The impact of hydrotherapy on a patient's perceived well-being: A critical review of the literature

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The impact of hydrotherapy on a patient's perceived wellbeing: A critical review of the literature

Short title: The impact of hydrotherapy on a patient's perceived wellbeing

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Abstract

Background: Physiotherapists commonly use hydrotherapy as a treatment approach for various types of conditions. As hydrotherapy utilizes the hydrodynamic properties of water to promote relaxation and decrease pain perception, previous research has suggested that hydrotherapy may help to decrease the health burden of musculoskeletal conditions. The aim of this review was to critically examine literature investigating (a) the benefits of hydrotherapy on reducing pain and disability associated with chronic musculoskeletal conditions, and (b) report on literature findings regarding the perceived benefit of hydrotherapy on the wellbeing of adults with chronic musculoskeletal conditions.

Methods: Select electronic databases were searched to identify relevant articles. Studies meeting the inclusion criteria were critically analyzed using the Downs and Black protocol with agreement between raters assessed via Kappa analysis.

Results: Nine original articles addressing the benefits of hydrotherapy on adult populations with chronic musculoskeletal conditions were analysed. The mean critical appraisal score was 73% (Kappa = 0.87) with the evidence suggesting that hydrotherapy had a positive effect on pain, quality of life, condition related disability and functional exercise capacity. It was also noted that following hydrotherapy, the perceived benefit of wellbeing was superior to land-based exercise protocols in cases where water temperature was within a thermoneutral range (33.5°C to 35.5°C).

Conclusion: Hydrotherapy helps to reduce the health burden of musculoskeletal conditions. Improvements in the perception of wellbeing are likely to occur following hydrotherapy that is conducted in water within the thermoneutral range.

Key Words: Hydrotherapy; Therapeutic exercise; Quality of life; Aquatic therapy; Chronic condition.

INTRODUCTION

Musculoskeletal (MSK) conditions are a major health burden worldwide.(1) MSK pain or more specifically chronic MSK pain (pain every day for 3 or more months) is an area which is under-reported in the research.(1) Over the past 40 years the prevalence of chronic MSK pain has increased two- to fourfold, causing disability within approximately 11% to 25% of adult populations worldwide.(1) Research suggests that the prevalence of MSK conditions will continue to increase.(1, 2) This surmise is based on the increasing sedentary lifestyle of adults, which in turn has led to higher proportions of overweight and obesity in adult populations worldwide.(1) Current evidence has identified links between obesity and the development of chronic MSK conditions, thus as obesity continues to increase, the proportion of the population suffering from MSK conditions is anticipated to increase as well.(1)

Currently research is focused on identifying the best treatment options for these types of conditions. Conclusive evidence has shown that exercise is the best non-pharmacological treatment for osteoarthritis (OA), chronic lower back pain (CLBP) and other chronic MSK conditions (2-4) as it helps to reduce condition related pain, improve physical function and enhance quality of life (QOL).(2, 4) Furthermore, research shows that exercise in water, often referred to as hydrotherapy, aquatic therapy or aquatic exercise, can help to decrease the burden of MSK conditions.(2) For the purpose of this review, the term hydrotherapy will be used to describe all water-based therapy including aquatic therapy and aquatic exercise.

Hydrotherapy sessions are performed in ordinary water (5) at a recommended temperature of 33.5°C to 35.5°C.(6) This temperature range helps to provide immediate and delayed therapeutic effects without over-cooling or over-heating during exercise.(6) In combination with water temperature, the compressive properties of water aid to promote muscle relaxation and reduce joint swelling.(5, 6) These compressive effects also help to increase muscle blood flow above dry land exercise by 225% in turn increasing the oxygen availability to skeletal muscles (6) and thereby helping to promote relaxation and tissue healing. In addition, as water immersion helps to decrease the gravitational load on the body,(6) hydrotherapy allows individuals to perform exercises that they may not be able to do on land.(7) Given these benefits of hydrotherapy, physiotherapists commonly use this modality as a treatment option for MSK conditions, and a variety of other conditions, as it allows the use of water's hydrodynamic properties in combination with movement to facilitate and restore function.(8)

Apart from the physiological effects, recent studies have started to assess the impact of hydrotherapy on wellbeing.(6) Wellbeing is a state of mental health or a person's psychological functioning which encompasses life satisfaction, happiness, self-esteem and the ability to develop and maintain relationships.(9) Within most studies, QOL outcome measures with a mental health component are utilized indirectly to make conclusions about the effects of hydrotherapy on wellbeing.(10-12) By observing the effect of hydrotherapy on QOL, studies have shown that hydrotherapy helps to reduce anxiety scores and improve perceived wellbeing equal to, or greater than, land-based exercise (LBE) as warm water-immersion decreases sympathetic nervous system activity thereby increasing parasympathetic nervous system activity, eliciting a relaxation response.(6) Hydrotherapy also reduces the risk of falling during exercise to a greater extent than on land, once again impacting the wellbeing of the participant.(6)

Within current literature, there is a plethora of evidence outlining the physical benefits of hydrotherapy, yet a critical review of this literature is needed to summarize the evidence investigating the benefits of hydrotherapy on reducing pain and disability associated with chronic MSK conditions and how this can impact QOL. For the purpose of this review, we are to report on any findings within the literature regarding the perceived benefit of hydrotherapy on the wellbeing of adults suffering from chronic MSK conditions.

MATERIALS AND METHODS

PubMed, PEDro, the Cochrane Library, CINAHL and Google Scholar electronic databases were searched using key words (detailed in Table 1). Following the removal of all duplications, journal titles and the article abstracts were screened against the selected inclusion criteria. The inclusion criteria used were (a) articles were published between the years of 2010 to 2014; (b) all articles reported original research; (c) participants included individuals with a chronic MSK condition; and (d) an aquatic-based intervention (hydrotherapy) formed part of the study.

Insert table 1 here

Retained articles were then subjected to exclusion criteria to ensure only research aligning with the review's aims were included. Exclusion criteria were (a) full text was unavailable and could not be acquired; (b) articles were not published in English and were unable to be translated into English; (c) the reported study did not include adult participants; or (d) the treatment modalities in the study included whirlpool therapy, spa-therapy, Balneotherapy, thermal mineral water therapy, Kneipp hydrotherapy or aqua fitness. Articles were excluded firstly by screening the article's title then screening the article's abstract. Articles meeting the criteria for this review were then critically appraised.

The methodological quality of all included articles was assessed using the Downs and Black Checklist, a tool used for grading the methodological quality of research articles.(13) The checklist allows for the assessment of both randomized and non-randomized studies of health care interventions. The checklist addresses five subcategories including reporting quality, external validity, internal validity (bias), internal validity (confounding) and statistical power. The checklist consist of 27-items for which each item is provided a score of 1=Yes, 0=No or 0=Unable to determine. Two of these questions have a greater scoring power. Item 5 can be scored from 0-2 points, where 1 point is awarded for partially detailing confounders and 2 points for definitively detailing confounders. Item 27 is scored from 0-5 points based on sample size where a larger sample is worth more points. For the purpose of this review, item 27 was scored with either 1 point where the study outlined the power of their sample size or 0 points where the study did not describe the power of their sample size. Scores were converted to a percentage of the total score by dividing each article's raw score by 28 points, total possible score, and multiplying it by 100%. All studies were independently rated by the two authors (AC, RO) with the level of agreement measured with Cohen's Kappa analysis of all raw scores (27 scores per paper). For final scores, any disagreements in points awarded were settled by consensus.

Information was extracted from studies meeting the review's criteria. Data detailing the study population (number of participants, MSK condition), demographics (age and gender), primary outcome measures assessed (pain, QOL, disability and functional exercise capacity) and intervention characteristics (type of intervention, length, frequency, duration and temperature of the water) were extracted as were the major findings and limitations.

Extracted information were then synthesized by looking at the affect of hydrotherapy on pain, QOL, condition related disability and functional exercise capacity. Where possible, these results were compared to the effect of LBE interventions and/or no intervention on the above factors.

In order to manage and reduce bias within the literature search and review, strategies were implemented into the search process. First, the Downs and Black Checklist(13) was used to reduce inclusion and extractor bias as the Checklist allows consistent assessment of the methodological quality of all articles included in this review. Second, all variations of hydrotherapy were included in the search terms and a number of different databases were used to reduce the risk of search bias during the initial literature search.

RESULTS

The literature search identified 1421 potential articles for screening. Following the removal of duplicates, 1390 titles were screened. Of these 38 met the inclusion criteria based on title of which 29 were excluded following a review of abstracts. A full-text assessment and critical appraisal was performed on the nine remaining articles. The overall search process is shown in the PRISMA diagram (Figure 1).

Insert figure 1 here

The mean methodological quality scores produced using the Downs and Black protocol(13) was 20.3±4.6 out of 28 points (73%), ranging from 13 out of 28 or 46%(14) to 27 out of 28 or 96%(15) (See Table 2). The inter-rater agreement for this review was considered almost perfect (k= 0.87).(16) The most notable limitations of these studies were the lack of reporting on the risk of adverse events, identifying if participants were representative of the entire population from which they were recruited, calculating power to detect if the intervention yielded a clinically important effect and the ability to blind the participants to the intervention. Notable strengths of the studies included outlining the aim, main outcomes to be measured, detailing study inclusion and exclusion criteria and administering appropriate statistical tests to assess the main outcomes.

Insert table 2 here

Description of included studies

Seven out of the nine studies included in this review involved both male and female participants.(15, 17-22) In all but one of these seven studies,(20) the number of female participants were greater than male participants. Of the remaining two studies, one(14) included only female participants while the other(23) did not specify participant gender. The total number of participants in each study varied widely from 12(18) to 149.(19) Likewise, the age of participants was variable ranging from means of 48.7(23) to 73.5(20) years of age.

The nature of the pathologies investigated were diverse. Four studies looked specifically at CLBP(14, 17, 18, 20), four studies looked specifically at knee OA (15, 19, 21, 22) and one study looked at CLBP, OA and chronic neck pain.(23) All hydrotherapy interventions were 40 to 60 minutes in length, with the exception of one study, which did not specify session duration.(21) The number of sessions varied between 2x/week,(19-21, 23) 3x/week (15, 19, 22, 23) to 5x/week.(14, 17, 19) One study did not state the number of sessions conducted per week.(18) Hydrotherapy intervention study durations varied from six weeks(18) to 52 weeks(23) with the most common duration was 10 to 12 weeks.(14, 20-22) Differences in water temperature were also noted, most aquatic-based interventions occurred within a 29.0°C to 30.0°C pool(17, 19, 22, 23) or 32.0°C to 34.0°C pool.(15, 18, 19) Three studies did not state the temperature of the water where the intervention took place.(14, 20, 21) Detailed characteristics of the included studies can be found in Table 3.

Insert table 3 here

Many different health-related variables were assessed across all nine studies. The most common outcomes assessed included pain,(14, 15, 17, 18, 21, 22) QOL,(15, 17, 19-23) condition related disability (15, 17, 19, 20, 23) and functional exercise capacity. (17, 21, 22) Differences in type of outcome measures used varied across all included studies with all studies employing multiple outcome measures.(14, 15, 17-23) Pain was assessed using a Visual Analog Scale (VAS),(14, 17, 18) self-reported use of analgesics,(21) Brief Pain Inventory (BPI)(15) and Knee Injury and Osteoarthritis Outcome Score (KOOS).(22) QOL was measured using the 36-item Short Form Health Survey (SF-36), perceived quality of life (PQOL) scale,(19) Chinese Arthritis Management Scales 2 (CAIMS2)(21) or KOOS.(22) Condition related disability measures used were dependent on the type of condition included in each study. To assess CLBP, the Oswestry Low Back Pain Disability Questionnaire (OLBPQ)(17) and Roland Morris Disability Questionnaire (RMDQ)(20, 23) were used. Chronic neck pain was assessed using the Neck Disability Index (NDI)(23) and

OA was assessed using either the 19-item Disability Index (DISINDX)(19) or Western Ontario and McMaster Universities Arthritis Index (WOMAC).(15, 23) Finally functional exercise capacity was assessed through health related fitness measures such as sit-and-reach, handgrip strength, curl-ups (upper and lower limb strength), the Rockport 1-mile test(17) and the six-minute walk test(21, 22) (walking speed/ mobility).

Pain was found to be significantly reduced across all six of the studies that specifically assessed pain following a hydrotherapy intervention.(14, 15, 17, 18, 21, 22) These studies included populations with CLBP(14, 17, 18) and knee OA.(15, 21, 22) This result was consistent when hydrotherapy was compared to a control group.(14, 15, 17, 22) While two studies found a significant change in pain between hydrotherapy and control groups in patients with CLBP,(14, 17) Lim et al(15) found a significant change in pain interference (as measured by the BPI) between hydrotherapy and LBE patients with knee OA. Conversely, Wang et al(22) and Bello et al(18) noted pain scores significantly decreased when assessing patients with knee OA and CLBP following both hydrotherapy and LBE interventions but no difference between the two interventions themselves.

As pain decreased following hydrotherapy, it was also noted that QOL increased. This trend was noted in all seven articles assessing the effect of hydrotherapy on QOL.(15, 17, 19-23) More specifically when assessing the QOL of individuals with CLBP following hydrotherapy, Baena-Beato et al(17) found a significant increase in the physical component score but no significant difference in the mental component score of the SF-36 questionnaire when compared to a control group. Costantino and Romiti(20) looked at hydrotherapy versus a 'Back School' program, where the Back School program initially provided participants with a holistic education session on lower back pain, subsequently followed by the execution of a lower limb and trunk strength and flexibility LBE program for the duration of the study. Results showed a significant improvement in QOL following both interventions.

In populations with OA, QOL was also found to increase following hydrotherapy.(15, 19, 21) Lau et al(21) observed a significant improvement in mobility, pain and mood following hydrotherapy. Of note however, this research did not include a control group against which to compare change. Considering this, Cadmus et al(19) did find that PQOL improved following hydrotherapy when compared to a control group. However improvement in PQOL following hydrotherapy was only seen in participants classified as obese.(19) When comparing hydrotherapy to both a LBE group and a control group, Lim et al(15) saw significant improvements in SF-36 scores in the physical component score for both hydrotherapy and LBE groups, and improvements in the mental component score from the hydrotherapy group only. Comparatively, Wang, et al(22) saw an overall improvement in QOL following a hydrotherapy and LBE intervention using the KOOS outcome measure (a 42-item questionnaire used to assess knee OA specific health related QOL). For populations with knee OA, CLBP and chronic neck pain, Cuesta-Vargas et al(23) found statistically significant improvements in mental and physical component scores outlined in the SF-36 following a multimodal physiotherapy program. Overall, following a hydrotherapy intervention, positive improvements to QOL are noted within the literature with QOL outcome measures showing that hydrotherapy had a positive effect on mental health and wellbeing.

Improvements seen within the mental component aspects of the QOL outcome measures indirectly show changes in perceived wellbeing.(10-12) Following hydrotherapy, studies by Cadmus et al,(19) Lau et al(21) and Lim et al(15) saw improvements in PQOL, mood and within the SF-36 Mental Component Scores respectively when compared to a LBE(15, 21) or control(19, 21) group. In addition, equal improvements in SF-36 physical and mental component scores were noted by Costantino and Romiti(20) and Cuesta-Vargas et al(23) following all interventions conducted. One exception to findings of improved perceived wellbeing following hydrotherapy come from the results of Baena-Beato et al,(17) who failed to find improvement in perceived wellbeing as measured by the SF-36 mental component score. Overall, there is indirect evidence showing that hydrotherapy positively impacts perceived wellbeing to an equal to or greater extent than LBE.

Condition related disability was assessed in seven of the studies included in this review.(15, 17, 19-23) All studies found significant decreases in disability following hydrotherapy. The three studies that compared hydrotherapy to LBE found a significant reduction in disability following both interventions as well.(15, 20, 22) These findings show that physical activity is an important management tool for individuals with chronic MSK conditions as it can assist to decrease condition related disability, which in turn may also help to improve one's perception of wellbeing.

Significant improvements were seen in health related fitness measures, sit-and-reach, handgrip strength, curl-ups, and the Rockport 1-mile test, following a hydrotherapy intervention as compared to a control group.(17) These results suggest that an improvement in functional exercise capacity can be provided by hydrotherapy treatments. A similar result was seen when looking at hydrotherapy and LBE compared to a control group where significant improvements in six-minute walk test results were observed.(22) As such the research suggests that that hydrotherapy and LBE can help improve walking speed/mobility(17, 21, 22) and health related fitness (upper limb and lower limb strength)(17) to a greater extent than no exercise intervention.

DISCUSSION

The aim of this review was to (a) critically analyze recent literature investigating the benefits of hydrotherapy on reducing pain and disability associated with chronic MSK conditions thus improving QOL and (b) to report findings within the literature regarding the perceived benefit of hydrotherapy on the wellbeing of adults suffering from chronic MSK conditions. After completing a search of recent literature, a wide range in quality of evidence was found when critiqued via the Downs and Black Checklist, where scores ranged from 46% to 96%. Thus more high quality evidence may be needed to strengthen this reviews findings and conclusions. Within this review, it was found that hydrotherapy and LBE both helped to reduce the impact of pain and disability as well as improve QOL and functional exercise capacity in populations suffering from chronic MSK conditions. Although the volume of evidence was minimal, the research also noted that, following hydrotherapy, the participant's perceived wellbeing was superior to those participants who followed a LBE protocol.

Hydrotherapy and its effects on pain

In the six articles (14, 15, 17, 18, 21, 22) that investigated the effect of hydrotherapy on pain, all studies concluded that pain decreased significantly following hydrotherapy. When hydrotherapy was compared to a control group, Baena-Beato et(17) and Han et al(14) found significant decrease in VAS pain scores in patients with CLBP. When hydrotherapy was compared to a LBE intervention, both Wang et al(22) and Bello et al(18) found a similar reduction in pain whereas Lim et al(15) observed a greater reduction in pain inference in the hydrotherapy group only. The differences in these results could be explained by the differences in water temperatures used.

Both water immersion and water temperature have been found to facilitate body relaxation and effect pain perception.(6) It has been noted that upon immersion in water, the parasympathetic nervous system function increases, suppressing the activation of the sympathetic nervous system, resulting in a lowered heart rate.(6) This variability of the heart rate associated with water immersion has been shown to affect how individuals perceive pain.(6) In addition it has also been suggested that with warmer water temperatures, parasympathetic activation increases thereby having a potential relaxing effect.(6) Facilitated by warmer water temperatures, this relaxation may also assist to reduce pain associated with MSK conditions. As such, Becker(6) states that water ranging from 33.5°C to 35.5°C is the preferred temperature for hydrotherapy pools as it prevents individuals from over-heating or becoming too cool while exercising and allows individuals to stay within the water for longer.(6)

In the studies above, the water temperature ranged from 30°C (Wang et al(22)), to 32°C to 34°C(Bello et al(18)), to 34°C(Lim et al(15)). Thus the added benefits of temperature in combination with water immersion may not have been provided to participants within the hydrotherapy groups in studies by Bello et al(18) and Wang et al(22) as water temperatures used were generally below the threshold associated with therapeutic benefits for chronic MSK conditions. This difference in water temperature may provide a reason for the contradicting results.

Hydrotherapy and its effects on QOL

In the seven studies(15, 17, 19-23) that assessed QOL, an improvement was seen following participation in hydrotherapy for individuals with CLBP, chronic neck pain and OA. A significant decrease in disability(15, 17, 19-23) and improvement in functional exercise capacity(17, 21, 22) were observed in the hydrotherapy groups when compared to control groups in all studies. This result is consistent with previous research.(2, 3, 6, 24)

Similar benefits have been seen within these populations following LBE(15, 19, 20, 22) Previous research notes similar physical health benefits following both hydrotherapy and LBE.(2, 6) Thus the physical improvements observed following hydrotherapy and LBE in each of these studies may be due to the general benefits exercise has on health and physical function. This improvement in physical function is likely to have assisted in improving QOL for all participants involved in an exercise intervention.

The study by Cadmus et al(19) serves as an example. In their study, a perceived improvement in QOL (using the PQOL scale) was observed following hydrotherapy; this improvement was considered to be mediated by changes to BMI. Of note however, the improvements in this instance were only noted within participants considered to be obese.(19) As such the result must be viewed with caution as a similar improvement in perceived wellbeing was not noted in patients within the normal BMI range. The impact of the properties of water; buoyancy, viscosity, temperature and hydrostatic pressure(7); may explain why PQOL was significantly improved for only the participants who where considered to be obese in the study by Cadmus et al.(19) These properties act to de-load the body reducing the impact of excess weight on the joints, making it easier for obese individuals to exercise(2, 6) a benefit that may have impacted other participants to a lesser degree.

Hydrotherapy and its effects on Wellbeing

While no studies meeting the review's inclusion criteria were found to focus specifically on the impacts of hydrotherapy on patient wellbeing, wellbeing can be indirectly inferred from QOL outcome measures.(10-12) Again some differences were noted in the literature regarding the mental benefits of hydrotherapy. Beana-Beato et al(17) found significant improvements in the SF-36 score within the Physical Component Score, but not the mental component score following hydrotherapy when compared to a control group. Conversely, not only did Lim et al(15) find significant improvements in SF-36 Physical Component Score in both hydrotherapy and LBE compared to control group but they also found a significant improvement in SF-36 Mental Component Score in the hydrotherapy group only. Again, the cooler water in the study by Beana-Beato et al(17) may have influenced the results through not being warm enough to facilitate the therapeutic effects, like relaxation promoted by warmer water.(6) Conversely, with the study by Lim et al(15) the hydrotherapy sessions were conducted in 34°C water thus participants were more likely to receive the added therapeutic benefits of exercising within water than the LBE group, which in turn yielded a greater improvement in wellbeing and SF-36 Mental Component Scores.

Individual preference of exercise type may have impacted on the overall benefit and sense of wellbeing following hydrotherapy. It has been noted in previous research that an individual's preference for exercise type may influence the effects on patient's pain, QOL, disability and functional exercise capacity as preference enhances compliance to exercise programs.(2, 3, 24) It can therefore be hypothesized that an individual's preference for exercise may impact their perceived benefit following a program, and thus indirectly influence the outcomes and their sense of wellbeing. Previous research by Barker et al(2) and Shamliyan et al(24) suggested that an intervention is more effective when exercise type is preferred by the participant as this increases compliance to the program (hydrotherapy or LBE). Considering this, exercise preference may be a motivator to exercise compliance and therefore those individuals who prefer hydrotherapy over LBE, may perceive hydrotherapy as more beneficial, thus improving their overall sense of wellbeing. The exploration of patient preference for hydrotherapy compared to LBE should be considered in future studies to assess if improved motivation to exercise performed during hydrotherapy positively affects a person's perceived wellbeing.

Limitations and challenges

Two key limitations of this review were the potential to miss relevant articles and the quality of the articles available for inclusion. The first limitation was due largely to the large variety of terms used within the literature to describe hydrotherapy (i.e. aquatic therapy, water therapy, aquatic physiotherapy, etc.) and wellbeing (well being, well-being, psychological effect, etc.). Thus some articles may have unintentionally been missed. Secondly, the quality of evidence identified within this review varied greatly as scores from the Downs and Black Checklist(13) ranged from 45% to 96%, this wide variation has the potential to influence the strength of findings presented in this review.

Three challenges were identified when comparing the literature presented in this review, these being the variations in water temperature used, the level of detail for exercise programs provided and a wide variety of outcome measures used within the literature. The wide variation of water temperature in each of the included studies, made it difficult to define hydrotherapy and definitively conclude why results occurred. In each of the included studies there was variation in regards to the type of hydrotherapy exercises and LBE provided with additional variance in the level of detail regarding the types of exercise performed. This again made it difficult to conclude why results occurred or determine a clear best-practice. Finally the wide variety of outcome measures made it difficult to directly compare the mental health benefits and thus perceived wellbeing of hydrotherapy. Future research should ensure that hydrotherapy programs are conducted within water that is within the thermoneutral range and provide a detailed account of the exercises prescribed. Additionally, direct assessment of wellbeing following hydrotherapy using well known and previously reported outcome measures (Warwick-Edinburgh Mental Wellbeing Scale) would be of benefit.

CONCLUSIONS

Based on the results within the nine papers identified for this review, the literature suggests that hydrotherapy can have positive effects on pain, QOL, condition related disability and functional exercise capacity for individuals suffering from a chronic MSK condition. However, the temperature of the water may impact on these results if the water is not within the thermoneutral range. The literature also noted that hydrotherapy may have a superior effect on a person's perceived wellbeing when compared to LBE. However there is minimal evidence assessing the effect of hydrotherapy on wellbeing both directly and indirectly. Additionally exercise preference may impact adherence to a hydrotherapy exercise program and thus perceived wellbeing and bears the need for further research.

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TABLE 1. Details of literature search: databases used and search terms

Database	Search Terms	No. of Articles Found	No. Met Inclusion Criteria	No. After Exclusion	No. of Duplicates Removed	New Articles
PubMed	(“hydrotherapy” OR “aquatic therapy” OR “water therapy” OR “aquatic physiotherapy” OR “aquatic physical therapy”) AND (“well being” OR “wellbeing” OR “health” OR “quality of life” OR benefit*)	279	18	261	0	18
PEDro	Hydrotherapy AND well being	25	3	22	1	2
	“Aquatic Physiotherapy”	18	5	13	2	3
	“Aquatic physical therapy”	10	3	7	1	2
	"hydrotherapy" AND "benefit*"	45	1	44	1	1
	“Aquatic therapy”	16	3	13	2	1
	“water therapy”	21	0	21	0	0
	“hydrotherapy” AND “quality of life”	113	11	102	8	3

EMBASE	(“hydrotherapy” OR “aquatic therapy” OR “water therapy” OR “aquatic physiotherapy” OR “aquatic physical therapy”) AND (“well being” OR “wellbeing” OR “health” OR “quality of life” OR “benefit”) NOT (fibromyalgia)	715	15	700	7	8
Cochrane Library	“hydrotherapy” OR “aquatic therapy” OR “water therapy” OR “aquatic physiotherapy” OR “aquatic physical therapy”	7	1	6	1	0
CINAHL	(“hydrotherapy” OR “aquatic therapy” OR “water therapy” OR “aquatic physiotherapy” OR “aquatic physical therapy”) AND (“well being” OR “wellbeing” OR “health” OR “quality of life” OR “benefit”) NOT (fibromyalgia OR “child*”)	112	8	104	5	3
Google Scholar	(“hydrotherapy” OR “aquatic therapy” OR “water therapy” OR “aquatic physiotherapy” OR “aquatic physical therapy”) AND (“well being”	57	1	56	0	1

	OR “wellbeing” OR “health” OR “quality of life” OR “benefit”)					

TABLE 2. Major findings, limitations and critical analysis score (CAS) of included studies

Author	**Major Findings**	**Limitations**	**CAS (%)**
Baena-Beato et al(17)	-Significant differences between control and hydrotherapy groups in pain (VAS), disability (ODI), QOL (P<0.001), BC (P<0.01) and health-related fitness (P<0.001) - AE: decreased back pain and disability. Increase in SF-36 physical component score (33.1 ± 2.2 to 43.7 ± 2.4). No significant difference in the SF-36 mental component score (53.7 ± 2.1 to 51.9 ± 1.6) -VAS for hydrotherapy (6.22 ± 0. 47 to 2.37 ± 0.38) and for control (6.14 ± 0. 52 to 6.42 ± 0. 43) - ODI for hydrotherapy (29.1 ± 3.6 to 16.4 ± 3.3) for control (29.6 ± 4.0 to 31.7 ± 3.6)	-Selection bias: as unable to randomize the intervention groups - Short intervention length - Improvements seen may have been due to a sedentary population	64
Bello et al(18)	- Significantly lower pain (VAS) was observed in hydrotherapy (6.50±1.52 to 5.00±1.79) and LBE (5.83±1.72 to 4.33±2.07) groups (P<0.05) - Significant increase in MSFT (5.33±0.52 to 6.17±0.41) and MSET (33.0±0.52 to 2.00±0.00) scores in hydrotherapy group (P=0.025 and P=0.046 respectively)	- Small population size - Short intervention length - Study population consisted of more females then males	61
Cadmus et al(19)	- Significantly higher PQOL in hydrotherapy (6.7±1.7 at baseline) compared to control group (6.5±1.5 at baseline) (P<0.01) - Where BMI was a mediator of this relationship	- High dropout rates in hydrotherapy group - Self-reported height and weight could have caused	86

	among obese individuals only (BMI≥30; P< 0.01)	an error in BMI measurement - Mediation analysis were limited by the modest main effect of hydrotherapy on PQOL	
Costantino & Romiti(20)	- Significant improvements were seen at 12weeks and 3month follow-up in hydrotherapy and LBE groups with RMDQ and SF-36 (P<0.001) - RMDQ for hydrotherapy (10.22±2.40 to 5.26±2.16) and LBE (9.59±3.08 to 6.33±2.48) - SF-36 for hydrotherapy (52.19±4.38 to 66.37±3.66) and LBE (52.96±5.52 to 66.26±4.90) - No statistically significant differences were seen with RMDQ and SF-36 scores between the groups (12weeks: p=0.096, p=0.925 respectively and 3 months: p=0.202, p=0.885 respectively)	-Small sample size - No true control group	68
Cuesta-Vargas et al(23)	- Statistically significant improvements in SF-12 physical and mental component scores when performing therapy 2 times (G2) and 3 times (G3) a week - Physical component score for G2 41.17±10.41(baseline) to 57.72±11.95 (12-months) and for G3 39.75±10.83 (baseline) to 58.64±12.71 (12-months) - Mental component score for G2 47.46±10.65 (baseline) to 75.50±14.86 (12-months)	- Selection Bias: only one area of Spain was assessed -No control group	82

	- Statistically significant improvements in disability specific measures (RMDQ, NDI, WOMAC) - RMDQ for G2 7.85±4.77 (baseline) to 4.15±1.10(12-months and for G3 8.93±6.45 (baseline) to 4.83±1.39(12-months) - NDI for G2 21.87±12.86(baseline) to 3.96±3.85(12-months) and for G3 23.82±14.30 (baseline) to 4.91±2.91 (12-months) - WOMAC for G2 25.51±16.15 (baseline) to 7.17±18.02 (12-months) and for G3 15.30±19.28 (baseline) to 6.35±3.81 (12-months)		
Han et al(14)	- Statistically significant changes in pain (VAS) (P<0.01) and maximal peak torque of trunk flexors (P<0.05) and extensors (P<0.05) was seen for the hydrotherapy group - VAS for hydrotherapy (6.52 ± 3.45 to 6.52 ± 3.45) and control (6.09 ± 4.33 to 5.89 ± 4.42) after 10 weeks - Peak torque trunk flexion for hydrotherapy (33.12 ± 7.89 to 33.12 ± 7.89) and control (32.46 ± 12.75 to 36.80 ± 13.54) after 10 weeks - Peak torque trunk extension for hydrotherapy (2.98 ± 8.96 to 12.98 ± 8.96 after 10 weeks) and control (13.26 ± 6.43 to 13.26 ± 6.43) after 10 weeks	- Small sample size - Non-functional measure of trunk muscle strength was used - Validity and reliability of the Cybex-770 is unknown	46
Lau et al(21)	- Decreased used of analgesics to manage pain (P=0.004)	- No control group - Short intervention	61

	- Where reported use of analgesics was 19 to 4 pre- to post-test - Decreased knee and thigh swelling (P=0,002 and P<0.001 respectively), increased MS (P<0.001), decreased pain at end range knee flexion (P<0.05) and increased knee ROM (P<0.01) -Significant improvement in mobility (0.5 to 0.0), pain (2.8 to 1.5) and mood (1.0 to 0.0) (P=0.002, P=0.001 and P=0.003 respectively) were observed using CAIMS 2	length - Co-interventions could have affected results - Recruitment bias -Objective measures were performed by an un-blinded practitioner	
Lim et al(15)	-Reduction in BMI in hydrotherapy and LBE groups (P<0.05), no change in the control occurred - Significant change in pain interference in hydrotherapy group (25.9± 15.0 to 17.3± 11.1) (p<0.05), compared to LBE (20.5± 12.2 to 16.61±10.8) and control (22.0± 15.5 to 23.1± 16.1) groups - A slight increase in SF-36 physical component score in the hydrotherapy (34.4± 7.4 to 38.8± 7.7) and LBE group (35.3± 7.0 to 40.4± 7.9) (P<0.05) and a small increase in SF-36 mental component score in hydrotherapy group only (47.3± 12.1 to 54.8± 8.8) (P<0.05) - A slight increase in WOMAC in hydrotherapy (35.1± 11.3 to 20.9± 9.9) and LBE (33.6± 12.6) groups (P<0.05)	- Short duration - Low intensity - Did not look at the reliability and validity of bioelectric impedance analysis	96
Wang et al(22)	- Significant decrease in pain (KOOS) in hydrotherapy (61± 20 to 72± 18) (P<0.001 at 6 and 12 weeks) and	- Recruitment bias: participants were	89

		LBE (65± 14 to 76± 15) groups (P=0.002 and P<0.001 at 6 and 12 weeks respectively) compared to the control (66± 18 to 68± 18) group - Significant improvements found in with sports/recreation, QOL, knee ROM and 6MWT in both hydrotherapy and LBE group, but not the control group using KOOS outcome measure - QOL results for hydrotherapy (67±13 to 73±12) and for LBE (73±12 to 74±11) - No significant difference occurred between hydrotherapy and LBE groups	recruited from community and sport centers vs. clinical setting - Selection bias - Short intervention length - Uncontrolled variables may have affected differences between the interventions

Abbreviations: Visual Analog Scale (VAS), Oswestry Disability Index (ODI), Quality of life (QOL), Land-based exercise (LBE), Body Composition (BC), Modified Schober Flexion Technique (MSFT), Modified Schober Extension Technique (MSET), Perceived Quality of Life (PQOL), Body Mass Index (BMI), Roland Morris Disability Questionnaire (RMDQ), Neck Disability Index (NDI), Western Ontario and McMaster osteoarthritis index (WOMAC, Knee Injury and Osteoarthritis Outcome Score (KOOS), Muscle strength (MS), range of motion (ROM), Western Ontario and McMaster osteoarthritis index (WOMAC), six-minute walk test (6MWT)

TABLE 3. Characteristics of included studies

Author (Year)	No. of Subjects and Age(y)±SD	Outcomes Assessed	Duration of Intervention (weeks) and Session Length x No. of Sessions per Week	Water temperature (°C)
Baena-Beato et al(17)	Hydrotherapy: n=21, 50.9±9.6 Control: n=17, 46.2±9.8	- Pain -QOL -BC -Health Related Fitness	8 55 to 60mins x 5	29±1
Bello et al(18)	Hydrotherapy: n=6, 53.0±8.67 LBE: n=6, 52.8±12.37	-Pain -Trunk flexibility – flexion and extension	6 45-60mins x 2	32-34
Cadmus et al(19)	Hydrotherapy: n=124, 65.7±5.9 Control: n=125, 66.0±6.1	-QOL -Self-Efficacy - Disability - Activity Limitation -Depression	20 45-60mins x 2-5	29-33
Costantino & Romiti(20)	Hydrotherapy: n=27, 73.30±3.55 LBE: n=27, 73.63±3.36	- Pain - QOL	12 60mins x 2	Not stated
Cuesta-Vargas et al(23)	G2:n=58, 50.04±12.20 G3: n=58,	-Pain -QOL	52 G2: 60mins x 2 G3: 60mins x 3	29-30

	47.38±15.39			
Han et al(14)	Hydrotherapy: n=9, 61.2 ±3.3 Control: n=10, 60.8 ±5.0	- Pain - Peak torque trunk flexion - Peak torque trunk extension	10 50mins x 5	Not stated
Lau et al(21)	Hydrotherapy: n=20, 72 ±2	-BMI -History of knee pain and management -Self-reported use of analgesics -QOL -Functional exercise capacity - LL Strength -Balance - Knee ROM	10 50mins x 2	Not stated
Lim et al(15)	Hydrotherapy: n=26, 65.7±8.9 LBE: n=25, 67.7±7.7 Control: n=24 63.3±5.3	- BW - BMI -Pain - Disability - QOL	8 40mins x 3	34
Wang et al(22)	Hydrotherapy: n=26, 66.7±5.6 LBE: n=26, 68.3±6.4	- Pain - QOL -ROM -Functional	12 60mins x 3	30

	Control: n=26, 67±5.9	exercise capacity	

Abbreviations: Quality of Life (QOL), Body Composition (BC), Land-based exercise (LBE), Body Mass Index (BMI), Lower limb (LL), Range of motion (ROM), Body Weight (BW).

FIGURE. 1: PRISMA flow chart of the search and study selection process.