

Effectiveness of exercise therapy: A best-evidence summary of systematic reviews

Nynke Smidt, Henrica CW de Vet, Lex M Bouter and Joost Dekker

for the Exercise Therapy Group^a

The purpose of this project was to summarise the available evidence on the effectiveness of exercise therapy for patients with disorders of the musculoskeletal, nervous, respiratory, and cardiovascular systems. Systematic reviews were identified by means of a comprehensive search strategy in 11 bibliographic databases (08/2002), in combination with reference tracking. Reviews that included (i) at least one randomised controlled trial investigating the effectiveness of exercise therapy, (ii) clinically relevant outcome measures, and (iii) full text written in English, German or Dutch, were selected by two reviewers. Thirteen independent and blinded reviewers participated in the selection, quality assessment and data-extraction of the systematic reviews. Conclusions about the effectiveness of exercise therapy were based on the results presented in reasonable or good quality systematic reviews (quality score ≥ 60 out of 100 points). A total of 104 systematic reviews were selected, 45 of which were of reasonable or good quality. Exercise therapy is effective for patients with knee osteoarthritis, sub-acute (6 to 12 weeks) and chronic (≥ 12 weeks) low back pain, cystic fibrosis, chronic obstructive pulmonary disease, and intermittent claudication. Furthermore, there are indications that exercise therapy is effective for patients with ankylosing spondylitis, hip osteoarthritis, Parkinson's disease, and for patients who have suffered a stroke. There is insufficient evidence to support or refute the effectiveness of exercise therapy for patients with neck pain, shoulder pain, repetitive strain injury, rheumatoid arthritis, asthma, and bronchiectasis. Exercise therapy is not effective for patients with acute low back pain. It is concluded that exercise therapy is effective for a wide range of chronic disorders. [Smidt N, de Vet HCW, Bouter LM and Dekker J (2005): Effectiveness of exercise therapy: A best-evidence summary of systematic reviews. *Australian Journal of Physiotherapy* 51: 71–85]

Key words: Exercise Therapy; Exercise Movement Techniques; Meta-analysis; Physical Therapy Techniques

Introduction

Exercise therapy is a regular component in the management of various (chronic) disorders, such as musculoskeletal, neurological, cardiovascular, and respiratory disorders (Chartered Society of Physiotherapy 2001, ACCP/AACVPR Pulmonary Rehabilitation Guidelines Panel, American College of Chest Physicians, American Association of Cardiovascular and Pulmonary Rehabilitation 1997, Gordon et al 2004, Pina et al 2003, Woolf et al 2004). Exercise therapy involves the prescription of muscular contraction and bodily movement ultimately to improve the overall function of the individual and to help meet the demands of daily living (Tan and Horn 1998).

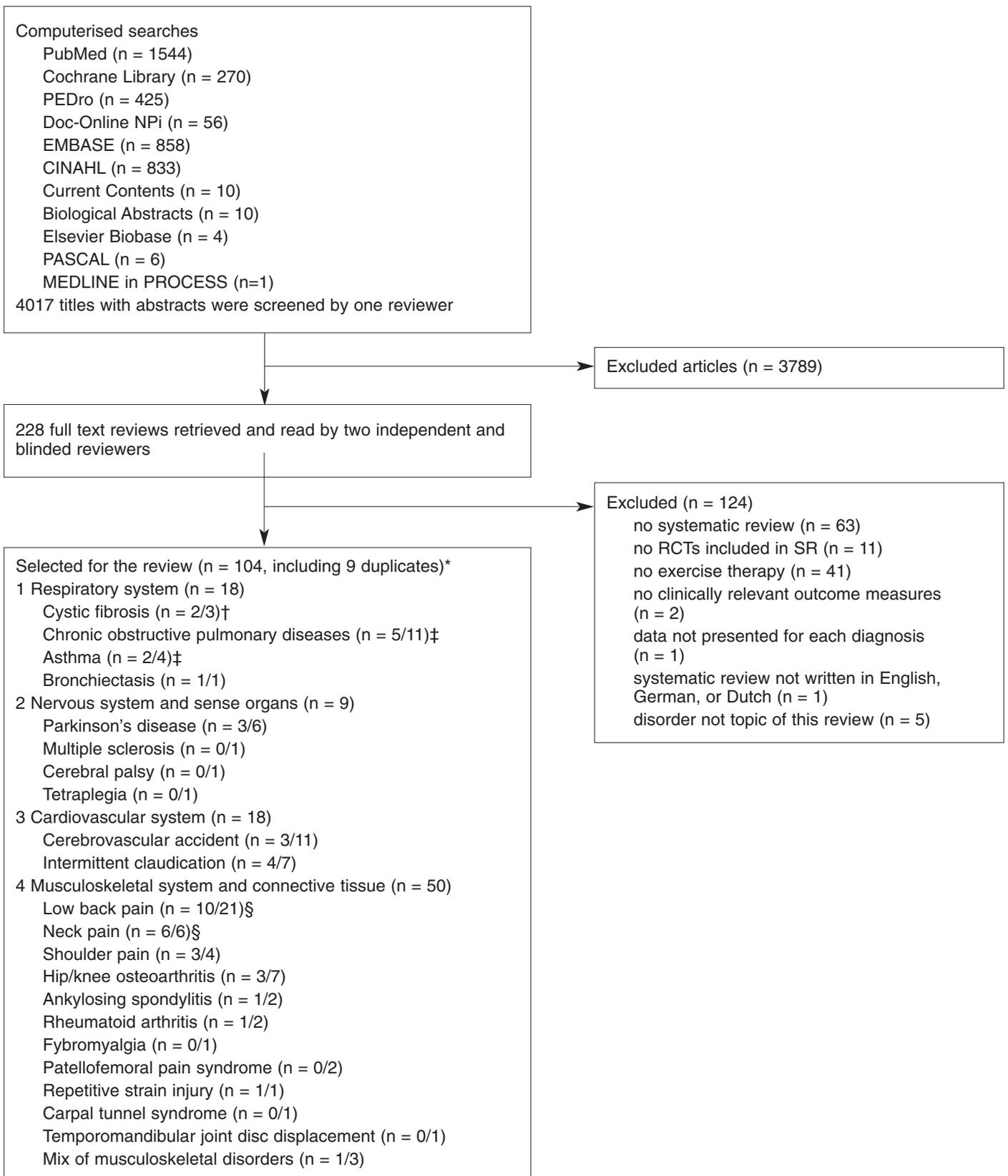
There is no up-to-date overview of the effectiveness of exercise therapy compared with no treatment or an alternative treatment (Beckerman et al 1993a, Beckerman et al 1993b, Bouter et al 1992, Herbert et al 2001). Such an overview will help: care providers to choose the most appropriate treatment option; policy makers in making decisions concerning health care; and research agencies in setting priorities in the field of physiotherapy. Our objective was therefore to assess and summarise the available evidence on the effects of exercise therapy in a best-evidence summary of systematic reviews.

Method

Searching One reviewer (NS) searched computerised bibliographical databases (MEDLINE 01/1966–03/2002, PEDro 03/2002, CINAHL 01/1990–07/2002, EMBASE 01/1990–08/2002, Cochrane Library Issue 3 2002, Current

Contents 01/1999–07/2002, Biological Abstracts 01/1999–07/2002, Elsevier Biobase 01/1999–07/2002, PASCAL 01/1999–07/2002, MEDLINE in PROCESS 01/1999–07/2002, and DocOnline (NPI) 10/1988–03/2002), using an approach based on the comprehensive search strategy outlined by Hunt and McKibbin (1997). The following specific subject (MeSH) headings and free text words were used to identify reviews of exercise therapy: pain, physical education and training, physical fitness, relaxation, physical endurance, physical therapy, exercise, motion therapy, and physiotherapy. In addition, references from retrieved reviews were screened.

Selection We included systematic reviews that met the following criteria: (i) the full text of the systematic review is published and it is based on a transparent and reproducible protocol (at least reporting on inclusion criteria, search date(s), and database(s)); (ii) at least one randomised controlled trial is included in the review; (iii) exercise therapy is compared with no treatment, other conservative types of treatment (e.g. steroid injections), surgery, or some other type of exercise therapy (e.g. flexion versus extension exercises); (iv) at least one clinically relevant outcome measure is included (e.g. pain, activities of daily living (ADL), walking distance, return to work) is included; (v) the results and conclusions are presented separately for each diagnosis; (vi) reviews are written in English, German or Dutch; (vii) the focus is on patients with disorders of the following: the musculoskeletal system and connective tissue, the nervous system and sense organs, the respiratory system, and the cardiovascular system (excluding coronary heart diseases),



*Duplicates came from Green et al (1998, 2002), Koes et al (1991a, 1991b), Lacasse et al (1997a, 1997b), Ram et al (2000, 2002), van Baar et al (1998a, 1999, 2001), van den Ende et al (1998, 2002), and van Tulder et al (1999, 2000a, 2002b). †Two of the 3 systematic reviews on the effectiveness of exercise therapy for cystic fibrosis had quality scores of at least 60 points out of 100. ‡In one review (<60 points) exercise therapy was investigated for both asthma and COPD therefore the sum of the individual sub-categories add up to more than the total category; §In one review (≥ 60 points) exercise therapy was investigated for both neck and low back pain therefore the sum of the individual sub-categories add up to more than the total category.

Figure 1. Selection of systematic reviews.

according to the International Classification of Diseases (ICD-10) are the topic of this summary (Anonymous 1992).

To determine whether a review should be included, the abstracts of all identified articles were read by one reviewer (NS). If there was any doubt, the full article was retrieved and read by two reviewers, independently. The articles were blinded for authors, journal, acknowledgements, and year of publication by a research assistant who was not involved in this study in any other way (KJ, see acknowledgements). Disagreements between reviewers about the final selection of the articles were discussed and resolved in a consensus meeting.

Quality assessment The quality of the systematic reviews was assessed according to the list of criteria developed by Assendelft et al (1995). This list consists of criteria for the selection of studies (30 points), assessment of the methodological quality of randomised controlled trials (20 points), description of the interventions (15 points), data presentation (20 points), and evaluation (15 points) (see Appendix I). The maximum quality score is 100 points. A total of 13 independent, blinded reviewers (see authors' affiliations) participated in the final selection and assessment of the quality of the systematic reviews. One reviewer (NS) assessed all systematic reviews and 12 other reviewers (MEB, SMAB, AH, SHJK, GK, TL, RPSP, MR, CT, CBT, APV, DAWMW) each evaluated a selection of the included reviews. Disagreements were discussed and resolved in a consensus meeting. If consensus could not be reached, a third reviewer (RWJGO) made the final decision.

The systematic reviews were categorised according their quality score: good quality (≥ 80 points), reasonable quality (60–79 points), moderate quality (40–59 points), poor quality (20–39 points), and very poor quality (< 20 points). Our conclusions regarding the effectiveness of exercise therapy are based on the results of reasonable quality (60–79 points) or good quality (≥ 80 points) systematic reviews (De Vet et al 2001).

Data extraction An overview of each systematic review (≥ 60 points) was made, including the research question(s) and details of all the randomised controlled trials investigating exercise therapy included in the systematic review (interventions in the experimental and control group, methodological quality, sample size (statistical power), outcome measures, timing of outcome assessment, and effectiveness of the exercise therapy (statistical significance)).

The conclusions reported in each systematic review were discussed with a panel of experts in the field of physiotherapy, general practice, rehabilitation medicine, and epidemiology (JHA, RAB, JD, PJMH, RABO, ST, HCWV). For each systematic review, categorisation of the conclusions was based on the following two research questions:

- A What is the effectiveness of exercise therapy, compared to no treatment, a placebo, or a wait-and-see policy?
- B What is the effectiveness of exercise therapy, compared to other treatments (e.g. steroid injections)? Is one specific type of exercise therapy more effective than others?

The following are all the possible conclusions that could be drawn for Question A:

- Exercise therapy is effective, compared to no treatment, placebo, or a wait-and-see policy (positive).
- Exercise therapy is not effective, compared to no treatment, placebo, or a wait-and-see policy (negative).
- Exercise therapy is less effective than no treatment, placebo, or a wait-and-see policy (harmful).
- There is insufficient evidence to support or refute the effectiveness of exercise therapy, compared to no treatment, placebo, or a wait-and-see policy (insufficient evidence).
- There is insufficient evidence, but there are indications to support the effectiveness of exercise therapy, compared to no treatment, placebo, or a wait-and-see policy (insufficient evidence but indications).

The following are all the possible conclusions that could be drawn for Question B:

- Exercise therapy is effective, compared to other treatments (positive).
- Exercise therapy is equally effective, compared to other treatments (equal).
- Exercise therapy is less effective, compared to other treatments (negative).
- There is insufficient evidence to support or refute the effectiveness of exercise therapy, compared to other treatments (insufficient evidence).
- There is insufficient evidence, but there are indications to support the effectiveness of exercise therapy, compared to other treatments (insufficient evidence but indications).

If the panel felt that the conclusions were not sufficiently justified by the data presented in the systematic review at issue, the conclusions reported in the systematic review were not endorsed, and the panel drew its own conclusions about the effectiveness of exercise therapy. In such cases, the panel's conclusions were based on randomised controlled trials that were of good methodological quality ($\geq 50\%$ of the quality score reported in the systematic review) with large sample sizes (smallest group $n \geq 50$).

For each disorder, the panel's final conclusions with regard to the effectiveness of exercise therapy were based on the conclusions of all available systematic reviews. If the conclusions of the systematic reviews were conflicting, the sources of discordance among the conclusions of systematic reviews were explored (Jadad et al 1997). The panel based its final conclusions on the most complete systematic review, using the decision tool described by Jadad et al (1997).

Results

Selection of studies The results of our search strategy are presented in a flow chart (Fig. 1). Out of a total of 4017 abstracts, 228 reviews were considered to be potentially eligible for our best-evidence summary. Reviewing the full text resulted in the inclusion of 104 systematic reviews, including nine duplicates. The systematic reviews have been marked with an asterisk in the reference list.

Quality assessment The overall inter-rater agreement for the quality assessment was 86% (Cohen's Kappa 0.73). Most of the disagreements were caused by differences in

Table 1. Results and conclusions of systematic reviews (quality score \geq 60 points) on the effectiveness of exercise therapy (n = 45)^a

Systematic review ^b	Disease	Score ^c	No. RCTs		Quality ^d		Conclusions SR		Dissent ^e	Conclusions Panel	
			A	B	A	B	A	B		A	B
Thomas et al (1995)	Cystic fibrosis	66	3	7	2	5	+	?	No	+	?
Bradley & Moran (2002)	Cystic fibrosis	75	3	4	0	0	?	?	No	?	?
Ram et al (2000, 2002)	Asthma	70	8	NA	0	NA	?	NA	No	?	NA
Holloway & Ram (2002)	Asthma	64	3	3	1	0	?	?	No	?	?
Bradley et al (2002)	Bronchiectasis	64	2	1	0	0	?	?	No	?	?
Smith et al (1992)	COPD, asthma and bronchitis	65	12	3	10	2	-	?	Yes	?	?
Lacasse et al (1996)	COPD	70	14	NA	14	NA	+	NA	No	+	NA
Lacasse et al (1997a, 1997b)	COPD	62	6	18	0	2	+	?	No	+	?
Cambach et al (1999)	COPD	64	12	2	2	0	+	?	No	+	?
Lacasse et al (2002)	COPD	71	23	NA	6	NA	+	?	No	+	?
De Goede et al (2001)	Parkinson's dis.	65	5	3	2	2	+	?	Yes	? (ind)	?
Deane et al (2002b)	Parkinson's dis.	64	NA	7	NA	5	NA	?	No	NA	?
Deane et al (2002a)	Parkinson's dis.	66	11	NA	5	NA	?	?	No	? (ind)	?
Kwakkel et al (1997)	CVA	61	3	5	0	0	?	?	No	?	?
van der Lee et al (2001)	CVA	79	1	12	1	9	?	? (ind)	No	? (ind)	? (ind)
Snels et al (2002)	CVA	62	NA	2	NA	1	NA	?	No	?	?
Brandsma et al (1998)	Inter. claudication	69	5	5	4	5	?	?	No	? (ind)	?
Robeer et al (1998)	Inter. claudication	76	6	6	5	6	+	+	Yes	? (ind)	?
Girolami et al (1999)	Inter. claudication	66	6	NA	6	NA	+	NA	No	+	NA
Leng et al (2002)	Inter. claudication	74	6	6	3	2	+	?	No	+	?
van der Heijden et al (1995) ^f	Neck & back pain	73	1	0	0	0	?	?	No	?	?
Aker et al (1996)	Neck pain	69	7	6	6	6	?	?	No	?	?
Hurwitz et al (1996)	Cervical spine dis.	72	1	4	0	2	?	?	No	?	?
Kjellman et al (1999)	Neck pain	63	4	6	1	1	?	?	No	?	?
Philadelphia Panel (2001b)	Neck pain	71	3	NA	0	NA	+	NA	Yes	?	?
Gross et al (2002)	Neck disorders	76	0	1	0	1	?	?	No	?	?
van der Heijden et al (1997)	Shoulder disorders	66	2	4	1	1	?	?	No	?	?
Green et al (1998, 2002)	Shoulder disorders	75	0	3	0	0	?	?	No	?	?
Philadelphia Panel (2001c)	Shoulder pain	66	1	NA	0	NA	?	NA	No	?	NA
Konijnenberg et al (2001)	RSI	75	2	4	1	2	?	?	No	?	?
Dagfinrud & Hagen (2002)	Ankyl. spondylitis	84	1	2	1	1	?	?	No	? (ind)	?
van Baar et al (1998a, 1999, 2001)	Hip and knee osteoarthritis	87	8	4	4	3	+ ⁹	?	No	+ ⁹	?
Philadelphia Panel (2001a)	Knee pain	72	6	NA	3	NA	+	NA	No	+	NA
Fransen et al (2002)	Knee osteoarthritis	78	11	3	7	2	+	?	No	+	?
van den Ende et al (1998, 2002)	Rheumatoid arth.	74	4	2	3	2	?	?	No	?	?
Koes et al (1991a, 1991b)	Low back pain (not specified)	66	5	14	3	1	?	?	No	?	?
van der Heijden et al (1995) ^f	Neck & back pain	73	0	2	0	0	?	?	No	?	?
Scheer et al (1995)	Low back pain (< 4 weeks)	63	5	5	4	4	?	?	No	?	?
van Tulder et al (1997)	Low back pain (\leq 6 weeks)	69	5	8	2	0	-	?	No	-	?
	Low back pain (> 12 weeks)	69	6	16	2	4	+	?	No	+	?
Hilde & Bo (1998)	Low back pain (> 4 weeks)	69	5	8	1	4	?	?	No	?	?
van Tulder et al (1999, 2000a, 2002b)	Low back pain (\leq 12 weeks)	83	3	11	2	3	-	?	No	-	?

	Low back pain (> 12 weeks)	83	8	19	3	10	+	±	No	+	±
	Low back pain (mixed group)	83	1	4	1	0	?	?	No	?	?
van Tulder et al (2000b)	Low back pain (> 12 weeks) ^h	81	11	13	3	3	+	?	No	+	?
Guzman et al (2001)	Low back pain (> 12 weeks) ⁱ	72	1	9	0	4	?	?	No	?	?
Philadelphia Panel (2001d)	Low back pain (< 4 weeks)	72	4	NA	2	NA	+	NA	Yes	?	NA
	Low back pain (4–12 weeks)	72	3	NA	1	NA	+	NA	No	+	NA
	Low back pain (> 12 weeks)	72	8	NA	2	NA	+	NA	No	+	NA
van Tulder et al (2002a)	Low back pain (≤ 12 weeks) ^j	88	3	2	1	1	?	?	No	?	?
	Low back pain (> 12 weeks) ^j	88	6	5	1	1	?	?	No	?	?
	Low back pain (mixed group) ^j	88	1	2	0	0	?	?	No	?	?
Beckerman et al (1993a)	Musculo. dis.	62	NA	NA	NA	NA	NA	NA	No	NA	NA

^aBecause there are nine duplicates, the number of systematic reviews presented in this table is 45. Duplicates came from van Tulder et al (1999, 2000a, 2002b), Koes et al (1991a, 1991b), Green et al (1998, 2002), van Baar et al (1998a, 1999, 2001), van den Ende et al (1998, 2002), Ram et al (2000, 2002) and Lacasse et al (1997a, 1997b). ^bThe systematic reviews are ranked in order of publication (for each disorder), equally ranked reviews are ordered alphabetically. ^cTotal quality score of the systematic review; the quality score is calculated as the sum of all items. ^dNumber of randomised controlled trials of high quality based on the methodological quality presented in the systematic review; RCTs with at least 50% of the maximum quality score were regarded as 'high quality'. ^eDisagreement between the conclusions in the systematic review and the conclusions of the panel. ^fThe systematic review of van der Heijden (1995) investigated exercise therapy for patients with low back pain and neck pain and is therefore presented twice in this table. ^gConclusions were drawn regarding the effectiveness of exercise therapy for patients with knee osteoarthritis; only one large (smallest group > 50) RCT of methodological good quality (≥ 50% quality scores) investigated the effectiveness of exercise therapy for hip osteoarthritis and found positive results on pain, observed disabilities, and patients, global assessment. ^hRCTs investigated the effectiveness of cognitive behavioural therapy (exercise therapy is included). ⁱRCTs investigated the effectiveness of multidisciplinary biopsychosocial rehabilitation (exercise therapy is included). ^jRCTs investigated the effectiveness of back schools (exercise therapy is included).

A, these columns contain data relating to the effectiveness of exercise therapy compared to no treatment, a placebo or a wait-and-see policy. Ankyl. Spondylitis = ankylosing spondylitis. B, these columns contain data relating to the effectiveness of exercise therapy compared to another treatment. ?(ind) = insufficient evidence to support the effectiveness of exercise therapy, but there are indications to support the effectiveness of exercise therapy. Cervical spine dis. = cervical spine disorders. Inter. Claudication = intermittent claudication. Musculo. dis. = musculoskeletal disorders. NA = not applicable (was not investigated in the review). Parkinson's dis. = Parkinson's disease. RCT = randomised controlled trial. Rheumatoid arth. = rheumatoid arthritis. RSI = repetitive strain injury. + = Exercise therapy is effective. ? = Insufficient evidence to support or refute the effectiveness of exercise therapy. ± = Exercise therapy is equally effective compared to other treatments. – = Exercise therapy is not effective compared to no treatment.

interpretation when discussing the power of the randomised controlled trials (see Appendix I, item L) and the heterogeneity of randomised controlled trials and outcomes (items N1, N2, N3, N4).

The mean (standard deviation) quality score of 95 systematic reviews (excluding the duplicate reviews) was 56 (17), ranging from 17 to 88 points (see Appendix II in the addenda at the AJP website, www.physiotherapy.asn.au/AJP). The most prevalent flaws were associated with the assessment of the methodological quality of the individual randomised controlled trials in the systematic review (items D1, D2, D5, D6, F, G), the data presentation (items J1, J2, J3, J4, L) and the evaluation of the results (items N1, N3, N4). There were 45 systematic reviews with a quality score of at least 60 points. These reviews investigated the effectiveness of exercise therapy for cystic fibrosis, chronic obstructive pulmonary disease (COPD), asthma, bronchiectasis,

Parkinson's disease, cerebrovascular accident (CVA), intermittent claudication, osteoarthritis, ankylosing spondylitis, rheumatoid arthritis, repetitive strain injury (RSI), neck pain, shoulder pain, and low back pain. Systematic reviews investigating the effectiveness of exercise therapy for patients with fibromyalgia, patellofemoral pain syndrome, carpal tunnel syndrome, temporomandibular joint displacement, multiple sclerosis, and cerebral palsy had low quality scores (< 60 points) (Baker and Tickle-Degnen 2001, Crossley et al 2001, Dodd et al 2002, Feuerstein et al 1999, Kropmans et al 1999, Rossy et al 1999, Stiller and Huff 1999, Zomerdijk et al 1998). Consequently, these disorders will not be discussed.

For each systematic review (≥ 60 points), the quality score, the total number of randomised controlled trials, the number of high quality randomised controlled trials, the conclusions reported in the review, and the final conclusions of the panel

are presented in Table 1. In five cases the panel disagreed with the authors of the systematic review with regard to the conclusions. These disagreements were mainly caused by inadequate reporting of the results of the randomised controlled trials in the systematic review (Philadelphia Panel 2001d, Robeer et al 1998) or because the conclusions were based on both randomised controlled trials and controlled clinical trials (De Goede et al 2001, Philadelphia Panel 2001b). In one systematic review the overall conclusions were drawn for a very heterogeneous patient population, namely patients with COPD, asthma, and bronchitis (Smith et al 1992).

Characteristics of the systematic review Details of each systematic review (≥ 60 points), including the research question(s), information on randomised controlled trials, the conclusions of the authors, and the final conclusions of the panel are presented in the Appendix III (see addenda at the AJP website, www.physiotherapy.asn.au/AJP).

Cystic fibrosis Three systematic reviews investigated the effectiveness of exercise therapy for patients with cystic fibrosis (Boyd et al 1994, Bradley and Moran 2002, Thomas et al 1995). Based on the results of two reasonable quality systematic reviews, we concluded that exercise therapy in addition to percussion, vibration, and postural drainage, has beneficial effects on FEV₁ (Forced Expiration Volume within one second) (Bradley and Moran 2002, Thomas et al 1995). The exercise therapy consisted of aerobic exercises (e.g. swimming), strength training exercises, and inspiratory muscle training. It is unclear whether exercise therapy is also effective for outcome measures such as quality of life. There is insufficient evidence to support or refute the effectiveness of exercise therapy, compared to no treatment (no randomised controlled trials available), or compared to treatment consisting of percussion, vibration, and postural drainage, or other treatments for patients with cystic fibrosis.

Asthma Four systematic reviews investigated the effectiveness of exercise therapy for patients with asthma (Ernst 2000, Gosselink and Wagenaar 1993a, Gosselink and Wagenaar 1993b, Holloway and Ram 2002, Ram et al 2002, Ram et al 2000). Based on the results of two reasonable quality systematic reviews (Holloway and Ram 2002, Ram et al 2002, Ram et al 2000), we concluded that there is insufficient evidence to support or refute the effectiveness of exercise therapy for children and adults with asthma, compared to no treatment or other conservative treatments.

Bronchiectasis With regard to bronchiectasis, we found only one reasonable quality systematic review (Bradley et al 2002). Due to the strict selection criteria applied in this systematic review, only two randomised controlled trials with poor quality reporting (abstract only) were included. Based on the results of this review, we concluded that there is insufficient evidence to support or refute the effectiveness of exercise therapy for patients with bronchiectasis.

Chronic obstructive pulmonary disease (COPD) During the period 1992–2002, 11 systematic reviews on the effectiveness of exercise therapy for COPD were published (Bekkering et al 1998, Cambach et al 1999, Chavannes and Vollenberg 2002, Devine and Peacy 1996, Gosselink and Wagenaar 1993a, Gosselink and Wagenaar 1993b, Lacasse et al 1996, Lacasse et al 1997a, Lacasse et al 1997b, Lacasse et al 2002, Lötters et al 2002, Ries et al 1997, Smith et al 1992). Based on the results of five reasonable quality systematic reviews

(Cambach et al 1999, Lacasse et al 1996, Lacasse et al 1997a, Lacasse et al 1997b, Lacasse et al 2002, Smith et al 1992) we concluded that exercise therapy, consisting of aerobic exercises (e.g. walking, cycling) and strengthening exercises, is effective in improving the maximum and functional exercise capacity and quality of life of patients with COPD. Exercise therapy in a supervised program is probably more effective than exercise therapy in an unsupervised program, which showed no beneficial effects, compared to no treatment (Lacasse et al 2002). However, there were no randomised controlled trials included in the systematic reviews that directly compared the effectiveness of supervised exercise therapy to unsupervised exercise therapy. There is insufficient evidence to support or refute the effectiveness of a specific type of exercise therapy. There is also insufficient evidence to draw conclusions with regard to the effectiveness of exercise therapy, compared to other conservative treatments.

Parkinson's disease Six systematic reviews investigated the effectiveness of exercise therapy for patients with Parkinson's disease (Deane et al 2002a, Deane et al 2002b, Deane et al 2002c, De Goede et al 2001, Nieuwboer et al 1994, Rubinstein et al 2002). Based on the results of three reasonable quality systematic reviews (Deane et al 2002a, Deane et al 2002b, De Goede et al 2001), we concluded that there is insufficient evidence to support or refute the effectiveness of exercise therapy for patients with Parkinson's disease. There are indications that intensive exercise therapy, consisting of general mobility activities focussing on balance, posture, walking, range of motion, fine motor dexterity, and functional exercises has positive effects on the activities of daily living for patients with Parkinson's disease. However, this is based on randomised controlled trials with poor methodological quality or randomised controlled trials with small sample sizes (Comella et al 1994, Gauthier et al 1987, Patti et al 1996).

Cerebrovascular accident (CVA) Eleven systematic reviews investigated the effectiveness of exercise therapy in patients who had suffered a stroke (CVA) (de Bie et al 1995, Hiraoka 2001, Kwakkel et al 1997, Langhorne et al 1996, Ottenbacher and Jannell 1993, Pedro-Cuesta et al 1992, Pomeroy and Tallis 2000, Schoppink et al 1996, Snels et al 2002, van der Lee 2001, van der Lee et al 2001). Based on the results of three reasonable quality systematic reviews (Kwakkel et al 1997, Snels et al 2002, van der Lee et al 2001), we concluded that there is insufficient evidence to support or refute the effectiveness of exercise therapy for patients who had suffered a stroke or for patients with hemiplegic shoulder pain, compared to no treatment or other conservative treatments. There are indications that (time-) intensive exercise therapy has more positive effects on the activities of daily living in patients who had suffered a stroke than less intensive exercise therapy. The exercise therapy consisted of neuromuscular facilitation and functional exercises, focusing on training of toilet transfers, rising from a sitting position, and walking. However, this was based on randomised controlled trials with poor methodological quality (Peacock et al 1972, Sivenius et al 1985, Smith et al 1981, Werner and Kessler 1996). More research is needed to confirm these results.

Intermittent claudication Seven systematic reviews investigated the effectiveness of exercise therapy in patients with intermittent claudication (Brandsma et al 1998, Gardner and Poehlman 1995, Girolami et al 1999, Leng et al 2002, Neill 1999, Radack and Wyderski 1990, Robeer et al 1998).

Based on the results of four reasonable quality systematic reviews (Brandsma et al 1998, Girolami et al 1999, Leng et al 2002, Robeer et al 1998), we concluded that exercise therapy is effective for patients with intermittent claudication, compared to no treatment. Exercise therapy consisted of (treadmill) training in walking, and lower limb strengthening exercises (e.g. stair climbing). The patients were encouraged to continue with daily walking exercises at home until they felt moderate pain. There are also indications that exercise therapy is more effective in improving maximal walking time than angioplasty (Creasy et al 1990) (Weighted Mean Difference (WMD) = 3.30 minutes; 95% CI 2.21 to 4.39) or antiplatelet therapy (Mannarino et al 1991) (WMD = 1.06 minutes; 95% CI 0.15 to 1.97), and there are indications that exercise therapy is equally as effective as surgery (Lundgren et al 1989) (WMD = -1.66 minutes; 95% CI -4.55 to 1.23). However, this was based on randomised controlled trials that either had small sample sizes or the methodological quality was not described in the review (unclear) (Creasy et al 1990, Lundgren et al 1989, Mannarino et al 1991). No conclusions can be drawn with regard to the effectiveness of a specific type of exercise therapy for patients with intermittent claudication.

Osteoarthritis Seven systematic reviews investigated the effectiveness of exercise therapy for patients with knee or hip osteoarthritis (Fransen et al 2002, McCarthy and Oldham 1999, Pendleton et al 2000, Petrella 2000, Philadelphia Panel 2001a, Puett and Griffin 1994, van Baar et al 1998a, Van Baar et al 1999, van Baar et al 2001). Based on the results of three reasonable or good quality systematic reviews, we concluded that exercise therapy, consisting of strengthening, stretching, and functional exercises, is effective for patients with knee osteoarthritis, compared to no treatment (Fransen et al 2002, Philadelphia Panel 2001a, van Baar et al 1998a, van Baar et al 1999, van Baar et al 2001). There are indications that exercise therapy (e.g. strengthening and stretching exercises, functional training, and ADL instruction) is effective for patients with hip osteoarthritis. However, this is based on one large randomised controlled trial with good methodological quality (van Baar et al 1998b). There is insufficient evidence to support or refute the effectiveness of a specific type of exercise therapy (individual, group therapy, or hydrotherapy) for patients with knee or hip osteoarthritis.

Ankylosing spondylitis Two systematic reviews investigated the effectiveness of exercise therapy for patients with ankylosing spondylitis (Ammer 1997, Dagfinrud and Hagen 2002). Based on one good quality systematic review (Dagfinrud and Hagen 2002), we concluded that there are indications to support the effectiveness of exercise therapy, compared to no treatment for patients with ankylosing spondylitis. The exercise therapy consisted of functional exercises and exercises to improve mobility, strength, and endurance, using normal movement patterns and proprioceptive neuromuscular facilitation. The patients received disease education and were encouraged to continue their exercises daily at home. However, this was based on only one small good quality randomised controlled trial (Kraag et al 1990). No conclusions can be drawn with regard to the effectiveness of exercise therapy, compared to other types of exercise therapy or other treatments.

Rheumatoid arthritis Two systematic reviews investigated the effectiveness of exercise therapy for patients with rheumatoid arthritis (Augustinus et al 2000, van den Ende et al 1998, van den Ende et al 2002). Based on one reasonable

quality systematic review, we concluded that there is insufficient evidence to support or refute the effectiveness of exercise therapy for patients with rheumatoid arthritis (van den Ende et al 1998, van den Ende et al 2002).

Repetitive strain injury With regard to repetitive strain injury, we found only one reasonable quality systematic review (Konijnenberg et al 2001). We concluded that there is insufficient evidence to support or refute the effectiveness of exercise therapy for patients with repetitive strain injury.

Neck pain We found six systematic reviews investigating the effectiveness of exercise therapy for patients with non-specific neck pain (Aker et al 1996, Gross et al 2002, Hurwitz et al 1996, Kjellman et al 1999, Philadelphia Panel 2001b, van der Heijden et al 1995). Based on the results of these six reasonable quality systematic reviews, we concluded that there is insufficient evidence to support or refute the effectiveness of exercise therapy, compared to no treatment or other conservative treatments, for patients with (non-specific) neck pain.

Shoulder pain During the period 1997–2002, four systematic reviews on the effectiveness of exercise therapy for shoulder pain were published (Green et al 1998, Green et al 2002, Johansson et al 2002, Philadelphia Panel 2001c, van der Heijden et al 1997). Based on the results of three reasonable quality systematic reviews (Green et al 1998, Green et al 2002, Philadelphia Panel 2001c, van der Heijden et al 1997), we concluded that there is insufficient evidence to support or refute the effectiveness of exercise therapy for patients with shoulder pain or shoulder complaints.

Low back pain A total of 21 systematic reviews, published between January 1985 and July 2002, investigated the effectiveness of exercise therapy (also exercise therapy including cognitive behavioural therapy, back school, multidisciplinary rehabilitation) in patients with low back pain (Elders et al 2000, Di Fabio 1995, Faas 1996, Guzman et al 2001, Hilde and Bo 1998, Koes et al 1991a, Koes et al 1991b, Koes et al 1995, Maier-Riehle and Härter 2001, Ottenbacher and Di Fabio 1985, Philadelphia Panel 2001d, Scheer et al 1995, Scheer et al 1997, Smith et al 2002, van Duijvenbode 1996, van Duijvenbode 1999, van Tulder et al 1997, van Tulder 1999, van Tulder et al 2000a, van Tulder et al 2000b, van Tulder et al 2002a, van Tulder et al 2002b, Weinhardt et al 2001). Ten systematic reviews had reasonable or good scores for quality (Guzman et al 2001, Hilde and Bo 1998, Koes et al 1991a, Koes et al 1991b, Philadelphia Panel 2001d, Scheer et al 1995, van Tulder et al 1997, van Tulder 1999, van Tulder et al 2000a, van Tulder et al 2000b, van Tulder et al 2002a, van Tulder et al 2002b).

For patients with acute low back pain (< 6 weeks) there is no difference in the effectiveness of exercise therapy (e.g. stretching, strengthening, extension/flexion exercises), compared to no treatment, care provided by a general practitioner, or manipulations (high velocity techniques). For patients with sub-acute (6 to 12 weeks) and chronic (> 12 weeks) low back pain, we concluded that exercise therapy is effective compared to no treatment. The exercise therapy consisted of aerobic exercises (e.g. walking, jogging), and intensive strengthening exercises for the abdomen and trunk muscles. Exercise therapy (e.g. aerobic exercises, progressive muscle relaxation) in combination with cognitive behavioural therapy is also more effective than no treatment for patients with chronic low back pain.

For patients with chronic (> 12 weeks) low back pain, exercise therapy (e.g. strengthening exercises) is more effective than continued care provided by a general practitioner, and equally as effective as conventional physiotherapy (e.g. traction, massage, ultrasound, mobilisation exercises, hot and cold packs). There is insufficient evidence to support or refute the effectiveness of a particular type of exercise therapy for patients with sub-acute or chronic low back pain. There are indications that intensive multidisciplinary bio-psychosocial rehabilitation with functional restoration (including intensive aerobic exercises, stretching exercises, and muscle relaxation therapy) is more effective than physical training plus back school for patients with chronic low back pain. However, this was based on only one good quality randomised controlled trial with a short and long-term follow-up (Bendix et al 1995).

There are indications that exercise therapy, consisting of abdominal strengthening exercises, in addition to back school, is effective for patients with chronic low back pain, compared to back school without exercise therapy. However, this was also based on only one randomised controlled trial with good methodological quality (Klaber-Moffett et al 1986). There is insufficient evidence to support or refute the effectiveness of cognitive behavioural therapy plus exercise therapy compared to other conservative treatments for patients with chronic low back pain. There is also insufficient evidence to draw conclusions with regard to the (in)effectiveness of back schools for patients with acute, sub-acute or chronic low back pain.

Discussion

Exercise therapy is effective for patients with knee osteoarthritis, sub-acute and chronic low back pain, cystic fibrosis, COPD, and intermittent claudication. Furthermore, there are indications that exercise therapy is effective for patients with ankylosing spondylitis, hip osteoarthritis, and Parkinson's disease, and also for patients who have suffered a stroke. We concluded that there is insufficient evidence to support or refute the effectiveness of exercise therapy for patients with neck pain, shoulder pain, RSI, rheumatoid arthritis, asthma, and bronchiectasis. Exercise therapy is not effective for patients with acute low back pain. Based on the available literature, we found no evidence that exercise therapy is harmful or that it provoked harmful side effects. However, systematic reviews provide little information on the safety aspects of exercise therapy. This is mainly due to the inadequate reporting of adverse effects in randomised controlled trials (Ernst and Pittler 2001).

For certain diseases (fibromyalgia, patellofemoral pain syndrome, carpal tunnel syndrome, temporomandibular joint displacement, multiple sclerosis, cerebral palsy), only systematic reviews with low scores for quality (< 60 points) were available (Baker and Tickle-Degnen 2001, Crossley et al 2001, Dodd et al 2002, Feuerstein et al 1999, Kropmans et al 1999, Rossy et al 1999, Stiller and Huff 1999, Zomerdijk et al 1998). For these disorders, we recommend that systematic reviews be carried out using methods that accord to the current state of knowledge (Egger et al 2001).

Although a number of systematic reviews were of reasonable or good quality, there was still insufficient evidence to draw firm conclusions with regard to the (in)effectiveness of exercise therapy for neck pain, shoulder pain, repetitive strain injury, rheumatoid arthritis, asthma, and bronchiectasis. This

was mainly due to the contradictory results, the poor methodological quality of the randomised controlled trials, inadequate reporting, small sample sizes, and the large variation in outcome measures and study populations. We recommend that searches be conducted for new published, large randomised controlled trials of good quality (since the last search date of the most recent systematic review of reasonable or good quality) on the effectiveness of exercise therapy for the following disorders: neck pain, shoulder pain, RSI, rheumatoid arthritis, asthma, and bronchiectasis. If no new randomised controlled trials have been published, or the retrieved randomised controlled trials are of poor methodological quality, we recommend that a new, large randomised controlled trial with good methodological quality be carried out.

We found indications to support the effectiveness of exercise therapy for patients with ankylosing spondylitis, hip osteoarthritis, Parkinson's disease and patients who had suffered a stroke, but more randomised controlled trials are needed to confirm these results.

With regard to the disorders for which exercise therapy appeared to be effective, it still remains to be determined whether exercise therapy should be included in a supervised or an unsupervised program, and whether exercise at home is sufficient or referral should be made to a physiotherapist. There is also insufficient evidence to support or refute the effectiveness of specific types of exercise therapy for almost all disorders. More research is also needed to investigate how the short-term effectiveness of exercise therapy can be maintained in the long-term. Programs or methods with which care-providers could encourage the compliance of patients with home exercises and motivate them to continue their exercises in the future would be very useful.

This best-evidence summary of systematic reviews has a number of limitations. First, different weights were applied to the five quality criteria, including the selection of studies, methodological quality assessment of the randomised controlled trials, description of the intervention, data presentation, and evaluation. Total quality scores were calculated by summing up the weights of all quality items. The advantage of using an overall quality score is its simplicity, but methodologically it is debatable. If equal weights were applied to each quality item, the division of systematic reviews into good, reasonable, moderate, poor, and very poor quality would be quite similar, and the final conclusions with regard to the effectiveness of exercise therapy would still be the same.

Second, the choice of the cut-off point for reasonable or good quality was arbitrary. The quality of the reporting of the results of systematic reviews with low scores for quality (< 60 points) was often too poor to draw conclusions with regard to the effectiveness of exercise therapy. If, for example, the cut-off point was set at 50 points, another 11 reviews would have been included. However, our conclusions with regard to the effectiveness of exercise therapy for the disorders discussed in this review would remain the same (data not shown). We could only draw new conclusions with regard to the effectiveness of exercise therapy for patellofemoral pain syndrome.

Third, our conclusions were based on statistically significant differences, rather than clinically relevant differences. Unfortunately, based on the results presented in the

systematic reviews, it was not possible to calculate effect sizes. Therefore, the clinically relevant differences were not taken into account in our conclusions.

Finally, a few systematic reviews on the same topic reported conflicting conclusions. However, based on the guidelines developed by Jadad et al (1997), explaining differences in research questions, assessment of the quality of randomised controlled trials, number of randomised controlled trials, and statistical methods for data-analysis, the panel succeeded in drawing clear conclusions.

In conclusion, exercise therapy has been shown to be effective for a wide range of (chronic) disorders.

Footnotes

*Contributing authors (members of the Exercise Therapy Group):

Johan H Arendzen, Leiden University Medical Center, Leiden, The Netherlands

Rob A de Bie, University of Maastricht, The Netherlands

Sita MA Bierma-Zeinstra, Erasmus Medical Center, Rotterdam, The Netherlands

Lex M Bouter, VU University Medical Center, The Netherlands

Henrica CW de Vet, VU University Medical Center, Amsterdam, The Netherlands

Joost Dekker, VU University Medical Center, Amsterdam The Netherlands (chair)

Paul JM Helders, University Medical Center Utrecht, The Netherlands

Samyra HJ Keus, Leiden University Medical Center, Leiden, The Netherlands

Gert Kwakkel, VU University Medical Center, Amsterdam, The Netherlands

Ton Lensen, University of Maastricht, The Netherlands

Rob AB Oostendorp, University Medical Center St. Radboud, Nijmegen, The Netherlands

Raymond WJG Ostelo, VU University Medical Center, Amsterdam, The Netherlands

Max Reijman, Erasmus Medical Center, Rotterdam, The Netherlands

Nynke Smidt, VU University Medical Center, Amsterdam, The Netherlands

Caroline B Terwee, VU University Medical Center, Amsterdam, The Netherlands

Carlo Theunissen, University of Maastricht, The Netherlands

Siep Thomas, Erasmus Medical Center, Rotterdam, The Netherlands

Margriet E van Baar, Erasmus Medical Center, Rotterdam, The Netherlands

Alex van 't Hul, VU University Medical Center, Amsterdam, The Netherlands

Roland PS van Peppen, VU University Medical Center, Amsterdam, The Netherlands

Arianne P Verhagen, Erasmus Medical Center, Rotterdam, The Netherlands

Daniëlle AWM van der Windt, VU University Medical Center, Amsterdam, The Netherlands

Acknowledgements This article was based on the work of the 'Panel on Exercise Therapy' of the Dutch Health Council. The authors would like to thank Karin Johnson for blinding the articles.

Correspondence Nynke Smidt, Institute for Research in Extramural Medicine, VU University Medical Center, van der Boechorststraat 7, 1081 BT Amsterdam, The Netherlands. Email: <n.smidt@vumc.nl>

References

Systematic reviews have been marked with an asterisk.

ACCP/AACVPR Pulmonary Rehabilitation Guidelines Panel; American College of Chest Physicians; American Association of Cardiovascular and Pulmonary Rehabilitation (1997): Pulmonary rehabilitation: Joint ACCP/AACVPR evidence-based guidelines. *Chest* 112: 1363–1396.

*Aker PD, Gross AR, Goldsmith CH and Peloso P (1996): Conservative management of mechanical neck pain: Systematic overview and meta-analysis. *BMJ* 313: 1291–1296.

*Ammer K (1997): Physiotherapy in seronegative spondylarthropathies—a systematic review. *European Journal of Physical Medicine and Rehabilitation* 7: 114–119.

Anonymous (1992): *International Statistical Classification of Diseases and Related Health Problems (ICD-10)*, 1989 Revision. Geneva: World Health Organization.

Assendelft WJ, Koes BW, Knipschild PG and Bouter LM (1995): The relationship between methodological quality and conclusions in reviews of spinal manipulation. *Journal of the American Medical Association* 274: 1942–1948.

*Augustinus L, Noordzij D, Verkerk K and De Visser D (2000): *Systematische Review Naar Actieve Bewegingsvormen Bij Reumatoïde Arthritis*. Rotterdam: Hogeschool Rotterdam (in Dutch).

*Baker NA and Tickle-Degnen L (2001): The effectiveness of physical, psychological and functional interventions in treating clients with multiple sclerosis: a meta-analysis. *American Journal of Occupational Therapy* 55: 324–331.

*Beckerman H, Bouter LM, van der Heijden GJMG, De Bie RA and Koes BS (1993a): Efficacy of physiotherapy for musculoskeletal disorders: What can we learn from research? *British Journal of General Practice* 43: 73–77.

*Beckerman H, Bouter LM, van der Heijden GJMG, De Bie RA and Koes BS (1993b): The efficacy of physiotherapy for musculoskeletal disorders – Overview of the current state of knowledge. *European Journal of Physical Medicine and Rehabilitation* 3: 236–241.

*Bekkering GE, Cambach W, Hendriks HJM, Chadwick-Straver RVM, Gosselink R, Jongmans M, Paterson WJ, van der Schans CP, Verhoef-de Wijk MCE and Decramer M (1998): Revalidatie bij patiënten met COPD: een systematische literatuurstudie. *Nederlands Tijdschrift voor Fysiotherapie* 108: 120–127 (in Dutch).

Bendix AF, Bendix T, Ostfeld S, Bush E and Andersen A (1995): Active treatment programs for patients with chronic low back pain: A prospective, randomised, observer-blinded study. *European Spine Journal* 4: 148–152.

*Bouter LM, Beckerman H, van der Heijden GM, Koes BW and De Bie RA (1992): [Effectiveness of physiotherapy; a summary of 9 meta-analyses.] *Nederlands Tijdschrift voor Geneeskunde* 136: 1058–1061 (in Dutch).

*Boyd S, Brooks D, Agnew-Coughlin J and Ashwell J (1994): Evaluation of the literature on the effectiveness of physical therapy modalities in the management of children with cystic fibrosis. *Pediatric Physical Therapy* 6: 70–74.

*Bradley J and Moran F (2002): Physical training for cystic fibrosis. The Cochrane Library, Issue 2. Oxford: Update Software.

- *Bradley J, Moran F and Greenstone M (2002): Physical training for bronchiectasis. The Cochrane Library, Issue 3. Oxford: Update Software.
- *Brandsma JW, Robeer BG, van den Heuvel S, Smit B, Wittens CHA and Oostendorp RAB (1998): The effect of exercises on walking distance of patients with intermittent claudication: A study of randomized clinical trials. *Physical Therapy* 78: 278-288
- *Cambach W, Wagenaar RC, Koelman TW, van Keimpema T and Kemper HCG (1999): The long-term effects of pulmonary rehabilitation in patients with asthma and chronic obstructive pulmonary disease: A research synthesis. *Archives of Physical Medicine and Rehabilitation* 80: 103-111.
- Chartered Society of Physiotherapy (2001): Neurology, Parkinson's disease, multiple sclerosis and severe traumatic brain injury. *Physiotherapy Effectiveness Bulletin* 3: 1-11.
- *Chavannes NH and Vollenberg JJH (2002): Effects of physical activity in mild to moderate COPD: A systematic review. *British Journal of General Practice* 52: 574-578.
- Comella CL, Stebbins GT, Brown-Toms N and Goetz CG (1994): Physical therapy and Parkinson's Disease: A controlled clinical trial. *Neurology* 44: 376-378.
- Creasy TS, McMillan PJ, Fletcher EWL, Collin J and Morris PJ (1990): Is percutaneous transluminal angioplasty better than exercise for claudication? Preliminary results from a prospective randomised trial. *European Journal of Vascular Surgery* 4: 135-140.
- *Crossley K, Bennell K, Green S and McConnell J (2001): A systematic review of physical interventions for patellofemoral pain syndrome. *Clinical Journal of Sport Medicine* 11: 103-110.
- *Dagfinrud H and Hagen K (2002): Physiotherapy interventions for ankylosing spondylitis. The Cochrane Library, Issue 2. Oxford: Update Software.
- *Deane KHO, Ellis-Hill C, Clarke CE, Playford ED and Ben-Shlomo Y (2002a): Physiotherapy for Parkinson's disease: A comparison of techniques. The Cochrane Library, Issue 2. Oxford: Update Software.
- *Deane KHO, Jones D, Playford ED, Ben-Shlomo Y and Clarke CE (2002b): Physiotherapy versus placebo or no intervention in Parkinson's disease. The Cochrane Library, Issue 2. Oxford: Software Update.
- *Deane KHO, Ellis-Hill C, Jones D, Whurr R, Ben-Shlomo Y, Playford D and Clarke CE (2002c): Systematic review of paramedical therapies for Parkinson's disease. *Movement Disorders* 17: 984-991.
- *de Bie RA, Schoppink EM and Kool JP (1995): Effectiviteit van oefentherapie bij CVA-patiënten: een meta-analyse van de literatuur. *Jaarboek Fysiotherapie*, pp 197-212 (in Dutch).
- *De Goede CJT, Keus SHJ, Kwakkel G and Wagenaar RC (2001): The effects of physical therapy in Parkinson's disease: A research synthesis. *Archives of Physical Medicine and Rehabilitation* 82: 509-515.
- De Vet HCW, Kroese MEAL, Scholten RJPM and Bouter LM (2001): A method for research programming in the field of evidence-based medicine. *International Journal of Technology Assessment in Health Care* 17: 433-441.
- *Devine EC and Percy J (1996): Meta-analysis of the effects of psychoeducational care in adults with chronic obstructive pulmonary disease. *Patient Education and Counseling* 29: 167-178.
- *Di Fabio RP (1995): Efficacy of comprehensive rehabilitation programs and back school for patients with low back pain meta-analysis. *Physical Therapy* 75: 865-878.
- *Dodd KJ, Taylor NF and Damiano DL (2002): A systematic review of the effectiveness of strength-training programs for people with cerebral palsy. *Archives of Physical Medicine and Rehabilitation* 83: 1157-1164.
- Egger M, Smith GD and Altman DG (2001): *Systematic Reviews in Health Care: Meta-Analysis in Context* (2nd Ed). London: BMJ Publishing Group.
- *Elders LAM, van der Beek AJ and Burdorf A (2000): Return to work after sickness absence due to back disorders—a systematic review on intervention strategies. *International Archives of Occupational and Environmental Health* 73: 339-348
- *Ernst E (2000): Breathing techniques—adjunctive treatment modalities for asthma? A systematic review. *European Respiratory Journal* 15: 969-972.
- Ernst E and Pittler MH (2001): Assessment of therapeutic safety in systematic reviews: Literature review. *BMJ* 323: 546.
- *Faas A (1996): Exercises: Which ones are worth trying, for which patients, and when? *Spine* 21: 2874-2879.
- *Feuerstein M, Burrell LM, Miller VI, Lincoln A, Huang GD and Berger R (1999): Clinical management of carpal tunnel syndrome: A 12-year review of outcomes. *American Journal of Industrial Medicine* 35: 232-245.
- *Fransen M, McConnell S and Bell M (2002): Therapeutic exercise for people with osteoarthritis of the hip or knee. A systematic review. *Journal of Rheumatology* 29: 1737-1745.
- *Gardner AW and Poehlman ET (1995): Exercise rehabilitation programs for the treatment of claudication pain. A meta-analysis. *Journal of the American Medical Association* 27: 975-980.
- Gauthier L, Dalziel S and Gauthier S (1987): The benefits of group occupational therapy for patients with Parkinson's disease. *American Journal of Occupational Therapy* 41: 360-365.
- *Girolami B, Bernardi E, Prins MH, Cate JW ten, Hettiarachchi R, Prandoni P, Girolami A and Büller HR (1999): Treatment of intermittent claudication with physical training, smoking cessation, pentoxifylline, or nafronyl. *Archives of Internal Medicine* 159: 337-345.
- Gordon NF, Gulanick M, Costa F, Fletcher G, Franklin BA, Roth EJ and Shephard T (2004): Physical activity and exercise recommendations for stroke survivors. *Circulation* 109: 2031-2041.
- *Gosselink HAAM and Wagenaar RC (1993a): Efficacy of breathing exercises in chronic obstructive pulmonary disease and asthma. A meta-analysis of the literature (part 1). *Journal of Rehabilitation Sciences* 6: 66-79.
- *Gosselink HAAM and Wagenaar CR (1993b): Efficacy of breathing exercises in chronic obstructive pulmonary disease and asthma. A meta-analysis of literature (part 2). *Journal of Rehabilitation Sciences* 6: 105-113.
- *Green S, Buchbinder R, Glazier R and Forbes A (2002): Interventions for shoulder pain. The Cochrane Library, Issue 2. Oxford: Update Software.
- *Green S, Buchbinder R, Glazier R and Forbes A (1998): Systematic review of randomised controlled trials of interventions for painful shoulder: Selection criteria, outcome assessment, and efficacy. *BMJ* 316: 354-360.
- *Gross AR, Aker PD, Goldsmith CH and Peloso P (2002): Physical medicine modalities for mechanical neck disorders. The Cochrane Library, Issue 1. Oxford: Update Software.
- *Guzman J, Esmail R, Karjalainen K, Malmivaara A, Irvin E and Bombardier C (2001): Multidisciplinary rehabilitation for chronic low back pain: Systematic review. *BMJ* 322: 1511-1516.
- Herbert RD, Maher CG, Moseley AM and Sherrington C (2001): Effective physiotherapy. *BMJ* 323: 788-790.
- *Hilde G and Bo K (1998): Effect of exercise in the treatment of chronic low back pain: A systematic review, emphasising type and dose of exercise. *Physical Therapy Review* 3: 107-117.
- *Hiraoka K (2001): Rehabilitation effort to improve upper extremity function in post-stroke patients: A meta-analysis. *Journal of Physical Therapy and Science* 13: 5-9.
- *Holloway E and Ram FSF (2002): Breathing exercises for asthma. The Cochrane Library, Issue 1. Oxford: Update Software.
- Hunt DL and McKibbin KA (1997): Locating and appraising

- systematic reviews. *Annals of Internal Medicine* 126: 532–538.
- *Hurwitz EL, Aker PD, Adams AH, Meeker WC and Shekelle PG (1996): Manipulation and mobilization of the cervical spine. A systematic review of the literature. *Spine* 21: 1746–1760.
- Jadad RA, Cook DJ and Browman GP (1997): A guide to interpreting discordant systematic reviews. *Canadian Medical Association Journal* 156: 1411–1416.
- *Johansson K, Öberg B, Adolfsson L and Foldevi M (2002): A combination of systematic review and clinicians' beliefs in interventions for subacromial pain. *British Journal of General Practice* 52: 145–152.
- *Kjellman GV, Skargren EI and Öberg BE (1999): A critical analysis of randomised clinical trials on neck pain and treatment efficacy. A review of the literature. *Scandinavian Journal of Rehabilitation Medicine* 31: 139–152.
- Kluber-Moffett JA, Chase SM, Portek I and Ennis JR (1986): A controlled prospective study to evaluate the effectiveness of a back school in the relief of chronic low-back pain. *Spine* 11: 120–122.
- *Koes BW, Bouter LM, Beckerman H, van der Heijden GJMG and Knipschild PG (1991a): Oefentherapie bij rugklachten. Een geblyndeerd literatuuronderzoek. *Nederlands Tijdschrift voor Fysiotherapie* 101: 229–234 (in Dutch).
- *Koes BW, Bouter LM, Beckerman H, van der Heijden GJMG and Knipschild PG (1991b): Physiotherapy exercises and back pain: A blinded review. *BMJ* 302:1572–6.
- *Koes BW, Bouter LM and van der Heijden GJMG (1995): Methodological quality of randomized clinical trials on treatment efficacy in low back pain. *Spine* 20: 228–235.
- *Konijnenberg HS, De Wilde NS, Gerritsen AAM, van Tulder MW and De Vet HCW (2001): Conservative treatment for repetitive strain injury. *Scandinavian Journal of Work, Environment and Health* 27: 299–310.
- Kraag G, Stokes B, Groh J, Helewa A and Goldsmith C (1990): The effects of comprehensive home physiotherapy and supervision on patients with ankylosing spondylitis—A randomised controlled trial. *Journal of Rheumatology* 17: 228–233.
- *Kropmans ThJB, Dijkstra PU, Stegenda B and De Bont LGM (1999): Therapeutic outcome assessment in permanent temporomandibular joint disc displacement. *Journal of Oral Rehabilitation* 26: 357–363.
- *Kwakkel G, Wagenaar RC, Koelman TW, Lankhorst GJ and Koetsier JC (1997): Effects of intensity of rehabilitation after stroke. A research synthesis. *Stroke* 28: 1550–1556.
- *Lacasse Y, Wong E, Guyatt GH, King D, Cook DJ and Goldstein RS (1996): Meta-analysis of respiratory rehabilitation in chronic obstructive pulmonary disease. *Lancet* 348: 1114–1119.
- *Lacasse Y, Guyatt GH and Goldstein RS (1997a): The components of a respiratory rehabilitation program. A systematic review. *Chest* 111: 1077–1088.
- *Lacasse Y, Goldstein RS and Guyatt GH (1997b): Respiratory rehabilitation in chronic obstructive pulmonary disease: Summary of a systematic overview of the literature. *Reviews in Clinical Gerontology* 7: 327–347.
- *Lacasse Y, Brosseau L, Milne S, Martin S, Wong E, Guyatt GH and Goldstein RS (2002): Pulmonary rehabilitation for chronic obstructive pulmonary disease. The Cochrane Library, Issue 3. Oxford: Update Software.
- *Langhorne P, Wagenaar R and Partridge C (1996): Physiotherapy after stroke: More is better? *Physiotherapy Research International* 1: 75–87.
- *Leng GC, Fowler B and Ernst E (2002): Exercise for intermittent claudication. The Cochrane Library, Issue 1. Oxford: Update Software.
- *Lötters F, van Tol B, Kwakkel G and Gosselink R (2002): Effects of controlled inspiratory muscle training in patients with COPD: A meta-analysis. *European Respiratory Journal* 20: 570–576.
- Lundgren F, Dahlhof AG, Lundholm K, Schersten T and Volkman R (1989): Intermittent claudication—surgical reconstruction or physical training? A prospective randomised trial of treatment efficiency. *Annals of Surgery* 209: 346–355.
- *Maier-Riehle B and Härter M (2001): The effects of back schools—A meta-analysis. *International Journal of Rehabilitation Research* 24: 199–206.
- Mannarino E, Pasqualini L, Innocente S, Scricciolo V, Rignanese A and Ciuffetti G (1991): Physical training and antiplatelet treatment in stage II peripheral arterial occlusive disease: Alone or combined? *Angiology* 42: 513–521.
- *McCarthy CJ and Oldham JA (1999): The effectiveness of exercise in the treatment of osteoarthritic knees: A critical review. *Physical Therapy Reviews* 4: 241–250.
- *Neill R (1999): A meta-analysis of the treatment of intermittent claudication. *Journal of Family Practice* 48: 418–419.
- *Nieuwboer A, De Weerd W, Nuyens G, Hantson L and Feys H (1994): Een literatuurstudie naar de effecten van fysiotherapie bij de ziekte van Parkinson. *Nederlands Tijdschrift voor Fysiotherapie* 5: 122–128 (in Dutch).
- *Ottenbacher K and Di Fabio RP (1985): Efficacy of spinal manipulation/mobilization therapy. A meta-analysis. *Spine* 10: 833–837.
- *Ottenbacher KJ and Jannell S (1993): The results of clinical trials in stroke rehabilitation research. *Archives of Neurology* 50: 37–44.
- Patti F, Reggio A, Nicoletti F, Sellaroli T, Deinite G and Nicoletti F (1996): Effects of rehabilitation therapy in Parkinson's disability and functional independence. *Journal of Neurologic Rehabilitation* 10: 223–231.
- Peacock PD, Riley CHP, Lampton TD, Raffel SS and Walker JS (1972): The Birmingham Stroke Epidemiology and Rehabilitation Study. In: Stewart GT (Ed.): *Trends in Epidemiology*. Springfield, Ill: Charles C Thomas, pp. 231–345.
- *Pedro-Cuesta de J, Widen-Holmqvist L and Bach-y Rita P (1992): Evaluation of stroke rehabilitation by randomised controlled studies: A review. *Acta Neurologica Scandinavica* 86: 433–439.
- *Pendleton A, Arden N, Dougados M, Doherty M, Bannwarth B, Bijlsma J, Cluzeau F, Cooper C, Dieppe PA, Günther K-P, Hauselmann HJ, Herrero-Beaumont G, Kaklamanis PM, Leeb B, Lequesne M, Lohmander S, Mazieres B, Mola E-M, Pavelka K, Serni U, Swoboda B, Verbruggen AA, Weseloh G and Zimmermann-Gorska I (2000): EULAR recommendations for the management of knee osteoarthritis: Report of a task force of the Standing Committee for International Clinical Studies Including Therapeutic Trials (ESCISIT). *Annals of the Rheumatic Diseases* 59: 936–944.
- *Petrella RJ (2000): Is exercise effective treatment for osteoarthritis of the knee? *British Journal of Sports Medicine* 34: 326–331.
- *Philadelphia Panel (2001a): Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for knee pain. *Physical Therapy* 81: 1675–1700.
- *Philadelphia Panel (2001b): Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for neck pain. *Physical Therapy* 81: 1701–1717.
- *Philadelphia Panel (2001c): Philadelphia panel evidence-based clinical practice guidelines on selected rehabilitation interventions for shoulder pain. *Physical Therapy* 81: 1719–1730.
- *Philadelphia Panel (2001d): Philadelphia panel evidence-based clinical practice guidelines on selected rehabilitation interventions for low back pain. *Physical Therapy* 81: 1641–1674.
- Pina IL, Apstein CS, Balady GJ, Belardinelli R, Chaitman BR, Duscha BD, Fletcher BJ, Fleg JL, Myers JN and Sullivan MJ (2003): Exercise and heart failure. A statement from the American Association Committee on Exercise, Rehabilitation,

- and Prevention. *Circulation* 107: 1210–1225.
- *Pomeroy VM and Tallis RC (2000): Physical therapy to improve movement performance and functional ability poststroke. Part 1. Existing evidence. *Clinical Gerontology* 10: 261–290.
- *Puett DW and Griffin MR (1994): Published trials of non-medicinal and noninvasive therapies for hip and knee osteoarthritis. *Annals of Internal Medicine* 121: 133–140.
- *Radack K and Wyderski RJ (1990): Conservative management of intermittent claudication. *Annals of Internal Medicine* 113: 135–146.
- *Ram FSF, Robinson SM and Black PN (2002): Physical training for asthma. The Cochrane Library, Issue 1. Oxford: Update Software.
- *Ram FSF, Robinson SM and Black PN (2000): Effects of physical training in asthma: A systematic review. *British Journal of Sports Medicine* 43: 162–167.
- *Ries AL, Carlin BW, Carrieri-Kohlman V, Casaburi R and Celli BR (1997): Pulmonary rehabilitation. Joint ACCP/AACVPR evidence-based guidelines. *Chest* 112: 1363–1396.
- *Robeer GG, Brandsma JW, Heuvel SP van den, Smit B, Oostendorp RAB and Wittens CHA (1998): Exercise therapy for intermittent claudication; a review of the quality of randomised clinical trials and evaluation of predictive factors. *European Journal of Vascular and Endovascular Surgery* 15: 36–43.
- *Rossy LA, Buckelew MA, Buckelew SP, Dorr N, Hagglund KJ, Thayer JF, McIntosh MJ, Hewett JE and Johnson JC (1999): A meta-analysis of fibromyalgia treatment interventions. *Annals of Behavioral Medicine* 21: 180–191.
- *Rubinstein TC, Giladi N and Hausdorff JM (2002): The power of cueing to circumvent dopamine deficits: A review of physical therapy treatment of gait disturbances in Parkinson's disease. *Movement Disorders* 17: 1148–1160.
- *Scheer SJ, Radack KL and O'Brian DR (1995): Randomized controlled trials in industrial low back pain relating to return to work. Part 1. Acute interventions. *Archives of Physical Medicine and Rehabilitation* 76: 966–973.
- *Scheer SJ, Watanabe TK and Radack KL (1997): Randomized controlled trials in industrial low back pain. Part 3. Subacute/chronic pain interventions. *Archives of Physical Medicine and Rehabilitation* 78: 414–423.
- *Schoppink EM, Kool JP and De Bie RA (1996): Oefentherapie bij CVA-patiënten. Een meta-analyse. *Nederlands Tijdschrift voor Fysiotherapie* 2: 41–51 (in Dutch).
- Sivenius J, Pyorala K, Heinonen OP, Salonen JT and Riekkinen P (1985): The significance of intensity of rehabilitation of stroke: A controlled trial. *Stroke* 16: 928–931.
- *Smith K, Cook D, Guyatt GH, Madhavan J and Oxman AD (1992): Respiratory muscle training in chronic airflow limitation: A meta-analysis. *American Review of Respiratory Disease* 145: 533–539.
- Smith DS, Goldberg E, Ashburn A, Kinsella G, Sheikh K, Brennan PJ, Meade TW, Zutshi DW, Perry JD and Reeback JS (1981): Remedial therapy after stroke: A randomised controlled trial. *BMJ* 282: 5–9.
- *Smith D, McMurray N and Disler P (2002): Early intervention for acute back injury: Can we finally develop an evidence-based approach? *Clinical Rehabilitation* 16: 1–11.
- *Snels IAK, Dekker JHM, van der Lee JH, Lankhorst GJ, Beckerman H and Bouter LM (2002): Treating patients with hemiplegic shoulder pain. *American Journal of Physical Medicine & Rehabilitation* 81: 150–160.
- *Stillier K and Huff N (1999): Respiratory muscle training for tetraplegic patients: A literature review. *Australian Journal of Physiotherapy* 45: 291–299.
- Tan JC and Horn SE (1998): Practical Manual of Physical Medicine and Rehabilitation: Diagnostics, Therapeutics, and Basic Problems. St Louis: Mosby, pp. 156–177.
- *Thomas J, Cook DJ and Brooks D (1995): Chest physical therapy management of patients with cystic fibrosis. A meta-analysis. *American Journal of Respiratory and Critical Care Medicine* 151: 846–850.
- *van Baar ME, Assendelft WJJ and Dekker J (2001): Effectiviteit van oefentherapie als behandeling voor patiënten met artrose van heup of knie: Een systematisch literatuuroverzicht van gerandomiseerde klinische trials. *Nederlands Tijdschrift voor Fysiotherapie* 111: 56–66 (in Dutch).
- *van Baar ME, Assendelft WJJ, Dekker J, Oostendorp RAB and Bijlsma JWW (1999): Effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee: A systematic review of randomized clinical trials. *Arthritis and Rheumatism* 42: 1361–1369.
- *van Baar ME, Assendelft WJJ, Dekker J, Oostendorp RAB and Bijlsma JWW (1998a): Exercise therapy is effective in patients with osteoarthritis of hip or knee: A systematic review of randomised clinical trials. In: Effectiveness of exercise therapy in osteoarthritis of hip or knee (Thesis). Utrecht: University Utrecht, pp. 107–131.
- van Baar ME, Dekker J, Oostendorp RA, Bijl D, Voorn TB, Lemmens JA and Bijlsma JW (1998b): The effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee: A randomized clinical trial. *Journal of Rheumatology* 25: 2432–2439.
- *van den Ende CHM, Vliet Vlieland TPM, Munneke M and Hazes JMW (2002): Dynamic exercise therapy for rheumatoid arthritis. The Cochrane Library, Issue 1. Oxford: Update Software.
- *van den Ende CHM, Vliet Vlieland TPM, Munneke M and Hazes JMW (1998): Dynamic exercise therapy in rheumatoid arthritis: A systematic review. *British Journal of Rheumatology* 37: 677–687.
- *van der Heijden GJMG, Beurskens AJHM, Koes BW, Assendelft WJJ, De Vet HCW and Bouter LM (1995): The efficacy of traction for back and neck pain: A systematic, blinded review of randomized clinical trial methods. *Physical Therapy* 75: 93–104.
- *van der Heijden GJMG, van der Windt DAWM and De Winter AF (1997): Physiotherapy for patients with soft tissue shoulder disorders: A systematic review of randomised clinical trials. *BMJ* 315: 25–30.
- *van der Lee JH (2001): Constraint-induced therapy for stroke: More of the same or something completely different? *Current Opinion in Neurology* 14: 741–744.
- *van der Lee JH, Snels IAK, Beckerman H and Lankhorst GJ (2001): Exercise therapy for arm function in stroke patients: A systematic review of randomized controlled trials. *Clinical Rehabilitation* 15: 20–31.
- *van Duijvenbode I (1999): Oefentherapeutische behandeling helpt bij (sub)chronische lage rugpijn: Een meta-analyse. *Tijdschrift voor Oefentherapie Mensendieck* 2: 34–40 (in Dutch).
- *van Duijvenbode ICD (1996): Het effect van therapeutische oefeningen bij lage rugpijn: Een meta-analyse (Thesis). Amsterdam: Faculteit der Bewegingswetenschappen VU Amsterdam (in Dutch).
- *van Tulder MW (1999): Oefentherapie bij acute en chronische lage rugpijn: Een systematisch literatuuroverzicht. *Tijdschrift voor Oefentherapie Mensendieck* 4: 12–19 (in Dutch).
- *van Tulder MW, Koes BW and Bouter LM (1997): Conservative treatment of acute and chronic nonspecific low back pain. A systematic review of randomized controlled trials of the most common interventions. *Spine* 22: 2128–2156.
- *van Tulder MW, Esmail R, Bombardier C and Koes BW (2002a): Back schools for non-specific low back pain. The Cochrane Library, Issue 1. Oxford: Update Software.
- *van Tulder MW, Malmivaara A, Esmail R and Koes BW (2002b): Exercise therapy for low back pain. The Cochrane Library, Issue 1. Oxford: Update Software.
- *van Tulder MW, Malmivaara A, Esmail R and Koes B (2000a):

Exercise therapy for low back pain. A systematic review within the framework of the Cochrane collaboration back review group. *Spine* 25: 2784–2796.

*van Tulder MW, Ostelo R, Vlaeyen JW, Linton SJ, Morley SJ and Assendelft WJ (2000b): Behavioral treatment for chronic low back pain. A systematic review within the framework of the Cochrane back review group. *Spine* 25: 2688–2699.

*Weinhardt C, Heller KD and Weh L (2001): Konservative Therapie des chronischen Rückenschmerzes: Spezifisches Krafttraining der Rückenmuskulatur oder Steigerung der allgemeinen körperlichen Fitness. *Zeitschrift für Orthopädie und ihre Grenzgebiete* 139: 490–495 (in German).

Werner RA and Kessler S (1996): Effectiveness of an intensive outpatient rehabilitation program for postacute stroke patients. *American Journal of Physical Medicine and Rehabilitation* 75: 114–120.

Woolf AD, Zeidler H, Haglund U, Carr AJ, Chaussade S, Cucinotta D, Veale DJ and Martin-Mola E (2004): Musculoskeletal pain in Europe; its impact and a comparison of population and medical perceptions of treatment in eight European countries. *Annals of the Rheumatic Diseases* 63: 342–347.

*Zomerdijk TE, Beetsma AF, Dekker J, van Wijck R and van Horn JR (1998). Conservatieve behandeling van het patellofemorale pijnsyndroom—Een systematisch literatuuronderzoek. *Nederlands Tijdschrift voor Fysiotherapie* 108: 95–102 (Dutch).

Appendix 1. Criteria for the assessment of the quality of the systematic reviews.

Criteria	Maximal points
<i>Study selection</i>	(30)
A Description of inclusion and exclusion criteria of the systematic review	
1 Study setting(s) included (i.e. industry, general practice, hospital)	2
2 Interventions type(s) included	2
3 Outcome type(s) included (i.e. pain, general improvement, disability questionnaire)	2
4 Years covered	2
5 Language(s) covered	2
B Search strategy	
1 Established bibliographic database included (Medline (or PubMed), and at least one other database)	5
2 Additional efforts to locate non-indexed randomised clinical trials (RCTs) (e.g. reference tracking, correspondence with experts, manual search of non-indexed journals)	5
C Emphasis on RCTs: RCTs only, or results or RCTs discussed separately from other study designs	10
<i>Methodological Quality Assessment</i>	(20)
D Assessment (of the validity) of RCTs included that is explicit (reproducible by readers of the review) regarding:	
1 Similarity of treatment groups at baseline (prognostic factors)	2
2 Similarity of treatment characteristics (co-interventions)	2
3 Adequacy of treatment of missing values (dropouts, loss to follow-up)	2
4 Blinding of outcome assessment	2
5 Relevance of outcome measures	2
6 Adequacy of statistical analysis (i.e. intention-to-treat analysis)	2
E Number of reviewers (at least two independent reviewers)	4
F Blinding of reviewer(s): (blinded for source of article: journal, year of the trial, publication, institute)	2
G Agreement of reviewer(s): reported (quantitatively in percentage agreement or Kappa statistics) and acceptable (cut-off Kappa statistics > 0.60, where Kappa statistics is not reported look at percentage agreement, which should be at least 80%). In the event of reviewer, use of an assessment list with established reliability.	2
<i>Intervention</i>	(15)
H Description of (index) intervention(s) (exercises) per RCT	
1 Description of therapeutic exercise (i.e. strength, endurance and cardiovascular fitness, mobility and flexibility, stability, relaxation, coordination, balance, and functional skills)	3
2 Profession or training of care provider	1
3 Treatment frequency or number of treatments	2
4 Duration of treatment period	2
I Description of control intervention(s): per RCT	
1 Type (e.g. conservative treatments, wait-and-see policy, surgery)	3
2 Treatment frequency or number of treatments	2
3 Duration of treatment period	2
<i>Data Presentation</i>	(20)
J Outcome presentation (for the most important (clinical relevant) outcome measures)	
1 The original data of the main outcome(s) are presented separately per RCT per group	5
2 Presentation of the mean difference (effect size, standardised mean differences, weighted mean differences) or ratio of outcome(s) (relative risk, risk difference, odds ratio) between intervention group(s) and control group(s)	3
3 Presence of confidence interval (i.e. 95% CI) or standard deviation (SD) per RCT	3
4 Graphic presentation of the most important outcome(s) (indicating outliers and distribution) per RCT (presentation of a tree plot, meta-analysis)	3

K	Adequate summary of research findings: statistical pooling of the most important outcome(s); discussion of the reason why pooling is not indicated or warranted; or pooling of the subset considered to be valid and similar enough	3
L	Discussion of the power of negative RCTs	
1	Calculation (quantitative) of the power of each RCT <i>or</i>	3
2	Narrative elaboration (qualitative) on the power of each negative RCT <i>or</i>	2
3	Overall narrative elaboration on the power of the negative RCTs (i.e. remarks about small sample sizes)	1
	<i>Evaluation</i>	(15)
M	Overall conclusion regarding the aggregated level of available RCTs on the effectiveness of the (index) intervention presented	5
N	Discussion of heterogeneity of RCTs and outcomes	
1	Identification of relevant subgroups (e.g. age, study setting, disease classification) with explicit motivation	4
2	Discussion of variety of treatment modalities in the intervention groups (i.e. high dose exercises)	2
3	Discussion of variety of treatment modalities in control groups (placebo, existing modality)	2
4	Discussion of relationship between methodological quality of RCTs and outcome	2
	Total	100