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. 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. 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. Chronic low back pain...
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 pain11,12 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 childbirth11 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 versus 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 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. 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.

The articles were further evaluated using the SIGN 50 (Scottish Intercollegiate Guidelines Network) assessment forms. 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%
Table 1  Description of methodology used

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

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>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects (N)</td>
<td>60</td>
<td>109</td>
<td>329</td>
<td>49</td>
<td>40</td>
<td>30</td>
<td>390</td>
</tr>
<tr>
<td>Intervention</td>
<td>30</td>
<td>45</td>
<td>129</td>
<td>24</td>
<td>20</td>
<td>15</td>
<td>192</td>
</tr>
<tr>
<td>Control</td>
<td>30</td>
<td>50</td>
<td>129</td>
<td>25</td>
<td>20</td>
<td>15</td>
<td>198</td>
</tr>
<tr>
<td>Drop-out</td>
<td>4 (2 from each)</td>
<td>14 (11 hydro)</td>
<td>9 ± 9</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>124 (60 = water, 64 = gym)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>58.11 ± 11.60</td>
<td>57 ± 15.2</td>
<td>28</td>
<td>40.5 ± 11.3</td>
<td>43.8</td>
<td>39.6 ± 6.33</td>
<td>29.1 ± 4.50</td>
</tr>
<tr>
<td>Intervention</td>
<td>57.36 ± 13.59</td>
<td>58 ± 15.0</td>
<td>29</td>
<td>41.9 ± 15.5</td>
<td>42.7</td>
<td>38.6 ± 6.57</td>
<td>29.2 ± 4.54</td>
</tr>
<tr>
<td>Duration of symptoms</td>
<td>&gt;6 months</td>
<td>Not clearly stated</td>
<td>N/A</td>
<td>&lt;90 days</td>
<td>&gt;12 months</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Type of symptoms</td>
<td>Non-specific</td>
<td>LBP, leg pain and disc</td>
<td>Pregnant women with LBP</td>
<td>Acute LBP</td>
<td>LBP, disc disease</td>
<td>LBP (disc involvement, neuro excluded)</td>
<td>Pregnant women LBP and pelvic pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>degeneration</td>
<td>with LBP</td>
<td>back and back/leg pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>Aquatic exercise with lumbar spine ROM, general strength and endurance</td>
<td>Aquatic therapy, 30 min aquatic exercise, 30 min relaxation</td>
<td>Deep water walking</td>
<td>Aquatic therapy, three-stage progressive programme</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>Land exercises, same structure as aquatic</td>
<td>Waiting list</td>
<td>Normal prenatal care</td>
<td>Deep water hanging, using upper limb buoyancy aids, no weights 20 min × 1 session</td>
<td>Body weight relief rehabilitation and stretching</td>
<td>Land exercises, same structure as aquatic</td>
<td></td>
</tr>
<tr>
<td>Treatment duration</td>
<td>2 × 50 min/week, for 6 weeks</td>
<td>2 × 60 min/week, for 4 weeks</td>
<td>1 h/week from week 18 of pregnancy</td>
<td>3 ×/week for 7 weeks</td>
<td>3 ×/week, for 4 weeks</td>
<td>1 h/week from week 18 of pregnancy</td>
<td></td>
</tr>
</tbody>
</table>

ROM, range of movement; LBP, lower back pain.
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
<td>Both interventions</td>
<td>Improvement in ODI score</td>
<td>No improvement in either group</td>
<td>Improvement in ODI score</td>
<td>Both groups showed intra-group VAS and Backill improvements. No difference between interventions</td>
<td>No difference between groups. Both groups showed improvements in ODI, Walk test, sit up test, spinal flexibility and trunk strength*</td>
<td>Less sick days in aquatic therapy group (P=0.03) and less pain experienced (P=0.04)</td>
</tr>
<tr>
<td>Improvement in active aquatic exercise group</td>
<td>Pain score (VAS) +13.5 mm 24.4%* ODI (8.7%)*</td>
<td>27% of group improved ODI by +10 patients vs. 8% in no treatment</td>
<td>502 (34%) Less sick days due to LBP taken. Insufficient data for pain scores</td>
<td>Pain score (VAS) +4.2 mm (9.1%)*</td>
<td>Based on figure: 5pt decrease in a 10 pt pain scale with 2 pt regressions at 1 year follow-up. No regression in weight reduction group</td>
<td>Insufficient data for pain scores</td>
<td></td>
</tr>
<tr>
<td>Standard mean difference (95% CI)</td>
<td>VAS -0.02 (−0.52, 0.49) ODI 0.10 (−0.40, 0.61)</td>
<td>Insufficient data</td>
<td>Insufficient data</td>
<td>VAS 0.28 (−0.28, 0.84)</td>
<td>Insufficient data</td>
<td>Insufficient data</td>
<td></td>
</tr>
<tr>
<td>Control of co-interventions</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Risk of bias Intention-to-treat analysis</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Control of co-interventions</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
</tr>
</tbody>
</table>

*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 pro-
gram, version 5.0.11. The heterogeneity among
studies, in numbers of subjects, symptom dura-
tions 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 addi-
tional articles were excluded as the intervention
was deemed passive (Figure 1). The remaining
seven articles20–26 were accepted into the review.
These included two studies pertaining to preg-
nancy-related low back pain and the effect of
aquatic exercise compared with normal prenatal
advice.22,26 Two studies comparing aquatic exer-
cise to land exercise,20,25 two comparing active
aquatic therapy to static traction techniques23,24
and one comparing aquatic exercise to no inter-
vention,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 parti-
cipants to the treatment or control group, however
only three,21,22,24 used true randomization tech-
niques and only one of these used computerized
randomization. Two of the studies used quasi-
randomization techniques20,26 and in the remain-
ing 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 moder-
ate (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, symp-
toms 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 stu-
dies 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 × week from gestation
week 18). Sjogren et al.20 and Yozbatiran
et al.25 attempted to reproduce the water train-
ing 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 \((0.28 (95\% \text{ CI} -0.28, 0.84))\). Saggini et al.\(^{24}\) found a significant decrease in pain \((5 \text{ points on a } 10\text{-point scale})\) 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 \((2 \text{ out of } 10 \text{ in the PEDro scale})\) 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.\textsuperscript{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\textsuperscript{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.\textsuperscript{13} Pregnant women who undertook a one-hour active aquatic session once a week had significantly less pregnancy-related back and pelvic pain ($P = 0.04$)\textsuperscript{26} and were 34\% less often absent from work\textsuperscript{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.\textsuperscript{27} Social interaction was highlighted as an important factor increasing patients' adherence to exercise programmes for chronic osteoarthritis.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.

Aquatic exercise for low back pain

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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\(^\text{18}\), 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.\(^\text{24}\) None of the reports examined stated that an intention-to-treat analysis was performed although one study reported a 31% drop-out rate.\(^\text{26}\) 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\(^\text{29}\) 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.\(^\text{29}\) 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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**References**

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### Appendix 1 - Keyword and search limits used

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<th>Hydrotherapy</th>
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<tr>
<td>Aquatic exercise</td>
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</tbody>
</table>

**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