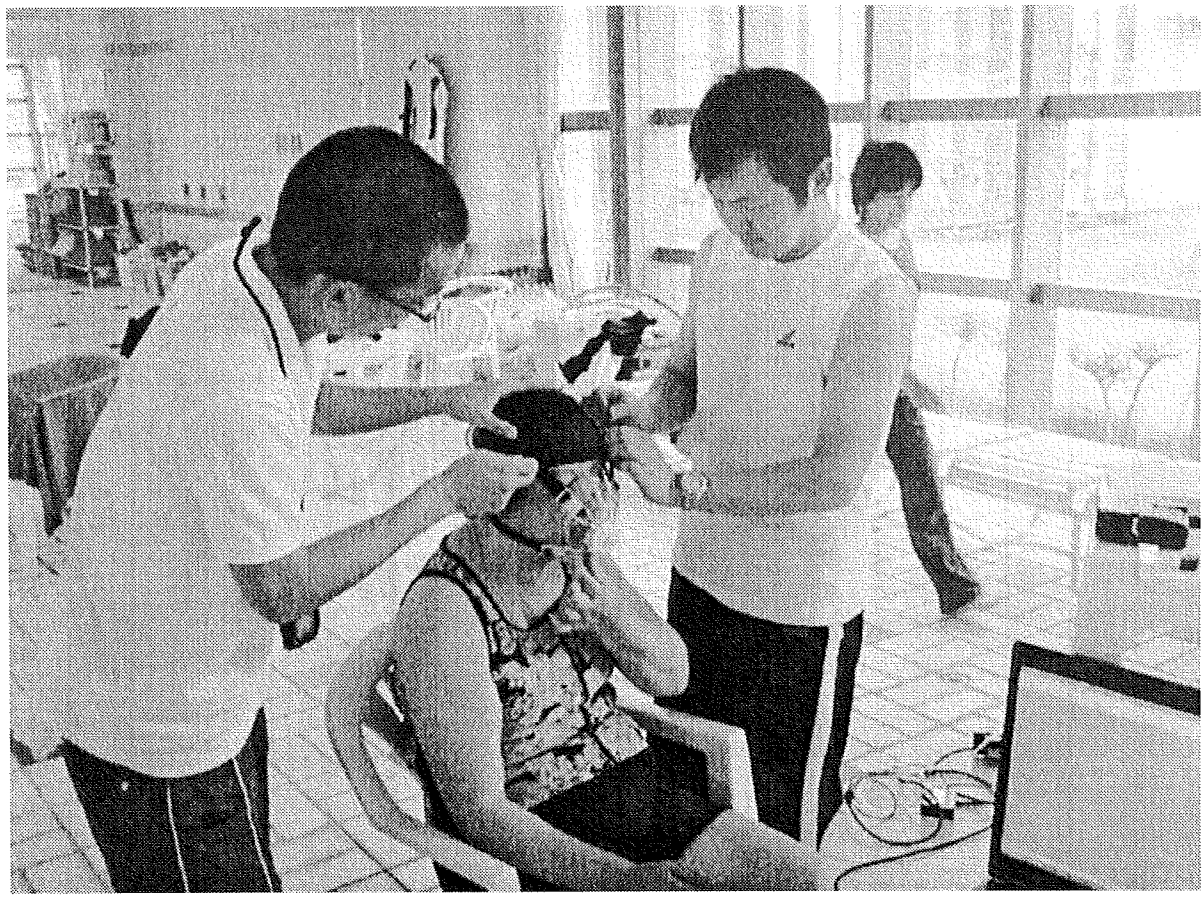

図４　測定機器装着の様子

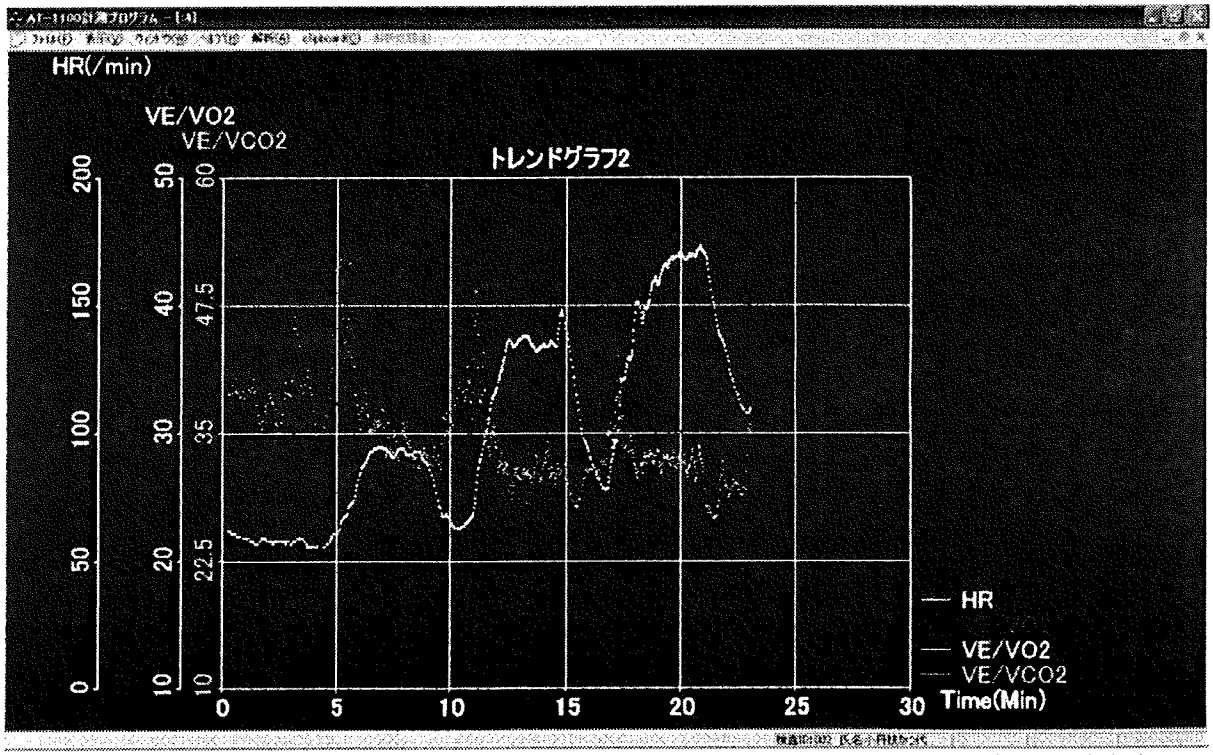

図５　水中歩行中に常時モニタリングされたデータ（エアロソニックAT-1100（アニマ社））

表３　歩行方向と主観的運動強度による各測定項目の平均値（6名：繰り返しのある二元配置分散分析）

測定項目	歩行方向	主観的運動強度（ＲＰＥ） 11「楽である」	13「ややきつい」	15「きつい」	p値（二元配置分散分析） 歩行方向	運動強度	方向×強度
酸素摂取量 （ml/分）	前方	747.5 ± 231.2	1153.3 ± 322.0	1384.0 ± 411.1	p=0.072 +	p<0.001 ***	p=0.455
	側方	592.9 ± 122.5	941.2 ± 173.2	1240.0 ± 201.9			
体重あたり酸素摂取量 （ml/分/kg）	前方	13.0 ± 3.2	20.0 ± 4.1	23.9 ± 5.1	p=0.045 *	p<0.001 ***	p=0.463
	側方	10.4 ± 2.3	16.6 ± 3.3	21.7 ± 3.3			
心拍数 （拍）	前方	97.8 ± 18.1	123.0 ± 27.2	138.4 ± 32.6	p=0.276	p<0.001 ***	p=0.293
	側方	90.2 ± 10.7	114.2 ± 19.0	135.9 ± 21.6			
収縮期血圧 （mmHg）	前方	157.3 ± 16.0	162.3 ± 23.0	172.0 ± 34.2	p=0.298	p=0.119	p=0.900
	側方	152.0 ± 12.8	158.3 ± 15.6	165.3 ± 28.4			
拡張期血圧 （mmHg）	前方	85.2 ± 15.3	87.0 ± 15.5	88.5 ± 22.5	p=0.340	p=0.787	p=0.887
	側方	83.8 ± 9.5	84.7 ± 15.6	85.3 ± 17.4			
乳酸 （mmol/l）	前方	1.1 ± 0.5	2.4 ± 1.5	5.0 ± 3.7	p=0.118	p=0.027 *	p=0.264
	側方	0.9 ± 0.2	1.5 ± 0.6	3.4 ± 1.6			
15m歩行時間 （秒）	前方	30.2 ± 6.2	23.5 ± 3.6	21.1 ± 2.7	p<0.001 ***	p<0.001 ***	p<0.001 ***
	側方	42.5 ± 7.9	30.8 ± 4.8	25.8 ± 2.9			
15m歩数 （歩）	前方	24.8 ± 7.7	23.8 ± 6.7	20.8 ± 2.8	p=0.004 **	p=0.069 +	p=0.416
	側方	21.5 ± 6.0	18.2 ± 3.8	17.2 ± 3.0			

+ p<0.10　* p<0.05　** p<0.01　*** p<0.001

表４　歩行方向と主観的運動強度による各測定項目の平均値（10名：繰り返しのある二元配置分散分析）

測定項目	歩行方向	主観的運動強度（ＲＰＥ） 11「楽である」	13「ややきつい」	15「きつい」	p値（二元配置分散分析） 歩行方向	運動強度	方向×強度
収縮期血圧 （mmHg）	前方	147.4 ± 18.0	155.0 ± 20.0	158.8 ± 31.5	p=0.497	p=0.016 *	p=0.851
	側方	150.7 ± 14.4	157.4 ± 12.7	164.0 ± 22.7			
拡張期血圧 （mmHg）	前方	83.1 ± 11.8	85.0 ± 12.3	84.9 ± 17.8	p=0.605	p=0.403	p=0.750
	側方	83.3 ± 7.7	85.7 ± 12.1	87.2 ± 13.2			
乳酸 （mmol/l）	前方	1.1 ± 0.4	2.0 ± 1.3	3.7 ± 3.2	p=0.551	p=0.007 **	p=0.629
	側方	1.1 ± 0.4	1.6 ± 0.7	3.3 ± 1.5			
歩行速度 （秒）	前方	32.0 ± 5.6	25.3 ± 4.0	23.1 ± 3.9	p=0.001 ***	p<0.001 ***	p<0.001 ***
	側方	41.1 ± 6.9	30.6 ± 4.5	26.3 ± 2.9			
15m歩数 （歩）	前方	24.0 ± 5.9	24.5 ± 5.4	22.6 ± 5.0	p<0.001 ***	p=0.188	p=0.129
	側方	21.2 ± 4.8	18.5 ± 3.5	18.0 ± 2.7			

* p<0.05　** p<0.01　*** p<0.001

表５　歩行方向と主観的運動強度による各測定項目の平均値の対象間比較（中高年女性6名と若年男性10名：繰り返しのある二元配置分散分析）

測定項目	歩行方向	対象	主観的運動強度（ＲＰＥ） 11「楽である」	13「ややきつい」	15「きつい」	p値（二元配置分散分析） 対象間	運動強度	対象×強度
酸素摂取量（ml/分）	前方	中高年女性	747.5 ± 231.2	1153.3 ± 322.0	1384.0 ± 411.1	p=0.703	p<0.001 ***	p=0.277
		若年男性	709.4 ± 221.3	1016.7 ± 279.8	1386.6 ± 341.8			
	側方	中高年女性	592.9 ± 122.5	941.2 ± 173.2	1240.0 ± 201.9	p=0.565	p<0.001 ***	p=0.884
		若年男性	660.1 ± 174.9	982.9 ± 217.3	1302.9 ± 259.3			
体重あたり酸素摂取量（ml/分/kg）	前方	中高年女性	13.0 ± 3.2	20.0 ± 4.1	23.9 ± 5.1	p=0.071 +	p<0.001 ***	p=0.262
		若年男性	10.2 ± 2.8	14.7 ± 3.8	20.2 ± 5.6			
	側方	中高年女性	10.4 ± 2.3	16.6 ± 3.3	21.7 ± 3.3	p=0.184	p<0.001 ***	p=0.252
		若年男性	9.5 ± 2.3	14.2 ± 3.1	18.9 ± 3.9			
心拍数（拍）	前方	中高年女性	97.8 ± 18.1	123.0 ± 27.2	138.4 ± 32.6	p=0.194	p<0.001 ***	p=0.341
		若年男性	85.3 ± 14.2	101.9 ± 17.4	126.0 ± 28.3			
	側方	中高年女性	90.2 ± 10.7	114.2 ± 19.0	135.9 ± 21.6	p=0.520	p<0.001 ***	p=0.796
		若年男性	85.2 ± 14.5	106.5 ± 18.5	130.2 ± 24.2			
収縮期血圧（mmHg）	前方	中高年女性	157.3 ± 16.0	162.3 ± 23.0	172.0 ± 34.2	p=0.054 +	p=0.002 **	p=0.581
		若年男性	130.6 ± 14.5	138.4 ± 19.2	152.8 ± 29.5			
	側方	中高年女性	152.0 ± 12.8	158.3 ± 15.6	165.3 ± 28.4	p=0.200	p=0.001 **	p=0.283
		若年男性	132.8 ± 12.1	145.6 ± 18.1	158.9 ± 28.3			
拡張期血圧（mmHg）	前方	中高年女性	85.2 ± 15.3	87.0 ± 15.5	88.5 ± 22.5	p=0.015 *	p=0.973	p=0.318
		若年男性	73.4 ± 5.1	72.0 ± 7.5	69.4 ± 6.3			
	側方	中高年女性	83.8 ± 9.5	84.7 ± 15.6	85.3 ± 17.4	p=0.019 *	p=0.817	p=0.335
		若年男性	73.1 ± 6.2	71.2 ± 6.9	69.4 ± 9.1			
乳酸（mmol/l）	前方	中高年女性	1.1 ± 0.5	2.4 ± 1.5	5.0 ± 3.7	p=0.027 *	p=0.001 **	p=0.053 +
		若年男性	0.9 ± 0.3	1.1 ± 0.3	2.1 ± 1.2			
	側方	中高年女性	0.9 ± 0.2	1.5 ± 0.6	3.4 ± 1.6	p=0.682	p=0.001 **	p=0.864
		若年男性	1.1 ± 0.3	1.8 ± 0.7	3.4 ± 2.7			
15m歩行時間（秒）	前方	中高年女性	30.2 ± 6.2	23.5 ± 3.6	21.1 ± 2.7	p=0.668	p<0.001 ***	p=0.526
		若年男性	32.3 ± 8.3	24.4 ± 4.4	21.2 ± 3.0			
	側方	中高年女性	42.5 ± 7.9	30.8 ± 4.8	25.8 ± 2.9	p=0.452	p<0.001 ***	p=0.569
		若年男性	42.0 ± 13.2	27.1 ± 5.0	22.7 ± 3.0			
15m歩数（歩）	前方	中高年女性	24.8 ± 7.7	23.8 ± 6.7	20.8 ± 2.8	p=0.063 +	p=0.012 *	p=0.300
		若年男性	23.0 ± 5.7	17.8 ± 2.0	17.4 ± 2.2			
	側方	中高年女性	21.5 ± 6.0	18.2 ± 3.8	17.2 ± 3.0	p=0.121	p=0.001 **	p=0.756
		若年男性	19.2 ± 5.2	15.3 ± 2.6	14.0 ± 1.3			

+ p<0.10　* p<0.05　** p<0.01　*** p<0.001

Ⅲ.　研究成果の刊行に関する一覧表

研究成果の刊行に関する一覧表

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Kamioka H, Tsutani K, Okuizumi H, Mutoh Y, Ohta M, Handa S, et al.	Effectiveness of aquatic exercise and balneotherapy: a summary of systematic reviews based on randomized controlled trials of water immersion therapies.	J Epidemiol	20巻	2-12.	2010年
上岡洋晴,栗田和弥,鈴木英悟,渡邉真也,北湯口純,鎌田真光ら	温泉の効果に関するエビデンスの整理と健康づくりを中心としたレジャーへの応用	身体教育医学研究	11巻	1-11	2010年

Ⅳ.　研究成果の刊行物・別刷

J Epidemiol 2010;20(1):2-12
doi:10.2188/jea.JE20090030

Review Article

Effectiveness of Aquatic Exercise and Balneotherapy: A Summary of Systematic Reviews Based on Randomized Controlled Trials of Water Immersion Therapies

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Received February 19, 2009; accepted July 2, 2009; released online October 31, 2009

ABSTRACT

Background: The objective of this review was to summarize findings on aquatic exercise and balneotherapy and to assess the quality of systematic reviews based on randomized controlled trials.

Methods: Studies were eligible if they were systematic reviews based on randomized clinical trials (with or without a meta-analysis) that included at least 1 treatment group that received aquatic exercise or balneotherapy. We searched the following databases: Cochrane Database Systematic Review, MEDLINE, CINAHL, Web of Science, JDream II, and Ichushi-Web for articles published from the year 1990 to August 17, 2008.

Results: We found evidence that aquatic exercise had small but statistically significant effects on pain relief and related outcome measures of locomotor diseases (eg, arthritis, rheumatoid diseases, and low back pain). However, long-term effectiveness was unclear. Because evidence was lacking due to the poor methodological quality of balneotherapy studies, we were unable to make any conclusions on the effects of intervention. There were frequent flaws regarding the description of excluded RCTs and the assessment of publication bias in several trials. Two of the present authors independently assessed the quality of articles using the AMSTAR checklist.

Conclusions: Aquatic exercise had a small but statistically significant short-term effect on locomotor diseases. However, the effectiveness of balneotherapy in curing disease or improving health remains unclear.

Key words: systematic review; aquatic exercise; randomized controlled trial; balneotherapy

INTRODUCTION

Aquatic exercise has been referred to as pool therapy, hydrotherapy, and, in earlier literature, sometimes even as balneotherapy.[1] Exercise in warm water, usually called hydrotherapy or aquatic therapy, is a popular treatment for many patients with painful neurologic or musculoskeletal conditions.[2] The warmth and buoyancy of water may block nociception by acting on thermal receptors and mechano-receptors, thus influencing spinal segmental mechanisms.[3,4] In addition, warm water may enhance blood flow, which is thought to help in dissipating algogenic chemicals, and facilitate muscle relaxation. In addition, the hydrostatic effect may relieve pain by reducing peripheral edema[5] and by dampening sympathetic nervous system activity.[6]

Bathing in water (balneotherapy or spa therapy) without exercise has also been frequently used in alternative medicine as a disease cure. Spa therapy is a very popular form of treatment for all types of arthritis in many European countries, as well as in Israel and Japan.[7,8] In addition, recent reports have demonstrated that comprehensive health education, which includes lifestyle education and exercise in combination with spa bathing, has positive effects for middle-aged and elderly people.[9,10]

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Although many studies have reported the effects of water exercise and balneotherapy, there is no review of systematic reviews of evidence from randomized controlled trials. The objective of this review was to summarize evidence for the effectiveness of aquatic exercise and balneotherapy and to assess the quality of systematic reviews based on randomized controlled trials of these therapies.

METHODS

Criteria for study inclusion

Types of studies

Systematic reviews based on randomized clinical trials (with or without a meta-analysis) were eligible.

Types of participants

Studies were not excluded based on the disease status of participants (ill vs healthy people).

Types of intervention and language

Studies that included at least 1 treatment group in which aquatic exercise or balneotherapy were included. A study of any type of exercise used in a therapeutic indoor pool or bath (range of motion exercise, dynamic exercise, aerobic exercise, immersion only, etc.) was acceptable. Studies had to include information on use of medication, alternative therapies, and lifestyle changes, and these had to be comparable among groups. When comparing different programs, type of exercise, type of water, water depth, and water temperature were considered. There was no restriction on the basis of language.

Methods used to identify studies

Bibliographic database

We searched the following databases: Cochrane Database Systematic Review, MEDLINE via PubMed from 1990, CINAHL from 1990, Web of Science from 1990, JDream II (in Japanese) from 1990, and Ichushi-Web (in Japanese) from 1990, for articles published up to August 17, 2008. The search was limited to studies published in or after 1990, the time period during which the systematic review methodology became accepted. All searches were performed by 2 hospital librarians who were qualified in medical information management and were highly trained in the retrieval of clinical trials.

Search strategies

The search strategies used for all databases contained the following elements and terms:

(I) Search "aquatic therapy" or "aquatic exercise" or "water exercise"

(II) Search ("water"[Majr] or "swimming"[Majr]) and exercise therapy/methods

(III) Search "water gymnastic" or "water training" or "water aerobics" or "pool exercise" or "pool therapy" or "aerobic aquatics" or "hydrotherapy" or "thalassotherapy" or "aquatics" or "balneotherapy" or "spa therapy"

(IV) Search I or II or III

(V) Search I or II or III Limits: systematic reviews/meta-analysis

Only keywords related to intervention were used for searching. First, titles and abstracts of identified published articles were reviewed to determine the relevance of the articles. Next, the references in relevant reviews and identified randomized controlled trials (RCTs) were screened.

Reference checking and hand searching

We did not check the references of included studies, nor did we perform any hand searches or contact institutions, societies, specialists with expertise in aquatic exercise or balneotherapy, or the authors of included studies to identify any additional published or unpublished data.

Review methods

Selection of trials

For the final selection of studies for this review, 2 authors (HK and TH) independently applied all criteria to the full text of the articles that had passed the initial eligibility screening (Figure 1). Disagreements and uncertainties were resolved by discussion between the authors.

Studies were selected when (1) the design was a systematic review of RCTs, and (2) one of the interventions was a form of aquatic exercise or balneotherapy. Effectiveness of cure or health improvement was used as a primary outcome measure. Health improvement was defined broadly, and encompassed improvements in blood pressure, serum lipid profile, immunity, and quality of life. We excluded systematic reviews of non-RCTs or observational studies. Trials that were excluded are shown, along with the reason for exclusion, in the Appendix.

Quality assessment of included studies

To ensure that variation was not caused by systematic errors in study design or execution, 2 review authors (MK and HK) independently assessed the quality of articles. A full quality appraisal of these papers was made using the AMSTAR,[11] which was developed to assess the methodological quality of systematic reviews. Disagreements and uncertainties were resolved by discussion between the review authors.

Summary of studies and data extraction

One author (HK) selected the summary from each of the structured abstracts and extracted the results for statistical analysis. The primary outcome measurement was always chosen for analysis.

Benefits and harms

The GRADE Working Group[12] reported that the balance between benefits and harms, quality of evidence, applicability, and the probability of baseline risk were all considered in judgments of the strength of recommendations. Adverse events and withdrawals are particularly important for researchers and users of clinical practice guidelines, and we present this information with the description of each article.

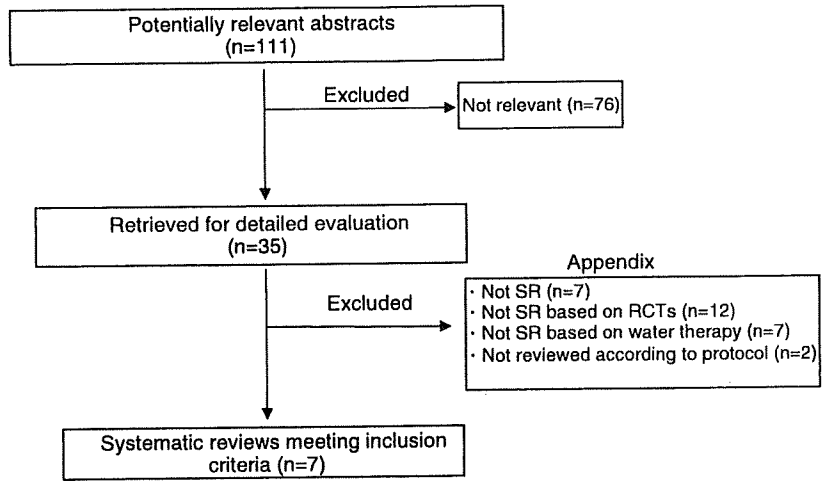

Figure 1. Flowchart of trial process
SR: systematic review. RCT: randomized controlled trial.

RESULTS

Study characteristics

The literature searches identified 111 potentially relevant articles (Figure 1). Abstracts from those articles were assessed and 35 studies were retrieved for further evaluation (assessment of relevant literature). Twenty-eight publications were excluded either because they were not a systematic review (SR), not an SR based on RCTs, not an SR in which water was a factor, or were not reviewed according to protocol (see Appendix). Seven trials[1,2,13–17] met all inclusion criteria (Tables 1 and 2). These included 3 SRs on aquatic exercise (spa therapy)[1,2,16] and 5 SRs on balneotherapy[13–17]; one of these concerned both balneotherapy and spa therapy (with physiotherapy). The target diseases and disorders included knee and hip osteoarthritis,[1,14,15] rheumatoid arthritis,[13] low back pain,[16] and neurologic or musculoskeletal disease (ie, rheumatoid arthritis, fibromyalgia, low back pain, and osteoarthritis), along with a number of other diseases and disorders.[2] Studies on health improvement were also included.[17] The SRs of aquatic exercise showed a curative effect in all studies; however, the SRs of balneotherapy provided no clear evidence of curative effect (Table 3).

Results of meta-analysis

Only 3 SRs[1,2,16] provided data that were suitable for statistical pooling. Regarding the effectiveness of aquatic exercise for the treatment of knee and hip osteoarthritis,[1] there was a small but statistically significant favorable effect for aquatic exercise on function ($P < 0.001$; weighted standardized mean difference [SMD], 0.26; 95% confidence interval [CI], 0.11 to 0.42; $n = 648$), quality of life ($P < 0.05$; SMD, 0.32; 95% CI, 0.03 to 0.61; $n = 599$), and mental health ($P < 0.05$; SMD, 0.16; 95% CI, 0.01 to 0.32; $n = 642$) measured immediately after the intervention period. Pain was assessed using a 100-mm visual analogue scale (VAS). A 3% absolute reduction and 6.6% relative reduction from baseline were found for pain ($P < 0.05$; SMD, 0.19; 95% CI, 0.04 to 0.35; $n = 638$). No statistically significant differences were found for walking ability or stiffness.

Next, we examined the effectiveness of aquatic exercise for pain relief.[2] Aquatic exercise was significantly inversely associated with pain ($P < 0.05$; SMD, −0.17; 95% CI, −0.33 to −0.01; $n = 594$). However, meta-analysis showed no differences between aquatic exercise and land exercise ($P = 0.56$; SMD, 0.11; 95% CI, −0.27 to 0.50; $n = 103$).

We then examined the effectiveness of spa therapy (with physiotherapy) and balneotherapy for treating low back pain.[16] Pain was assessed using a 100-mm VAS. Spa therapy was significantly inversely associated with pain ($P < 0.001$; SMD, 26.6; 95% CI, 20.4 to 32.8; $n = 442$), as was balneotherapy ($P < 0.001$; SMD, 18.8; 95% CI, 10.3 to 27.3; $n = 138$). Results on the Schober index and assessment of lumbar flexibility suggested there were no significant intergroup differences.

Withdrawals and adverse events

Withdrawals (dropouts) were reported in 3 studies, and adverse events were reported in 4 studies (Table 4). No fatal accidents or serious adverse effects were noted in studies that reported adverse events.

Quality assessment

A list of excluded studies (3 trials, 43%) and the use of graphic aids to assess publication bias (1 trial, 14%) were evaluated by using the AMSTAR checklist (Table 5).

DISCUSSION

We identified only 7 published SRs on aquatic exercise and balneotherapy, which indicates that there is little evidence demonstrating the effectiveness of the warmth, buoyancy, and

Table 1. Summary of articles based on structured abstracts (aim and methods)

No.	Author	Journal Year; Vol.; Page.	Title	Aim/Objective	Data source/Search strategy	Selection criteria/period of intervention	Data extraction/Data collection and analysis
1	Bartels EM, et al.	Cochrane Database Syst Rev 2007;4:CD005523. (in English)	Aquatic exercise for the treatment of knee and hip osteoarthritis.	To compare the effectiveness and safety of aquatic exercise interventions in the treatment of knee and hip osteoarthritis.	MEDLINE from 1949, EMBASE from 1980, CENTRAL (Issue 2, 2006), CINAHL from 1982, Web of Science from 1945, all up to May 2006. There was no language restriction.	Randomized controlled trials or quasi-randomized clinical trials. The duration of interventions was from 6 weeks to 12 months.	Two review authors independently selected trials for inclusion, assessed the internal validity of included trials and extracted data. Pooled results were analyzed using standardized mean differences (SMD).
13	Verhagen AP, et al.	Cochrane Database Syst Rev 2008;3:CD000518. (in English)	Balneotherapy for rheumatoid arthritis.	To assess the effectiveness of balneotherapy for rheumatoid arthritis.	They searched the following databases up to October 2006: CENTRAL (Issue 3, 2006), PubMed, CINAHL, the database from the Cochrane "Rehabilitation and Related Therapies" Field and Pedro, and performed reference checking and personal communications with authors to retrieve eligible studies.	Selection criteria: randomized controlled trials comparing balneotherapy with any other intervention or with no intervention. Included patients were all suffering from definite or classical rheumatoid arthritis as defined by the American Rheumatism Association Criteria or by the criteria of Steinbrocker. At least one of the WHO/ILAR core set of endpoints for RA clinical trials had to be among the main outcome measures. The duration of interventions was from 14 weeks to 6 months and 4 weeks.	Two authors independently assessed quality and extracted data. Disagreements were solved by consensus.
14	Verhagen AP, et al.	Cochrane Database Syst Rev 2007;4:CD006864. (in English)	Balneotherapy for osteoarthritis.	To assess the effectiveness of balneotherapy for patients with osteoarthritis (OA).	They searched the following databases up to October 2006: EMBASE, PubMed, the Cochrane "Rehabilitation and Related Therapies" Field database, PEDro, CENTRAL (Issue 3, 2006), and performed reference checking and communicated with authors to retrieve eligible studies.	Randomized controlled trials (RCT) comparing balneotherapy with any intervention or no intervention. At least 90% of the patient population had to be diagnosed with osteoarthritis; duration of interventions was from 15 days to 27 weeks.	Two authors independently assessed quality and extracted data. Disagreements were solved by consensus. In the event of clinical heterogeneity or lack of data they refrained from statistical pooling.

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Continued.

No.	Author	Journal Year; Vol.; Page.	Title	Aim/Objective	Data source/Search strategy	Selection criteria/period of intervention	Data extraction/Data collection and analysis
15	Forestier R, et al.	Joint Bone Spine 2008;75:138–148. (in English)	Crenobalneotherapy for limb osteoarthritis: Systematic literature review and methodological analysis.	To conduct a systematic literature review on crenobalneotherapy for limb osteoarthritis and to discuss the study methods used to evaluate this treatment modality.	They searched the Medline database. They also reviewed the reference lists of articles retrieved by the Medline search. The studies had to be written in English or French.	Studies that compared crenobalneotherapy to other interventions or to no intervention were considered. Massage (usually an integral part of spa programs) is not specific to spa therapy and therefore was not studied here. Only studies of patients with osteoarthritis of the knee, hip, and/or hands were selected. The duration of interventions was from 16 days to 1 year and 3 months.	They used a checklist specifically designed to evaluate the internal validity of nonpharmacological trials. External validity and the quality of the statistical analysis were also evaluated.
16	Pittler MH, et al.	Rheumatol 2006;45:880–883. (in English)	Spa therapy and balneotherapy for treating low back pain: meta-analysis of randomized trials.	To assess the evidence for or against the effectiveness of spa therapy and balneotherapy for treating low back pain.	Systematic searches were conducted on Medline, Embase, Amed Cochrane Central, the UK National Research Register and ClincalTrials.gov (all until July 2005).	All trials reporting that the sequence of allocation was randomized (RCTs). Testing balneotherapy or spa therapy for treating patients with low back pain were included. Trials reported in duplicate were excluded. The duration of interventions was from 3 weeks to 4 weeks.	Data abstraction was performed systematically and independently according to design, quality, sample size, intervention, water characteristics, results, adverse events and concomitant treatment.
2	Hall J, et al.	Arch Phys Med Rehabil 2008;89:873–883. (in English)	Does aquatic exercise relieve pain in adults with neurologic or musculoskeletal disease? A systematic review and meta-analysis of randomized controlled trials.	To evaluate the literature on the effectiveness of aquatic exercise in relieving pain in adults with neurologic or musculoskeletal disease.	A systematic literature search of 14 databases was examined for research on aquatic exercise over the period from January 1980 to June 2006.	Randomized controlled trials (RCTs) that included adults with neurologic or musculoskeletal disease, pain as an outcome measure, and exercise in water were included. The duration of interventions was from 4 weeks to 12 months.	Information on the participants, interventions, and outcomes was extracted from the included studies. Quality appraisal was assessed using the Scottish Intercollegiate Guidelines Network criteria for RCTs.
17	Kamioka H, et al.	J Jpn Soc Balneol Climatol Phys Med 2006;69:155–166. (in Japanese with English abstract)	A systematic review of randomized controlled trials on the therapeutic and health-promoting effects of spas.	To review randomized controlled trials of the effects of treatment in spas, thereby clarifying therapeutic effects of these treatments on individual diseases, and its health-promoting effects.	They searched the PubMed database twice: in Sept. 2004 and in April 2005. Articles published after 1990 and written in English were searched.	Key words for study selection were "randomized controlled trial" and "spa" or "balneotherapy". No criteria were set up concerning the number of subjects, the observation period, or the kind of disease studied. The duration of interventions was from 3 weeks to 12 months.	The quality of individual articles was evaluated on a 13-point modified PEDro scale that was constructed by adding three terms, representing the number of subjects, the observation period, and water characteristics to the 10-point PEDro scale.

Table 2. Summary of articles based on structured abstracts (results and conclusion)

No.	Author	Main results	Conclusion
1	Bartels EM, et al.	In total, six trials (800 participants) were included. At the end of treatment for combined knee and hip osteoarthritis, there was a small-to-moderate effect on function (SMD 0.26, 95% confidence interval (CI) 0.11 to 0.42) and a small-to-moderate effect on quality of life (SMD 0.32, 95% CI 0.03 to 0.61). A minor effect of a 3% absolute reduction (0.6 fewer points on a 0 to 20 scale) and 6.6% relative reduction from baseline was found for pain. Only two studies reported adverse effects, that is, the interventions did not increase self-reported pain or symptom scores.	Aquatic exercise appears to have some beneficial short-term effects for patients with hip and/or knee OA; no long-term effects were documented. The controlled and randomized studies in this area are still too few to give further recommendations on how to apply the therapy, and studies of clearly defined patient groups with long-term outcomes are needed.
13	Verhagen AP, et al.	One extra study is included in this update. Now seven trials (412 patients) were included in this review. Most trials reported positive findings on their main outcomes, but were methodologically flawed to some extent. A 'quality of life' outcome was reported by two trials. None of the trials performed an intention-to-treat analysis and only two performed a comparison of effects between groups. Pooling of the data was not performed because of heterogeneity of the studies, multiple outcome measurements, and the overall poor data presentation. We found a significant benefit of mineral baths compared to Cyclosporine A at eight weeks on pain in one study (RR = 2.4; 95% CI: 1.4, 3.8). Overall there is insufficient evidence that balneotherapy is more effective than no treatment, that one type of bath is more effective than another, or that one type of bath is more effective than mudpacks, exercise, or relaxation therapy.	Silver level evidence was found for one study in favor of mineral baths compared to drug treatment at eight weeks. Insufficient evidence was found for all other comparisons. However the scientific evidence is insufficient because of poor methodological quality. Therefore, the noted "positive findings" should be viewed with caution.
14	Verhagen AP, et al.	Seven trials (498 patients) were included in this review. Two studies compared spa treatment with no treatment. One study evaluated baths as an add-on treatment to home exercise and the author compared thermal water from Cserkeszolo with tap water (placebo). Three studies compared sulphur or Dead Sea baths with no treatment or mineral baths with tap water baths or no treatment. Only one of the trials performed an intention-to-treat analysis and two studies provided enough data to perform our own intention-to-treat analysis. A 'quality of life' outcome was reported by one trial.	They found silver level evidence concerning the beneficial effects of mineral baths compared to no treatment. Regarding all other balneological treatments, no clear effects were found. However, the scientific evidence is weak because of the poor methodological quality and the absence of adequate statistical analysis and data presentation. The noted "positive findings" should be viewed with caution.
15	Forestier R, et al.	Crenobalneotherapy was associated with improvements in the evaluation criteria (pain, function, and quality of life) compared to baseline. However, inadequate internal validity precluded the establishment of a causal link between these improvements and crenobalneotherapy. External validity was often poorly defined. Some studies found no significant differences with the control group but failed to include a sample-size calculation, suggesting inadequate statistical power as a possible explanation for the result. In several studies, the use of multiple evaluation criteria and measurements led to a high risk of Type I error.	Although the consistency of the results suggests a therapeutic effect of crenobalneotherapy in limb osteoarthritis, available studies are methodologically inadequate and sample sizes too small to allow definitive conclusions. They suggest a number of solutions to these shortcomings. Carefully designed studies in larger patient populations are needed to determine the role of crenobalneotherapy in knee osteoarthritis.
16	Pittler MH, et al.	Five randomized clinical trials met all inclusion criteria. Quantitative data synthesis was performed. The data for spa therapy, assessed on a 100-mm visual analogue scale (VAS), suggest significant beneficial effects compared with waiting list control groups (weighted mean difference 26.6 mm, 95% confidence interval 20.4–32.8, $n = 442$) for patients with chronic low back pain. For balneotherapy, the data, assessed on a 100-mm VAS, also suggest beneficial effects compared with control groups (weighted mean difference 18.8 mm, 95% confidence interval 10.3–27.3, $n = 138$).	Even though the data are scarce, there is encouraging evidence suggesting that spa therapy and balneotherapy may be effective for treating patients with low back pain. These data are not compelling but warrant rigorous large-scale trials.
2	Hall J, et al.	Nineteen studies met the inclusion criteria; 8 had a moderate-to-low risk of bias, and 5 of these had data suitable for meta-analyses. This showed that aquatic exercise has a small posttreatment effect in relieving pain compared with no treatment ($P = .04$; standardized mean difference [SMD], −.17; 95% confidence interval [CI], −.33 to −.01), but it is not possible to draw a firm conclusion because of the lack of consistency of evidence across studies. Comparable pain-relieving effects were found between aquatic and land-based exercise ($P = .56$; SMD = .11; 95% CI, −.27 to .50).	There is sound evidence that there are no differences in pain-relieving effects between aquatic and land exercise. Compared with no treatment, aquatic exercise has a small pain-relieving effect; however, the small number of good-quality studies and inconsistency of results means that insufficient evidence limits firm conclusions.
17	Kamioka H, et al.	A total of 17 articles were reviewed. Diseases studied in these articles were mostly locomotor disorders, with pain as a main symptom: rheumatism, osteoarthritis, lumbago, Parkinson's disease, varicosis, psoriasis, and health-promotion. The mean score on the 13-point modified PEDro scale was 7.5 (SD, 2.3), with a minimum score of 2 points and a maximum score of 12 points. In addition to balneotherapy, exercise therapy, mud pack treatment, and douche massage were employed in numerous studies. Improvements in the indicators were always more marked in balneotherapy intervention groups than in control groups, irrespective of the disease studied.	They devised a "3-layer model of evidence to be accumulated in balneotherapy" and concluded that RCT quality, evidence level, and expectation of good results were high for, in descending order, pain-relieving effect, functional recovery and improvement in quality of life, and health-promoting effects.

Table 3. Brief summary of 7 systematic reviews

No.	Author	Year of publication	Intervention type	Meta-analysis	Object disease	Effects noted
1	Bartels EM, et al.	2007	Aquatic exercise	Performed	Hip and knee Osteoarthritis	Short-term effects
13	Verhagen AP, et al.	2008	Balneotherapy	Not performed	Rheumatoid arthritis	Unclear, but effects in some trials
14	Verhagen AP, et al.	2007	Balneotherapy	Not performed	Osteoarthritis	Unclear, but effects in some trials
15	Forestier R, et al.	2008	Balneotherapy	Not performed	Limb osteoarthritis	Unclear, but effects in some trials
16	Pittler MH, et al.	2006	Balneotherapy and aquatic exercise	Performed	Low back pain	Effect for both interventions
2	Hall J, et al.	2008	Aquatic exercise	Performed	Neurologic or musculoskeletal disease	Small effect
17	Kamioka H, et al.	2006	Balneotherapy	Not performed	Locomotor disease and health improvement	Unclear, but effects in some trials

Table 4. Description of adverse events and withdrawals in articles

No.	Author	Title	Withdrawals (dropouts) described?	Adverse events described?
1	Bartels EM, et al.	Aquatic exercise for the treatment of knee and hip osteoarthritis	Yes	Yes
14	Verhagen AP, et al.	Balneotherapy for rheumatoid arthritis	Yes	Yes
15	Verhagen AP, et al.	Balneotherapy for osteoarthritis	Yes	Yes
16	Forestier R, et al.	Crenobalneotherapy for limb osteoarthritis: Systematic literature review and methodological analysis	Yes	No
17	Pittler MH, et al.	Spa therapy and balneotherapy for treating low back pain: meta-analysis of randomized trials	No	Yes
2	Hall J, et al.	Does aquatic exercise relieve pain in adults with neurologic or musculoskeletal disease? A systematic review and meta-analysis of randomized controlled trials	Yes	Yes
18	Kamioka H, et al.	A systematic review of randomized controlled trials on the therapeutic and health-promoting effects of spas	No	No

hydrostatic effects of water for curing disease or improving health. One reason for the limited number of SRs may be that aquatic exercise and balneotherapy are similar practices and distinguishing between them in RCTs is thus difficult. In addition, participants may find the intervention process, which requires them to undress and wear a swimsuit, to be troublesome. Furthermore, it is difficult to perform meta-analyses because, in the case of balneotherapy, the chemical content and temperature of the waters studied differ in various countries and the data are therefore not easily integrated.

Aquatic exercise versus balneotherapy (without exercise)

We distinguished between aquatic exercise and balneotherapy to determine which was more effective, because many studies do not do so. Aquatic exercise had a small but statistically significant effect on pain, function, QOL and mental health, and included more voluntary movements during water immersion. This suggests that an intervention requiring exercise is more effective for the treatment of musculoskeletal diseases, as compared to balneotherapy, which involves passive immersion. However, it should be noted that this was only the immediate effect of intervention, and not the long-term result. The intervention period ranged from 3 weeks to 12 months in aquatic exercise studies, and from 15 days to 12 months in studies of balneotherapy. This might reflect the difficulty of maintaining long-term participation in an RCT. Whatever the case, the long-term effects are not clear.

We did not pool data from SRs of balneotherapy[13–15,17] because of their heterogeneity, multiple and varied outcome measurements, and poor overall quality. SRs of balneotherapy suggested that the scientific evidence was insufficient because of the poor methodological quality of RCTs of balneotherapy. Thus, it is difficult to determine the independent effect of balneotherapy without exercise.

Table 5. Evaluation of the quality of systematic reviews by using the AMSTAR checklist[11]

No.	Items	Answer	*n*	(%)
1.	Was an 'a priori' design provided? The research question and inclusion criteria should be established before the conduct of the review.	Yes	7	(100)
		No	0	(0)
		Can't answer	0	(0)
		Not applicable	0	(0)
2.	Was there duplicate study selection and data extraction? There should be at least two independent data extractors and a consensus procedure for disagreements should be in place.	Yes	6	(86)
		No	0	(0)
		Can't answer	1	(14)
		Not applicable	0	(0)
3.	Was a comprehensive literature search performed? At least two electronic sources should be searched. The report must include years and databases used (e.g., Central, EMBASE, and MEDLINE). Key words and/or MESH terms must be stated and where feasible the search strategy should be provided. All searches should be supplemented by consulting current contents, reviews, textbooks, specialized registers, or experts in the particular field of study, and by reviewing the references in the studies found.	Yes	5	(71)
		No	2	(29)
		Can't answer	0	(0)
		Not applicable	0	(0)
4.	Was the status of publication (i.e., grey literature) used as an inclusion criterion? The authors should state that they searched for reports regardless of their publication type. The authors should state whether or not they excluded any reports (from the systematic review), based on their publication status, language etc.	Yes	7	(100)
		No	0	(0)
		Can't answer	0	(0)
		Not applicable	0	(0)
5.	Was a list of studies (included and excluded) provided? A list of included and excluded studies should be provided.	Yes	3	(43)
		No	4	(57)
		Can't answer	0	(0)
		Not applicable	0	(0)
6.	Were the characteristics of the included studies provided? In an aggregated form such as a table, data from the original studies should be provided on the participants, interventions and outcomes. The ranges of characteristics in all the studies analyzed e.g., age, race, sex, relevant socioeconomic data, disease status, duration, severity, or other diseases should be reported.	Yes	7	(100)
		No	0	(0)
		Can't answer	0	(0)
		Not applicable	0	(0)
7.	Was the scientific quality of the included studies assessed and documented? 'A priori' methods of assessment should be provided (e.g., for effectiveness studies if the author(s) chose to include only randomized, double-blind, placebo controlled studies, or allocation concealment as inclusion criteria); for other types of studies alternative items will be relevant.	Yes	7	(100)
		No	0	(0)
		Can't answer	0	(0)
		Not applicable	0	(0)
8.	Was the scientific quality of the included studies used appropriately in formulating conclusions? The results of the methodological rigor and scientific quality should be considered in the analysis and the conclusions of the review, and explicitly stated in formulating recommendations.	Yes	7	(100)
		No	0	(0)
		Can't answer	0	(0)
		Not applicable	0	(0)
9.	Were the methods used to combine the findings of studies appropriate? For the pooled results, a test should be done to ensure the studies were combinable, to assess their homogeneity (i.e. Chi-squared test for homogeneity). If heterogeneity exists a random effects model should be used and/or the clinical appropriateness of combining should be taken into consideration (i.e., is it sensible to combine?).	Yes	5	(71)
		No	1	(14)
		Can't answer	1	(14)
		Not applicable	0	(0)
10.	Was the likelihood of publication bias assessed? An assessment of publication bias should include a combination of graphical aids (e.g., funnel plot, other available tests) and/or statistical tests (e.g., Egger regression test).	Yes	1	(14)
		No	6	(86)
		Can't answer	0	(0)
		Not applicable	0	(0)
11.	Was the conflict of interest stated? Potential sources of support should be clearly acknowledged in both the systematic review and the included studies.	Yes	5	(71)
		No	2	(29)
		Can't answer	0	(0)
		Not applicable	0	(0)

Table 6. Overall evidence and future research agenda

Intervention	Evidence	Specific agenda	Common agenda
Aquatic exercise	Small but significant effect (no differences between aquatic exercise and land exercise)	1. Long-term effect 2. Type of dose (intensity, frequency and duration)	1. Randomized controlled trials for various diseases 2. Cost-benefit analysis 3. Description of adverse effects
Balneotherapy	Poor/Unclear	Satisfactory methodology (intention-to-treat analysis, blinding, adequate control group, etc.)	

Quality assessment

Seven of the included SRs were published after 2006 and, hence, relatively recent. We used the AMSTAR checklist because its content validity is high and the number of articles reviewed to evaluate SR quality was as few as 11. The requirements of the AMSTAR checklist were generally satisfied; however, an assessment of publication bias was frequently omitted. The AMSTAR requires that an assessment of publication bias include a combination of graphic aids (eg, funnel plot other available tests). One important publication reported that authors were more likely to publish RCTs in an English-language journal if the results were statistically significant.[18] English language bias may therefore be present in reviews and meta-analyses that include only trials reported in English.

There were few lists of excluded studies: only 3 Cochrane Reviews[1,13,14] reported this information. If the format of SRs adheres to that of the Cochrane Review, recording omissions would be minimal. However, many scientific journals limit the length of submissions, so such descriptions may not be published. We believe it is necessary to include a list of excluded studies in order to improve the certainty and transparency of studies.

Overall evidence and future research agenda

Table 6 shows the overall evidence and future research agenda for aquatic exercise and balneotherapy. Aquatic exercise had a small but statistically significant effect. Future RCTs should investigate the long-term effectiveness of aquatic exercise or its effectiveness with respect to type or duration of exercise. Then, SRs based on such RCTs can be conducted. Regarding balneotherapy, RCTs based on appropriate research methodology are needed because no clear effect was found in the present study. A common problem with RCTs is that they do not properly evaluate adverse effects; future studies should include these data.

A recent study suggested that the most important questions that authors of systematic reviews face are as follows[19]: (1) How can incorporating existing reviews into new work adhere to the principles of comprehensive, transparent, and unbiased methods required for systematic reviews? (2) If an effort is made to incorporate existing reviews, will it save time and resources? (3) Are there instances where an independent, critical assessment of the evidence warrants conducting a complex review "from scratch" even if there are existing reviews?

Study limitations

There were several limitations to the present study. Some selection criteria were common to the studies, as described above; however, bias remained due to differences in the eligibility for participation in each study.

Publication bias was also a limitation. Although we did not limit our search to English language articles, we found no articles published in other languages. Also, we were not able to check references by means of hand searches. Nor were we able to contact institutions, societies, or specialists with expertise in aquatic exercise or balneotherapy or authors of included studies to identify any additional published or unpublished data. Another limit of the study was that we were not able to search the PEDro database, which is used in fields such as rehabilitation medicine and physiotherapy.

In terms of quality assessment, disagreements and uncertainties were resolved by discussion between 2 authors; discussions with a third expert and contact with authors for the purpose of clarification were not allowed.

Conclusion

There were relatively few SRs of RCTs on aquatic exercise and balneotherapy. We found that aquatic exercise had a small but statistically significant effect on pain relief and related outcome measurements for locomotor diseases. However, the long-term effectiveness of these treatments remains unclear.

Because there was insufficient evidence due to the poor methodological quality of balneotherapy studies, we are unable offer any conclusions about the effects of this intervention. Common flaws included an inadequate description of excluded RCTs and insufficient assessment of publication bias.

ACKNOWLEDGEMENTS

This study was supported by Health and Labour Sciences Research Grants (Research on Health Security Control: ID No. H20-007) from the Japanese Ministry of Health, Labour and Welfare in 2008. We would like to express our appreciation to M. Makishi, Y. Yamada, and S. Moriyama for their assistance in this study.

Appendix. Studies excluded in the present review

No.	Author. Journal (Year)	Title	Reason for exclusion
E1	Cardoso JR, et al. Cochrane Database Systc Rev (2008)	Aquatic therapy exercise for treating rheumatoid arthritis (Protocol)	Not reviewed due to protocol
E2	Beamon S, et al. Cochrane Database Syst Rev (2008)	Hydrotherapy for asthma (Protocol)	Not reviewed due to protocol
E3	Dziedzic K, et al. Best Practice Research Clin Rheumatol (2008)	Land- and water-based exercise therapies for musculoskeletal condition	Not SR
E4	Getz M, et al. Clin Rehabili (2006)	Effects of aquatic interventions in children with neuromotor impairments: a systematic review of the literature	Not SR based on RCTs
E5	Tejirian T, et al. Diseases Colon Rectum (2005)	Sitz bath: where is the evidence? Scientific basis of a common practice	Not SR
E6	Herman PM, et al. BMC Complementary Alternative Med (2005)	Is complementary and alternative medicine (CAM) cost-effective? a systematic review	Not SR based on water
E7	Karagulle MZ, et al. Forsch Komplementarmed Klass Naturheilkd (2004)	Balneotherapy and spa therapy of rheumatic diseases in Turkey: a systematic review (in German)	Not SR based on RCTs
E8	Meremikwu M, et al. Cochrane Database Syst Rev (2008)	Physical methods for treating fever in children	Not SR based on water
E9	Liao WC. Int J Nursing Studies (2002)	Effects of passive body heating on body temperature and sleep regulation in the elderly: a systematic review	Not SR based on RCTs
E10	Pennick VE, et al. Cochrane Database Syst Rev (2007)	Interventions for preventing and treating pelvic and back pain in pregnancy	Not SR based on water
E11	Teschendorf ME, et al. Am J Maternal/Child Nursing (2000)	Hydrotherapy during labor: an example of developing a practice policy	Not SR based on RCTs
E12	Verhagen AP, et al. J Rheumatol (1997)	Taking baths: the efficacy of balneotherapy in patients with arthritis. A systematic review	Not SR based on RCTs
E13	Sim J, et al. Clin J Pain (2002)	Systematic review of randomized controlled trials of nonpharmacological interventions for fibromyalgia	Not SR based on water
E14	Rosimini C, et al. J Am Academy Nurse Practitioners (2003)	Benefits of swim training for children and adolescents with asthma	Not SR based on RCTs
E15	Schiltenwolf M, et al. Schmerz (2008)	Physiotherapy, exercise and strength training and physical therapies in the treatment of fibromyalgia syndrome (in German)	Not SR based on RCTs
E16	Toumaire M, et al. e CAM (2007)	Complementary and alternative approaches to pain relief during labor	Not SR
E17	Bouchama A, et al. Critical Care (2007)	Cooling and hemodynamic management in heatstroke: practical recommendations	Not SR based on RCTs
E18	Iarustovskaia OV, et al. Vopr Kurotol Fizioter Lech Fiz Kult (2006)	Thermocontrast hydrotherapy in the treatment of neuroendocrine disorders in females of reproductive age (in Russian)	Not SR based on RCTs
E19	Balint G, et al. Orv Hetil (2006)	Rehabilitation and balneotherapy, wellness 2004 (in Hungarian)	Not SR based on RCTs
E20	Adilov VB, et al. Vopr Kurotol Fizioter Lech Fiz Kult (2006)	Mineral waters for external (balneological) application. Guide for physicians (in Russian)	Not SR
E21	Markel W. Wien Kiln Wochenschr (2006)	Can the effects of radon therapy be scientifically substantiated? (in Russian)	Not SR
E22	Getenbrunner C. Wien Klin Wochenschr (2006)	Could balneology and medical climatology have more than historic importance in the therapy of chronic diseases? (in Russian)	Not SR
E23	Davydova DB, et al. Vopr Kurotol Fizioter Lech Fiz Kult (2006)	Hydrobalneotherapy of patients with cardiovascular disease. Manual for physicians (in Russian)	Not SR
E24	Hodgson S. Clin Orthopaedics Related Research (2006)	Proximal humerus fracture rehabilitation	Not SR based on RCTs
E25	Liu Y, et al. Current Opinion Rheumatol (2004)	Recent advances in the treatment of the spondyloarthropathies	Not SR based on water
E26	Watts R, et al. Int J Nursing Practice (2003)	Nursing management of fever in children: a systematic review	Not SR based on water
E27	Pengel HM, et al. Clin Rehabili (2002)	Systematic review of conservative interventions for subacute low back pain	Not SR based on water
E28	Constant F, et al. Bull Soc Sci Med Grand Duche Luxemb (1995)	Critical bibliographic analysis of international medical literature in the domain of thermal research	Not SR based on RCTs

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●総　説

温泉の効果に関するエビデンスの整理と健康づくりを中心としたレジャーへの応用

Evaluation of the evidence on hot spa efficacy and its applications to leisure activities, particularly those aimed at health promotion

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Abstract

The purposes of this study were to evaluate the evidence of spa therapy, as well as spa effects, on health promotion, and to discuss the proper applications of spa to leisure activities that are focused on fitness.

A relatively small number of highly evidence-graded studies, such as randomized controlled trials (RCTs), were identified from a literature search, and many had problems in methodology. Results showed that aquatic exercises conducted in hot water, including hot spa, obviously alleviated pain in locomotorium diseases. However, few RCTs are currently available concerning other diseases, and consequently, there is no evidence on aquatic exercise efficacy in those diseases.

An increasing number of people enjoy leisure activities, particularly hot spa bathing, primarily for fitness. Obviously, hot spa has pain-relieving effects on locomotorium diseases, which are prevalent in middle-aged or elderly people. Therefore, hot spa bathing, as well as a change of air, and other complex factors associated with hot spa visits, are expected to promote health.

It is hoped that people will learn more about hot spa, and enjoy it as a regular leisure activity.

Key words：balneotherapy, evidence, leisure activity
温泉，エビデンス，レジャー

1．緒言

日本は世界有数の温泉愛国である。2007（平成19）年度の環境省の統計[1]によると，日本には，源泉地数（宿泊施設を有する）3,139，源泉総数（自噴と動力の合計）2万8,090，宿泊施設数1万4,907，年度延べ宿泊利用者数1億3,587万2,728人であり，宿泊利用者数からすると，1年間に国民1人が1回以上宿泊して温泉を利用した計算となる（表1）。また，2007年度で，温泉を保有する地方自治体（市町村）は1,489あり，当年度の自治体総数が1,772なので，全国の市町村の83.5%に温泉が存在することを意味している[1]。大都市周辺地域においても掘削が相次ぎ，「温泉ブーム」が続いている。

「レジャー白書2008」[2]によると，年間の温浴施設への参加人口3,990万人，市場規模6,020億円を推計している。岩盤浴は，それぞれ1,160万人，1,100億円で，いずれにしても，日帰りを含む温泉などを利用する，というレジャー活動の人気の高さを知ることができる。「現在の温泉ブームは，加熱気味だが，根底には人々の健康志向，自然回帰志向の高まりを反映している」[3]とする見解もあるが，古来より国民に愛されている貴重な地域資源を，広く健康づくりに有効活用できるとすれば，医療費の軽減や介護予防にだけでなく，地域活性化にもつながりうる。

ところで，日本では，唯一，温泉医学を研究する学会として，日本温泉気候物理医学会がある。1935（昭和10）年に発足し，日本医学会においても第15番目に分科会となった歴史ある学会である。1981（昭和56）年に発足した学会認定医制協議会（現：日本専門医認定制機構）に当初から参加し，「温泉療法医（2009（平成21）年5月30日現在，1,041名）」を認定している[4]。また，財団法人日本健康開発財団は，安全かつ適切な温泉入浴プログラムを提供するために「温泉利用指導者」と「温泉入浴指導員」の資格認定を行っている[5]。

これまでの温泉研究は，疫学・臨床報告が多いが，温泉の成分は，唯一無二の特徴があり，ひとつの研究結果から普遍性を語るのは難しい側面がある。さらには，代替医療としての可能性は古くから指摘されているが，治療効果の面では，いわゆる西洋医学に基づく治療方法の方が即効性が高い場合が多い。その反面，温泉療法では，副作用が少ないという長所もある。科学的根拠に基づい

表1　環境省が発表した1989(平成元)年から2007(19)年度までの温泉利用状況

(文献1より一部改変作表)

年　度	温泉保有市町村数	温泉地数	源泉総数	宿泊施設数	収容定員(人)	年度延宿泊利用人員(人)	温泉利用の公衆浴場数
平成元(1989)年	1,685	2,302	21,758	15,085	1,168,157	134,870,936	3,112
2(1990)年	1,732	2,360	22,353	15,119	1,202,382	140,138,479	3,283
3(1991)年	1,798	2,382	23,097	15,082	1,210,747	142,853,123	3,576
4(1992)年	1,875	2,357	23,568	15,154	1,227,095	143,246,266	3,867
5(1993)年	1,918	2,383	24,061	15,227	1,245,672	139,728,475	4,038
6(1994)年	1,963	2,431	24,679	15,356	1,254,429	138,779,626	4,164
7(1995)年	2,015	2,508	25,129	15,714	1,288,594	140,572,876	4,375
8(1996)年	2,074	2,565	25,455	15,504	1,298,283	143,164,495	4,738
9(1997)年	2,132	2,615	25,822	15,643	1,332,588	140,301,952	5,080
10(1998)年	2,184	2,839	26,077	15,638	1,371,708	139,711,747	5,525
11(1999)年	2,213	2,893	26,270	15,548	1,357,089	135,377,318	5,835
12(2000)年	2,238	2,988	26,505	15,512	1,363,017	137,525,810	6,034
13(2001)年	2,280	3,023	26,796	15,558	1,373,318	137,097,634	6,433
14(2002)年	2,292	3,102	27,043	15,389	1,384,302	137,935,709	6,738
15(2003)年	2,280	3,127	27,347	15,390	1,387,981	136,285,534	7,006
16(2004)年	1,939	3,114	27,644	15,332	1,408,683	135,867,119	7,294
17(2005)年	1,492	3,162	27,866	15,024	1,413,088	136,613,954	7,431
18(2006)年	1,489	3,157	28,154	15,024	1,431,504	137,088,966	7,748
19(2007)年	1,480	3,139	28,090	14,907	1,410,100	135,872,728	7,859

注1）温泉地数は宿泊施設のある場所を計上
　2）宿泊利用人員は参考数値
出典：環境省自然環境局自然環境整備担当参事官室「温泉利用状況」
＜著者追記＞
温泉保有市町村数の減少は合併のためである。

た医療（Evidence Based Medicine：EBM）の推進により，より「温泉を科学する」必要性が求められている[6]。

ところで，疾病治療だけではなく，近年の温泉ブームもあり，「温泉の健康増進効果」のエビデンスもまた，求められている。厚生労働省の諮問機関として，「温泉利用型健康増進施設のあり方」検討会[7]が設置され，当該施設の基準や方向性について意見が求められた。その報告では，「明確な医科学的根拠に基づき，積極的に健康状態の改善を行うことにより，健康に暮らすことができる期間を延長するとともに，生活の質の向上を目指すプログラムを提供することを必須要件とし，合わせてプログラムの実施効果やその評価方法も含めた検証が必要である。」と結論づけ，温泉の健康増進効果に関して，さらなるエビデンスが不可欠であることを示す答申となっている。わが国においては，前述のようにレジャーとして温泉を好む特徴とその現実は無視できず，国民がより安全かつ効果的に温泉を活用することが求められる。

そこで，本研究は，温泉*の治療と健康増進の効果に関するエビデンスを整理するとともに，健康づくりを中心とするレジャーへの適切な応用方法を考察することを目的とした。

＊　温泉の定義として，1948（昭和23）年7月10日に公布された温泉法（法律第125号）に準拠し，「温泉とは，地中からわき出す温水，鉱水及び水蒸気その他のガスで，定められた19種類の物質を含む，または温度が25℃以上（温泉源）のもの」とする。ただし，温泉研究において国際的にはその定義が異なるため，「spa，hot spring，balneotherapy，cure thermale，Badekurなど」[8]の用語を広く含めることとする。

また，温泉の泉質と効用（適応症・禁忌症）[6),9)]については，日本温泉気候物理医学会において，現在検討中であることから泉質をめぐる議論は割愛した。温泉のもつ化学・浮力・温熱・静水圧作用だけでなく，環境なども含めた効果を「総合的生体調節作用（general conditioning action）」[6]と称して，検討が続けられている。