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Therapeutic aquatic exercise in the treatment of low back pain: a systematic review

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Objective: To examine the effectiveness of therapeutic aquatic exercise in the treatment of low back pain.
Design: A systematic review.
Methods: A search was performed of PEDro, CINAHL (ovid), PUBMED, Cochrane Controlled Trials Register and SPORTDiscus databases to identify relevant studies published between 1990 and 2007. *Population*: Adults suffering from low back pain. *Intervention*: All types of therapeutic aquatic exercise. *Comparison*: All clinical trials using a control group. *Outcomes*: Oswestry Disability Index, McGill Pain Questionnaire, subjective assessment scale for pain (e.g. visual analogue scale) and number of work days lost as a direct result of low back pain. Methodological quality was assessed using the PEDro scale and the SIGN 50 assessment forms.
Results: Thirty-seven trials were found and seven were accepted into the review. Therapeutic aquatic exercise appeared to have a beneficial effect, however, no better than other interventions. Methodological quality was considered low in all included studies. The heterogeneity among studies, in numbers of subjects, symptoms durations, interventions and reporting of outcomes, precluded any extensive meta-analysis of the results.
Conclusion: There was sufficient evidence to suggest that therapeutic aquatic exercise is potentially beneficial to patients suffering from chronic low back pain and pregnancy-related low back pain. There is further need for high-quality trials to substantiate the use of therapeutic aquatic exercise in a clinical setting.

Introduction

Low back pain is the most common cause of referral to a physical therapist and is one of the leading causes of disability.[1] Between 75% and 85% of the population will experience some form of low back pain during their lifetime. In the UK it has been estimated that low back pain costs the economy £10 688 million (more than 20 million dollars) per year through medical costs and lost work days.[2] Low back pain can be classified into three categories: acute, subacute and chronic. In most cases (90%) pain is resolved within 12 weeks without long-term impairment.[3] Chronic low back pain

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accounts for the remaining 10% of the cases and is responsible for the majority of the associated economical burden.[3,4]

The management of low back pain is multifaceted.[5] A recent systematic review concluded that exercise therapy relieves pain and increases function in patients suffering from non-specific low back pain,[1] a finding supported by other published treatment guidelines.[6–8] Exercise therapy is considered a vital part of a multifaceted approach to the treatment and prevention of low back pain.[8–10] Between 51% and 72% of expectant women suffer from pregnancy-related back and pelvic girdle pain[11,12] and it is a common reason for lost work time, early commencement of maternity leave and decreased ability to perform activities of daily living.[13] Causes are thought to be related to loosening of the pelvic ligaments as the body prepares for childbirth[11] and recommended treatments include exercise therapy, back support, massage and education.[13] The recent systematic review by Stuge *et al.*[13] on exercise in the treatment of pregnancy-related back and pelvic girdle pain concluded that exercise is beneficial but not superior to other interventions such as electrotherapy, exercise and sacroiliac belt.[13]

Aquatic therapy has been used for many years in the management of musculoskeletal problems including low back pain. Water immersion decreases axial loading of the spine and, through the effects of buoyancy, allows the performance of movements that are normally difficult or impossible on land.[14] By utilizing the unique properties of water (buoyancy, resistance, flow and turbulence) a graded exercise programme from assisted to resisted movements can be created to suit the patients' needs and function. Additionally, water is theoretically an ideal and safe medium for pregnant women to exercise because the spine and pelvis are supported by buoyancy and hydrostatic pressure. A meta-analysis of spa therapy and balneotherapy indicated that these treatments could also be beneficial for reducing low back pain.[15] The meta-analysis indicated a positive difference in pain (intervention verses control: visual analogue scale) after spa therapy of 26.6 mm (95% confidence interval (CI) 20.4–32.8, $n = 442$) and after balneotherapy of 18.8 mm (95% CI 10.3–27.3) $n = 134$).[14] Therapeutic aquatic exercises were not included in these studies. Although therapeutic aquatic exercise is mentioned in a number of recent low back pain guidelines,[6–10] there is no systematic review available looking at the effects of this treatment form and the quality of the available literature.

Therefore the objective here was to answer the following question: Is therapeutic aquatic exercise an effective treatment for relieving low back pain?

Methods

Literature search

A literature search was performed to identify all possible studies that could help answer the research question. PEDro, CINALH (ovid), PUBMED, Cochrane Controlled Trials Register and SPORTDiscus databases were examined. The databases were searched using combinations of the keywords and search limits presented, with an example for PUBMED, in Appendix 1.

Inclusion criteria

Inclusion criteria were defined using the PICO model (population, intervention, control/comparison and outcome).

- Population: People older than 18 years suffering from low back pain. The inclusion of all types of low back pain was essential to identifying at which stages therapeutic aquatic exercise might be most effective. Women during pregnancy were included while patients post surgery were excluded.
- Intervention: All types of therapeutic aquatic exercise such as aqua-aerobics and aqua-jogging were included. Spa therapy and balneotherapy (non-active) were excluded.
- Control/comparison: Randomized controlled and clinical non- or quasi-randomized controlled trials (CCT) were included.
- Outcomes: Oswestry Disability Index, McGill Pain Questionnaire, subjective assessment scales for pain (e.g. visual analogue scale) and number of work days lost as a direct result of low back pain.

Quality assessment

The databases were searched and 588 studies were identified and examined. Based on titles those clearly deemed inappropriate or doubles were immediately excluded (Figure 1). The full abstracts of the remaining 37 articles were read and a final selection was made. Reference lists from all these studies were also examined but no additional potential studies were found. To ensure accuracy the accepted studies were further read and assessed by three reviewers and comparison of findings between two reviewers was made. In case of disagreement a third reviewer was included. When further disagreement remained, a senior professor or a university sports faculty member was consulted. Reviewers were not blinded to author, institution or journal.

Initially methodological quality was assessed using the PEDro[16] Scale which is based on the Delphi list and has been reported to have a fair to good reliability for its use in systematic reviews of randomized controlled trials in physiotherapy.[17] The scale awards each study a value from 0 to 10 based on a series of 11 criteria (the first criterion is not included in the final score) with each criteria having a simple yes (1)/no (0) answer. For a yes to be awarded the answer must be clearly reported in the study. The scores were summed and a higher score represents better methodological quality. A study scoring 6 from the 10 criteria is considered to have a high methodological quality and those under 6 a low-methodological quality.[17]

The articles were further evaluated using the SIGN 50 (Scottish Intercollegiate Guidelines Network) assessment forms.[18,19] The SIGN checklist includes three sections: the first considers internal validity, second degree of bias and third assists extracting relevant data from the study (see Tables 1–3). There is no weightings of the answers. The degree of bias was classified into three groups. Low: all or most of the criteria have been fulfilled therefore conclusions of the study or review were still unlikely to be altered. Moderate: some of the criteria have been fulfilled, but the conclusions are unlikely to alter. High: few or no criteria fulfilled and the conclusions of the study are thought likely or very likely to be altered.

Analysis

Based on the selected studies comparisons could be made between therapeutic aquatic exercises versus (a) active land exercises or (b) no intervention in the management of low back pain. Where possible, standardized mean differences and 95%

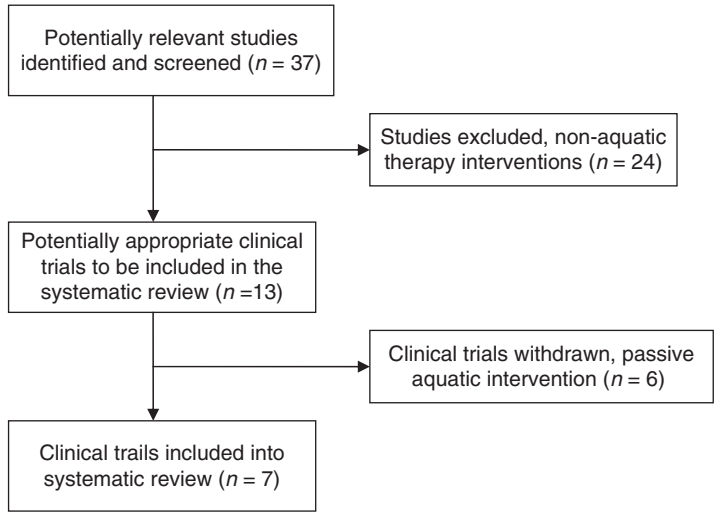

Figure 1 Flowchart showing selection of studies.

Table 1 Description of methodology used

Study	Sjogren *et al.* (1997)[20]	McIlveen and Robertson (1998)[21]	Kihlstrand *et al.* (1999)[22]	Schrepfer and Fritz (2000)[23]	Saggini *et al.* (2004)[24]	Yozbatiran *et al.* (2004)[25]	Granath *et al.* (2006)[26]
PEDro score	5	2	6	4	4	2	2
Randomization of trial	Sequentially allocated in order of presentation to clinic	Withdrawing a marked lottery ticket from a box	Sealed envelopes	States randomization in abstract no other details	Permuted block randomization	States randomization in abstract no other details	By date of birth
Patient blinded	No	No	No	No	No	No	No
Therapist blinded	No	Not reported	Not reported	No	Not reported	Not reported	Yes
Assessor blinded	Yes	Yes	Not applicable	Not applicable	Not applicable	Not reported	Yes
Time of follow-up used for analysis	6 weeks, immediately after treatment	4 weeks, immediately after treatment	week 34 of pregnancy, 1 week postpartum	Immediately after 1st treatment	7 weeks, immediately after treatment	4 weeks immediately after treatment	Up to birth
Longer follow-up	No	No	No	No	Yes 1 year	No	No
Outcome measures	Schober, VAS pain, ODI, Walking test, Medication	Modified Schober, Passive SLR, Tendon reflexes, Strength, McGill Pain, Sensation, ODI	VAS pain (daily), unvalidated questionnaire, days of sick leave associated with LBP	VAS pain, ODI	VAS pain, Backill, medication	VAS pain, ODI, 12-min walk test, Sorensen, SLB, sit and reach, sit up test, BMI	Days of sick leave associated with LBP. VAS pain

VAS, visual analogue scale; ODI, Oswestry Disability Index; SLR, straight leg raise; BMI, body mass index; SLB, single leg balance; LBP, lower back pain.

Table 2 Participants and interventions used in the selected studies

Study	Sjogren *et al.* (1997)[20]	McIlveen and Robertson (1998)[21]	Kihlstrand *et al.* (1999)[22]	Schrepfer and Fritz (2000)[23]	Saggini *et al.* (2004)[24]	Yozbatiran *et al.* (2004)[25]	Granath *et al.* (2006)[26]
Subjects (*N*)	60	109	329	49	40	30	390
Intervention	30	45	129	24	20	15	192
Control	30	50	129	25	20	15	198
Drop-out	4 (2 from each)	14 (11 hydro)	9 + 9	None	None	None	124 (60 = water, 64 = gym)
Age (years)							
Intervention	58.11 ± 11.60	57 ± 15.2	28	40.5 ± 11.3	43.8	39.6 ± 6.33	29.1 ± 4.50
Control	57.36 ± 13.59	58 ± 15.0	29	41.9 ± 15.5	42.7	38.6 ± 6.57	29.2 ± 4.54
Duration of symptoms	>6 months	Not clearly stated	N/A	<90 days	>12 months	>3 months	N/A
Type of symptoms	Non-specific LBP, Disc degeneration	LBP, leg pain and disc disease	Pregnant women with LBP	Acute LBP back and back/ leg pain	LBP, disc disease	LBP (disc involvement, neuro excluded)	Pregnant women LBP and pelvic pain
Intervention	Aquatic exercise with lumbar spine ROM, general strength and endurance	60 min active aquatic therapy, strength, flexibility and endurance	Aquatic therapy, 30 min aquatic exercise, 30 min relaxation	Deep water walking	Aquatic therapy, three-stage progressive programme	Aquatic fitness, 15 progressive exercises and cool down, stretching and light aerobic exercise	45 min active aquatic therapy (strength, flexibility and fitness), 5 min relaxation
Control	Land exercises, same structure as aquatic	Waiting list	Normal prenatal care	Deep water hanging, using upper limb buoyancy aids, no weights	Body weight relief rehabilitation and stretching	Land exercises, same structure as aquatic	Land-based exercise, same aims as aquatic
Treatment duration	2 × 50 min/ week, for 6 weeks	2 × 60 min/ week, for 4 weeks	1 h/week from week 18 of pregnancy	20 min × 1 session	3×/week for 7 weeks	3×/week, for 4 weeks	1 h/week from week 18 of pregnancy

ROM, range of movement; LBP, lower back pain.

Table 3 Outcome of studies included

Study	Sjogren *et al.* (1997)[20]	McIlveen and Robertson (1998)[21]	Kihlstrand *et al.* (1999)[22]	Schrepfer and Fritz (2000)[23]	Saggini *et al.* (2004)[24]	Yozbatiran *et al.* (2004)[25]	Granath *et al.* (2006)[26]
Outcome	Both interventions produced improvements in pain scores (VAS) with no difference between groups	Improvement in ODI score ($P=0.04$) in aquatic therapy group	Less pain VAS at 1 week postpartum ($P=0.034$) and less sick days taken in aquatic therapy group ($P=0.09$)	No improvement in either intervention group	Both groups showed intra-group VAS and Backill improvements. No difference between interventions	No difference between groups. Both groups showed improvements in ODI, Walk test, sit up test, spinal flexibility and trunk strength*	Less sick days in aquatic therapy group ($P=0.03$) and less pain experienced ($P=0.04$)
Improvement in active aquatic exercise group	Pain score (VAS) +13.5 mm 24.4%* ODI (8.7%)*	27% of group improved ODI by +10 patients vs. 8% in no treatment	502 (34%) Less sick days due to LBP taken. Insufficient data for pain scores	Pain score (VAS) +4.2 mm (9.1%)	Based on figure: 5 pt decrease in a 10 pt pain scale with 2 pt regressions at 1 year follow-up. No regression in weight reduction group	Pain score (VAS) +35.3mm 64.7%* ODI +19.34 (48%)*	No subjects required sick leave due to LBP. Insufficient data for pain scores
Standard mean difference (95% CI)	VAS –0.02 (−0.52, 0.49) ODI 0.10 (−0.40, 0.61)	Insufficient data	Insufficient data	VAS 0.28 (−0.28, 0.84)	Insufficient data	VAS −0.35 (−1.07, 0.37) ODI 0.03 (−0.75, 0.69)	Insufficient data
Control of co-interventions	Good	Good	Poor	Good	Poor	Good	Poor
Risk of bias	Moderate	Moderate	Moderate	High	Moderate	Moderate	High
Intention-to-treat analysis	No	No	No	No	No	No	No
Control of co-interventions	Good	Good	Poor	Good	Poor	Good	Poor

*Significant with a *P*-value <0.05.
ODI, Oswestry Disability Index; VAS, visual analogue scale.

confidence intervals were calculated using the Cochrane Collaboration Review Manager 5 program, version 5.0.11. The heterogeneity among studies, in numbers of subjects, symptom durations and especially interventions and outcome measures along with inconsistent reporting of results, precluded any extensive meta-analysis.

Results

After the initial database search and selection based on title and keywords, a total of 37 studies were found. Based on reading of the full abstracts 24 studies were then eliminated due to non-aquatic interventions. The abstracts from all 13 remaining articles were then further examined and six additional articles were excluded as the intervention was deemed passive (Figure 1). The remaining seven articles[20–26] were accepted into the review. These included two studies pertaining to pregnancy-related low back pain and the effect of aquatic exercise compared with normal prenatal advice.[22,26] Two studies comparing aquatic exercise to land exercise,[20,25] two comparing active aquatic therapy to static traction techniques[23,24] and one comparing aquatic exercise to no intervention,[21] all in the management of low back pain.

Methodological quality

Table 2 presents the methodology used in each study. Only one of the seven studies taken in this review scored 6 using the PEDro scale.[22] All studies included claimed to randomly assign participants to the treatment or control group, however only three,[21,22,24] used true randomization techniques and only one of these used computerized randomization. Two of the studies used quasi-randomization techniques[20,26] and in the remaining two papers, the method of randomization was not reported.[23,25] In no studies were patients blinded to the treatment. Evaluator and therapist blinding was often poorly reported. The outcome measures most commonly included were the visual analogue scale for pain (6 out of 7) and Oswestry Disability Index (4 out of 7), but there was no single outcome measure used in all the studies. Only one study included a follow-up after the initial postintervention assessment.[24] Based on the information gathered using the SIGN 50 assessment guidelines, bias was considered moderate (in 5 out of 7 studies) or high (in 2 out of 7 studies) (Table 3).

The study participants (in total $n = 1007$) are described in Table 2, including mean ages, symptoms and duration of low back pain and sample size. In addition this table also presents the interventions used. Only one study included people with acute and subacute low back pain,[23] three studies examined people with chronic low back pain, [20,24,25] and in one study the duration of symptoms was unclear. In studies including pregnant women, low back pain was classified as pregnancy-related low back or pelvic pain.[22,26] The overall age range was 18–74 with mean age per study never above 60 years. The age ranges and duration/type of symptoms varied widely among studies. This fact as well as unclear reporting prevented any further analysis of small cohort groups. Interventions all differed in content as well as duration (1–21 sessions) with the exception of the two pregnancy-related studies where the treatments appeared to be almost identical ($1 \times$ week from gestation week 18). Sjogren *et al.*[20] and Yozbatiran *et al.*[25] attempted to reproduce the water training on dry land with the control group.

Outcomes

The primary outcome of each study, as well as possible bias in the results, is given in Table 3. Intention to treat was not reported in any of the studies. In both the pregnancy-related back and pelvic pain studies significant benefits were demonstrated in both reduced number of sick days related to low back pain (34%, $P = 0.09$)[22] and lower visual analogue scale pain score ($P = 0.034$)[22] and ($P = 0.04$)[26] in the aquatic exercise groups. In other low back pain groups there was no significant difference (see Table 3) in effect between therapeutic aquatic and land exercises with mean effect sizes (95% CI) of −0.02 (−0.52, 0.49)[20] and −0.35 (−1.07, 0.37)[25] for pain scores and 0.10 (−0.40, 0.61)[20] and 0.03 (−0.75, 0.69).[25] The meta-analysis of these did not provide additional information.

Both the experimental interventions and control interventions showed significant improvements compared with baseline measurements. Active aquatic therapy also improved the Oswestry score ($P = 0.04$) compared with no treatment after four weeks of intervention, with no significant changes in symptoms occurring in the control group. No data concerning the size of the changes were reported.[21] Schrepfer and Fritz[23] compared the effect of one 20-minute session of aqua-jogging with the same duration of static aquatic lumbar traction. Their results showed no significant pain relief as measured with the visual analogue scale pain scale for the patients in either group (0.28 (95% CI −0.28, 0.84)). Saggini *et al.*[24] found a significant decrease in pain (5 points on a 10-point scale) and reduction of medication intake after seven weeks of treatment for both a progressive aquatic exercise programme and a programme of weight relief treatment and stretching. At one year follow-up the aquatic intervention group had regressed somewhat while no regression was found in the weight relief treatment group. Both improvements were still significant. None of the studies indicated a negative effect of active aquatic therapy in the treatment of low back pain.

Discussion

This study indicates that therapeutic aquatic exercise appears to be a safe and effective treatment modality for patients who are suffering from chronic low back pain and women suffering from pregnancy-related low back pain. Six of the studies[20,21,22,24–26] showed that therapeutic aquatic exercise produced a statistically significant benefit for patients suffering from chronic low back pain. There was, nevertheless, no evidence that the control interventions were more or less effective in the treatment of low back pain at the end of intervention. The one study with a long-term follow-up did find that the alternative intervention had more substantial long-term effects. Only one study[23] included subjects suffering from acute low back pain but due to poor methodological quality and limited intervention duration no conclusion on the role of therapeutic aquatic exercise in the management of acute low back pain can be currently made. None of the studies indicated any negative effects. Drop-out rates were comparable if both groups received some kind of treatment.

The results indicate that the effect of therapeutic aquatic exercise is comparable to that of spa therapy and balneotherapy. The mean change in visual analogue scale pain scores in three studies for the group participating in therapeutic aquatic therapy could be calculated. Improvements of 4.2 mm (9.1%),[23] 13.5 mm (24.4%)[20] and 35.3 mm (64.7%)[25] were reported. These improvements appear to be similar to those reported by Pittler *et al.*[15] in the review of spa- and balneotherapy, suggesting that the effects might be similar. However due to methodological and numerical differences direct comparison between the two types of interventions is hazardous.

The first comparison examined here was therapeutic aquatic exercise verses no intervention, for which only one study of low quality (2 out of 10 in the PEDro scale) was included.[21] The results indicated that aquatic exercise resulted in a significant improvement in function ($P = 0.04$) as measured by the Oswestry Disability Index but not in any direct measurements of function. This study did not report the descriptive data from the outcome measures, thus preventing comparison of the size of the change related to the intervention. These authors did set standards for clinically relevant improvement in the measures they use and pointed out that these standards were most often met in the aquatic intervention group even when mean changes did not reach statistical significance. The bias in this study was considered high as the patients had already been referred to aquatic therapy by an experienced clinician and therefore were already presumed to benefit from aquatic therapy.

Active aquatic exercises also compared favourably to land exercise.[20,25] Both the aquatic and land-based exercise programmes produced significant improvements in function as measured with the Oswestry Disability Index and reduction in pain scores (visual analogue scale), suggesting that the water environment is possibly as effective for patients with low back pain as land. The study by Yozbatiran *et al.*[25] produced much larger

improvements (although there was no statistical difference). Possible reasons are that the intervention was provided at a higher frequency than the Sjogren *et al.*[20] study (three times a week compared to two), the earlier treatment phase or the younger sample. The starting point of the patient group might have provided a larger potential for improvement. The meta-analysis for this comparison was not included in this study because it did not provide any further information and because of the differences in initial scores, the small sample size ($n = 45$) and difference in methods. The comparable effect of land and aquatic exercise is important to note in any case.

Schrepfer and Fritz[23] compared deep water walking to deep water hanging with subjects suffering from acute low back pain (less than 90 days duration of symptoms) and found no benefit from either intervention. This study only included measurement of pain before and after a single treatment session and scored very low on methodological quality and high on risk of bias. Inclusion of this article was nevertheless warranted as it fit the inclusion criteria of this review and considering that a secondary aim was to investigate the quality of all relevant studies published. In addition, these interventions are not reproducible on dry land and therefore further investigation into these methods is necessary. Exclusion of this study would not have raised this research question.

Aquatic exercise is commonly used with pre- and postnatal women and the evidence presented in this review indicates that it is both an effective and safe modality for the management of pregnancy-related low back pain. These findings support those by Stuge *et al.*[13] Pregnant women who undertook a one-hour active aquatic session once a week had significantly less pregnancy-related back and pelvic pain ($P = 0.04$)[26] and were 34% less often absent from work[22] than pregnant women who received normal prenatal advices. During pregnancy, women receive information from various sources, family members, midwives and friends and therefore the control of co-interventions in these studies would have been difficult.

Compliance was high in the studies examined. Adherence to exercise has been shown to be higher for supervised exercise than for home-based individual programmes.[27] Social interaction was highlighted as an important factor increasing patients' adherence to exercise programmes for chronic osteoarthritis.[28] The programmes described in this review were performed in groups. Adherence to an intervention is partly dependent on patient satisfaction, which was examined in only one study.[22] This study indicated that 98% of women would recommend aquatic exercise to other pregnant women and would also participate in aquatic exercise during their following pregnancy.

In all studies the aquatic exercise programmes used were different and in most cases not well reported, creating a major problem when trying to apply the results of the trials clinically. Often the details of the intervention were completely absent. The durations of the treatments ranged from one 20-minute treatment session to 21 one-hour treatment sessions and only one study attempted to reproduce a comparable control intervention. Frequency of the aquatic exercise varied considerably from once to three times a week and interestingly three times a week produced the largest improvements.[25] The degree and duration of symptoms experienced by participants in each study varied considerably. There was no clarification whether symptoms were periodic or constant or when the previous episode occurred. In some cases intervertebral disc involvement was an exclusion criterion and in others it was not. This made comparisons between studies difficult, and combined with poor reporting prevented extraction of cohorts. It is therefore unclear which patient groups would benefit most from therapeutic aquatic exercise. Theoretically, patients with acute low back pain would find it easier to initiate an exercise programme in water as it is easier to move, but results from these patients in this study were limited to one poor-quality study.[23] Adherence to aquatic therapy appears to be high and results were similar to other interventions. Therapeutic aquatic exercise could be used to motivate a patient whose compliance to treatment is low or who has become disillusioned with their current rehabilitation programme. Therefore future research should focus on specific groups of patients to determine when and how therapeutic aquatic exercise is most effective in the treatment of low back pain.

The overall quality of the articles was poor with a number of methodological faults, especially concerning randomization and its reporting. All studies included in this review claimed to be randomized controlled trials. However on evaluation, with the help of a standard checklist[18], only three studies used appropriate randomization methods, two studies used quasi-randomization methods and the remaining two papers did not report the method used. Intention-to-treat is another essential part of evaluating the clinical relevance of the results. Only one study included a follow-up assessment.[24] None of the reports examined stated that an intention-to-treat analysis was performed although one study reported a 31% drop-out rate.[26] Only one study reported a much higher drop-out rate in the aquatic therapy group. In this case however, the alternative group was on a waiting list for aquatic therapy and thus had every reason not to abandon the study. Only one paper contained a flowchart showing the phases of the randomized trial, as suggested by the CONSORT[29] group. It is therefore essential that all researchers undertaking a randomized controlled trial familiarize themselves with the CONSORT checklist when planning their study. The use of this checklist has been shown to significantly improve the quality of reporting an randomized controlled trial.[29] It must be stressed that even though all the studies included showed several methodological and reporting flaws, all but one study reported a positive benefit for the patients as a result of active aquatic therapy while no study found a negative effect from an aquatic intervention.

The weaknesses of this systematic review may be in the exclusion criteria used. Spa therapy and balneotherapy were both excluded, but distinguishing the difference between 'active' and 'non-active' aquatic therapy is difficult. The inclusion of studies only written in English and limits within the keywords could have eliminated some appropriate studies. The quality of the articles available and the small sample size of 288 when excluding expectant mothers, created the potential for fault in the results. However, it is the opinion of the author that the results accurately represent the quality of the current literature covering this subject.

Clinical messages

- Therapeutic aquatic exercise appears to be an effective treatment intervention for chronic and pregnancy-related low back pain.
- No studies reported a negative effect on low back pain due to therapeutic aquatic exercise.
- More high-quality trials are needed to clarify the role of therapeutic aquatic exercise in the management of low back pain.

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Competing interests

None identified.

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Appendix 1 – Keyword and search limits used

Hydrotherapy	Low back pain	RCT
Aquatic therapy	LBP	CCT
Aquatics	Back pain	
Water therapy	Spine pain	
Water exercises		
Swimming		
Aquatic exercise		

Limits:
- Human
- Adult (age >19)
- Published in the previous 17 years (1990–2007)
- English language

Example of search and number of hits (PUBMED):
- Search (''Hydrotherapy''[Mesh] OR ''Swimming''[Mesh]) AND ''Low Back Pain''[Mesh]

Limits:
- Publication Date from 1990 to 2007/07/01, Humans, Clinical Trial, Meta-Analysis, Randomized Controlled Trial, All Adult: 19+ years Hits = 21