illnesses [16]. The Romans used water for the therapeutic treatment of orthopaedic conditions, but after the Roman era spa-therapy fell into disuse. In the sixteenth century baths were rediscovered. Since then, spa-therapy has been practised continuously in the management of musculoskeletal conditions [16,17].

The water (thermal water, sea water) is generally heated to a temperature between 34 and 36 °C [15]. The hydrostatic force (Archimedes' principle) brings about relative pain relief by reducing loading; the water reduces gravity on painful joints. The warmth and buoyancy of water may block nociception by acting on thermal receptors and mechanoreceptors [11]. Also warm water may enhance blood flow, which may dissipate algogenic chemicals and facilitate muscle relaxation. Apart from these mechanical and thermal mechanisms one should not undervalue the psychological mechanisms of the spa environment. The related mental relaxation may also play a role in pain relief [15].

Aim

In the last decades there has been an increase of well-conducted high-quality randomized controlled trials of a variety of interventions targeted towards patients with a variety of musculoskeletal conditions. For practitioners it appeared difficult to obtain up-to-date and relevant evidence for use in day-to-day practice [18]. Clinical guidelines and best-evidence analysis are useful ways of summarizing the best available evidence from randomized controlled trials (RCTs) and systematic reviews (SRs). Summarizing the evidence also identifies areas requiring further research. Therefore, the aim of this paper is to present a best-evidence synthesis of current systematic reviews of aquatic exercises and balneotherapy used for musculoskeletal conditions and to highlight gaps where more research is warranted.

Methods

We performed a systematic literature search to enable an evidence-based synthesis of the most recent, high-quality systematic reviews (SRs) evaluating aquatic exercises and balneotherapy interventions for musculoskeletal conditions. The musculoskeletal disorders of interest are osteoarthritis, rheumatoid arthritis, fibromyalgia and chronic low back pain (greater than 6 months duration), as these are the most frequent musculoskeletal disorders treated by aquatic exercises or balneotherapy. For this evidence-based synthesis we systematically searched PubMed, EMBASE, Cinahl and PEDro and Web of Science for recent systematic reviews (SRs), meta-analysis and randomised controlled trials (RCTs). Search terms used were aquatic exercises, exercise treatment, land-based exercises, balneotherapy, spa-therapy, spa-treatment. We included studies published between 2006 and date of last search (15 April 2012) and selected the most recent update of a systematic review and additional RCTs. Systematic reviews are most effective when performed using the Cochrane method, as this methodology guarantees high-quality and transparency [19].

Results

How do the effects of aquatic exercises compare with those of land-based exercises?

This question can be answered using studies comparing aquatic exercises with land-based exercises. Because few studies evaluated this direct comparison we start with describing the effectiveness

of land-based exercises and aquatic exercises compared to no treatment to enable people to perform an indirect comparison. The results of the studies evaluating the direct comparison are presented last.

Effects of land-based exercises

The number of high-quality SRs on the effectiveness of land-based is enormous. Several summaries of SRs were found on the effectiveness of (land-based) exercises [18,20,21]. All three papers present a best-evidence synthesis and included SRs of randomised controlled trials (RCTs) on the effectiveness of exercise. All three papers used similar methodology with comparable selection criteria. None of the articles reported data from statistical pooling, rather the authors provided a conclusion based on a level of evidence synthesis [22]. This has been an acceptable way of analysis for a period when statistical pooling was not possible due to heterogeneity concerning patient population interventions and outcomes. One paper published in 2005 included 95 unique SRs published before 2003. They concluded that exercise therapy (any form of exercise was included) is effective for patients with knee osteoarthritis, sub-acute (6–12 weeks) and chronic ($>$ or = 12 weeks) low back pain, cystic fibrosis, ankylosing spondylitis and hip osteoarthritis [20]. They found insufficient evidence to support or refute the effectiveness of exercise therapy for patients with neck pain, shoulder pain, repetitive strain injury, rheumatoid arthritis, and found exercise therapy not effective for patients with acute low back pain. No statistical pooling was performed [20]. Another best-evidence synthesis summarised 38 SRs of good quality published between 2002 and 2005 [21]. They concluded that exercise (any form of exercise) was beneficial for patients with osteoarthritis of the knee and chronic low back pain. They also concluded that exercise was more likely to be effective if it was relatively intense. The data also suggested that more targeted and individualised exercise programs might be more beneficial than standardised programs, but no details were provided [21]. The third best-evidence synthesis combined the results of both above mentioned best-evidence synthesis and included recent SRs and RCTs (published after the dates of last search of these best-evidence syntheses until 2007) [18]. None of these best-evidence syntheses provided pooled effect estimates, mainly because the original RCTs did not provide enough information to do so or were to heterogeneous concerning patient population and interventions.

In conclusion, there is limited evidence that exercise was effective for managing pain and disability and reducing sick leave in people with chronic low back pain, neck pain and knee osteoarthritis. We conclude that exercise therapy is a beneficial component of the management of many musculoskeletal conditions for reducing pain and disability. There is however no conclusive evidence that one particular exercise treatment is more beneficial than another.

Effects of aquatic exercises

Several SRs focus on the effectiveness of aquatic exercises, of which one SR is a best-evidence synthesis on aquatic therapy (and balneotherapy) [23], one Cochrane review on hip and knee osteoarthritis [24] and three additional systematic reviews (two on fibromyalgia and one on low back pain) [25,26,27] were identified.

For patients with knee and hip arthritis, the best evidence concluded there was a small but statistically significant short-term effect of aquatic therapy on function (standardised mean difference SMD: 0.26; 95% confidence interval CI: 0.11–0.42), quality of life (SMD: 0.32; 95%CI: 0.03–0.61) and pain (SMD: 0.19; 95%CI: 0.04–0.32) [23]. The Cochrane review also concluded that aquatic exercise appears to have some beneficial short-term effects on function (SMD 0.26; 95%CI: 0.11–0.42) for patients with hip and/or knee OA. No long-term effects were documented [24].

For patients with low back pain, the authors found a small but significant reduction in pain as assessed using a visual analogue scale (VAS) in favour of aquatic exercises of 26.6 mm (95%CI: 20.4–32.8) [23].

Two additional SRs were identified evaluating hydrotherapy/aquatic exercises in patients with fibromyalgia [25,26]. Both reviews vary in selection criteria, so some of the included RCTs overlap, meaning they are included in both reviews. One SR concluded based on 10 RCTs that there was moderate evidence for reduction of pain in favour of hydrotherapy/aquatic exercises (SMD 0.78; 95%CI: 0.13–1.42) at the end of therapy and at 14 weeks follow-up (SMD 1.27; 95%CI: 0.38–2.15) [25]. The second SR found moderate evidence to support the additional benefits that aquatic exercise in patient with fibromyalgia based on 4 RCTs [26]. The latter SR did not perform a meta-analysis, so no data were available.

Lastly, one other additional SR evaluated all types of aquatic exercises in adults with all types of low back pain [27]. Based on seven RCTs they found that aquatic exercises are equally effective when compared to other interventions in patients with chronic low back pain and pregnancy related low back pain.

The main problem mentioned in most reviews is the overall high risk of bias (low quality) and low power of the individual studies that hamper firm conclusions.

Effects of aquatic exercises versus land-based exercises

Few studies (mainly RCTs) compared the effectiveness of land-based exercises versus aquatic exercises using a direct comparison. We found two systematic reviews, one including 10 RCTs on patients with hip and knee arthritis only [8]. One other SR included a subgroup of 10 RCTs that evaluated aquatic exercises compared to land-based exercises in a variety of musculoskeletal conditions such as rheumatoid arthritis, osteoarthritis, fibromyalgia and chronic low back pain [9].

Based on a meta-analysis of two studies (one including patients with RA (rheumatoid arthritis), one with fibromyalgia) of sufficient quality and data available ($n = 103$) no differences between aquatic exercise and land-based exercises were found on pain (SMD = 0.11; 95%CI: 0.27–0.50).

For patients with hip and knee arthritis, there were no statistically significant differences for any outcomes comparing aquatic exercises to land-based exercise [8]. For instance, regarding function the authors reported an overall non-significant effect estimate (SMD = 0.07; 95%CI: –0.26 to 0.12) which was comparable to other outcomes measures evaluated in this SR [8]. On the other hand, the Cochrane review included one RCT in patients with knee osteoarthritis ($n = 46$) with a direct comparison and concluded that aquatic exercises were more beneficial than land-based exercises for reducing on pain in the short-term (SMD = 0.86; 95%CI: 0.25–1.47) [24]. Immediately after the treatment, there was no evidence of effect on stiffness or walking ability [24].

In one RCT, included in an SR, evaluating aquatic exercise compared to land-based exercises in patients with fibromyalgia no differences were found between the groups [26].

In two RCTs which compared land-based and aquatic exercise in adults with all types of low back pain the pooled effect estimate showed no difference in effect between the groups for pain (VAS) and function (ODI, Oswestry Disability Index) [27].

Finally, in a large Cochrane review focussing on physiotherapy for patients with ankylosing spondylitis one RCT was included comparing additional aquatic exercises in spa resorts (+home-based exercises) with home based exercises alone, concluding that there is a beneficial effect of aquatic exercise at on pain and global perceived effect at 4 and 16 weeks after randomisation, but no differences at long-term (28 and 40 weeks). Also no differences were found on function for patients with ankylosing spondylitis [28].

Based on the evidence found we conclude that aquatic therapy is probably effective in patients with osteoarthritis, low back pain and fibromyalgia in the short-term, when compared to no treatment. Nevertheless, it remains unclear whether aquatic exercises are more effective than other active interventions such as land-based exercises. Furthermore there is a lack of evidence for specific doses and timing of exercise programmes because most RCTs and SRs did not provide enough information to address these issues. Often the intervention was rather poorly described in the original papers.

How do the effects of aquatic exercises compare with those of balneotherapy?

This question can be best answered by studies comparing aquatic exercises with balneotherapy. Because few studies evaluated this direct comparison we start with describing the effectiveness of balneotherapy compared to no treatment to enable people to perform an indirect comparison with aquatic exercises as described above. The results of the studies evaluating the direct comparison are presented last.

Effects of balneotherapy

Several systematic reviews focus on the effectiveness of balneotherapy, of which one best-evidence synthesis on (aquatic therapy and) balneotherapy [23], two Cochrane reviews (one on osteoarthritis

and one on rheumatoid arthritis) [29,30], and three additional SRs (one on osteoarthritis, one on fibromyalgia and one all kinds of diseases) [26,31,32].

The best-evidence synthesis found five SRs, including both Cochrane reviews, and concluded that none of the included SRs provided clear evidence of a beneficial effect of balneotherapy in patients with hip and knee osteoarthritis, rheumatoid arthritis and low back pain [23].

Both Cochrane reviews explicitly state that because of the methodological flaws, an answer about the apparent effectiveness of balneotherapy cannot be provided in patients with rheumatoid arthritis as well as osteoarthritis [29,30]. Both reviews are being updated at the moment, but concerning rheumatoid arthritis the update is only a minor one and the conclusion does not change.

One additional SR evaluated the effectiveness of balneotherapy across different musculoskeletal disorders and found studies on osteoarthritis, fibromyalgia, ankylosing spondylitis, rheumatoid arthritis and chronic low back pain [31]. Combining data from different studies using statistical pooling was not possible so their conclusion was that “the available data suggest that balneotherapy may be truly associated with improvement in several rheumatological diseases. However, existing research is not sufficiently strong to draw firm conclusions” [31]. This conclusion was in accordance with the systematic review focussing on patients with knee osteoarthritis alone [32].

The SR on patients with fibromyalgia concluded, based on 4 RCTs, that there is moderate evidence in favour of the use of balneotherapy [26]. Unfortunately, no meta-analysis was performed, no data were presented, and most studies showed major methodological flaws.

The possibility to draw firm conclusions on the effectiveness of balneotherapy seems to be seriously hampered by the fact that most studies suffer from low power, a high risk of bias and a poor data presentation.

Effects of aquatic exercises versus balneotherapy

Very few studies compare aquatic exercises and balneotherapy in a direct comparison. In all SRs we found four RCTs relevant for this comparison.

One RCT, including patients with fibromyalgia, evaluated the additional value of aquatic exercises on balneotherapy and found only a difference on depression (no data available) in favour of additional aquatic exercises [31].

Another included RCT evaluated balneotherapy compared to a home exercise program in patients with ankylosing spondylitis. They found no differences between balneotherapy and aquatic exercises on pain and function at one and three months after treatment [31]. Nevertheless no differences between the groups were found in two RCTs included in a SR focussing on aquatic therapy in patients with fibromyalgia and rheumatoid arthritis [9].

Based on the evidence we conclude that it remains unclear whether balneotherapy is effective, compared to no treatment or aquatic exercises, in patients with rheumatoid arthritis, osteoarthritis, ankylosing spondylitis, low back pain and fibromyalgia. Studies were heterogeneous concerning patient populations, interventions and outcome measures and based on poor data presentation often statistical pooling was not possible. Nevertheless in the individual studies balneotherapy seem to be beneficial for most patients. Evidence on balneotherapy is less extensive compared to aquatic therapy and overall the methodological quality is lower which makes drawing conclusions at all difficult.

Are there specific indications?

Based on the above discussed studies, no clear answer can be provided about the specific indications for either aquatic exercises or balneotherapy. To do so studies needed to provide subgroup analyses, which have not been done yet. Balneotherapy and aquatic exercises are most often evaluated in patients with rheumatological diseases. This does not mean it would not be effective in other musculoskeletal conditions.

As there appeared to be no clear difference in effectiveness between specific forms of exercise treatments, nor that we could find any subgroup analysis we can only suggest indications based on a theoretical construct. Aquatic exercises seem specifically relevant for musculoskeletal conditions in which weight bearing is a problem, like rheumatological conditions and post-operative conditions (for instance after hip or knee surgery and when risk for infections is low). Furthermore, when exercise is too difficult to perform on land, aquatic programs provide a suitable alternative.

Balneotherapy seems to be specifically indicated in patients with rheumatological diseases, because of the warmth, buoyancy and minerals of the water. There is a clear lack of evidence on indicating special subgroups in that clearly benefit from aquatic exercises or balneotherapy.

Cost-effectiveness

Four studies were found about cost-effectiveness of aquatic therapy in rheumatic diseases [33–36]. In a British study they compared the effects of combined aquatic exercises and land-based physiotherapy with land-based physiotherapy only in children with juvenile idiopathic arthritis through a RCT. The results showed two months after the intervention no significant differences in mean costs between the two groups, although the combined group had slightly lower mean costs (6.9 pond Sterling) [33].

Two studies evaluated costs of aquatic exercises to usual care in patients with osteoarthritis [34,35]. The oldest study evaluates cost of the Arthritis Foundation aquatic exercise classes in Washington State [34]. Lifetime osteoarthritis-related costs from the societal perspective were \$8328 higher for the aquatic exercise group than for the usual care control group, but differences between the groups were not significant. In another British study the aquatic exercise programme produced a favourable cost-benefit outcome concerning pain reduction. The mean cost difference showed a saving in the aquatic exercise group of 123–175 pond Sterling per patient per year [35]. One very small study from Spain stated that adding an aquatic exercise program to the usual care of women with fibromyalgia was cost-effective [36].

Practice points

- Aquatic therapy is a popular treatment for many patients with musculoskeletal disorders, and seems a beneficial treatment in patients with osteoarthritis, chronic low back pain and fibromyalgia.
- It remains unclear whether balneotherapy is more or less effective than aquatic exercises. They seem equally effective and these treatments seem particularly useful when patients are unable to exercise on land.
- For patients with osteoarthritis aquatic exercise is not a costly intervention and it might be cost-effective, but further research on cost-effectiveness is warranted.

Research Agenda

As stated in the introduction, summarizing the evidence in systematic reviews or best-evidence synthesis also identifies areas that need further research.

- High-quality trials are needed on aquatic exercises research in specific patient categories that might benefit most from aquatic exercises, e.g. post-operative knee and hip patients
- High-quality trials are needed on balneotherapy. Specific attention should be paid to:
 - better quality trials (low risk of bias)
 - with sufficient power and
 - adequate data presentation
 - in specific patient categories
- Research is also lacking on cost-effectiveness of aquatic therapy and balneotherapy.

Summary

We aim to present a best-evidence synthesis of the current systematic review evidence for aquatic exercises and balneotherapy used for musculoskeletal conditions and to highlight gaps where more

research is warranted. Musculoskeletal disorders are very common among all age groups. The most common self-reported musculoskeletal pain sites were low back pain, shoulder pain and neck pain. Bathing or exercise in warm water are very popular treatment for many patients with musculoskeletal conditions, but especially in rheumatologic conditions. Based on the evidence found we conclude that aquatic therapy is probably effective at short-term in patients with osteoarthritis, low back pain and fibromyalgia. Nevertheless it remains unclear whether aquatic exercises are more effective than other active interventions such as land-based exercises. Furthermore there is a lack of evidence for specific doses and timing of exercise programmes overall. It remains unclear whether balneotherapy is effective, compared to no treatment or aquatic exercises, in patients with rheumatoid arthritis, osteoarthritis, ankylosing spondylitis, low back pain and fibromyalgia. Based on poor data presentation often statistical pooling was not possible. Nevertheless in the individual studies balneotherapy seem to be beneficial for most patients. Evidence on balneotherapy is less extensive compared to aquatic therapy and overall the methodological quality is lower which makes drawing conclusions at all difficult

Conflict of interest

All authors declare that they have no conflict of interest.

Funding

No funding.

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