

DYNAMIC EXERCISE THERAPY IN RHEUMATOID ARTHRITIS: A SYSTEMATIC REVIEW

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SUMMARY

The aim of this systematic review was to determine the effectiveness of dynamic exercise therapy in improving joint mobility, muscle strength, aerobic capacity and daily functioning in patients with rheumatoid arthritis (RA). In addition, possible unwanted effects such as an increase in pain, disease activity and radiological progression were studied. A computer-aided search of the MEDLINE, Embase and SCISEARCH databases was performed to identify controlled trials on the effect of exercise therapy. Randomized trials were selected on the effect of dynamic exercise therapy in RA patients with an exercise programme fulfilling the following criteria: (a) intensity level such that heart rates exceeded 60% of maximal heart rate during at least 20 min; (b) exercise frequency ≥ 2 a week; and (c) duration of intervention ≥ 6 weeks. Two blinded reviewers independently selected eligible studies, rated the methodological quality and extracted data. Six out of 30 identified controlled trials met the inclusion criteria. Four of the six included studies fulfilled $\geq 7/10$ methodological criteria. Because of heterogeneity in outcome measures, data could not be pooled. The results suggest that dynamic exercise therapy is effective in increasing aerobic capacity and muscle strength. No detrimental effects on disease activity and pain were observed. The effects of dynamic exercise therapy on functional ability and radiological progression are unclear. It is concluded that dynamic exercise therapy has a positive effect on physical capacity. Research on the long-term effect of dynamic exercise therapy on radiological progression and functional ability is needed.

KEY WORDS: Rheumatoid arthritis, Exercise therapy.

TRADITIONALLY, the most important objectives of exercise therapy in rheumatoid arthritis (RA) were to preserve joint mobility and maintain muscle strength. Exercise forms which put little stress on the joints, like range of motion exercises and non-weight-bearing, isometric exercises, were advocated [1-3]. Historically, dynamic exercises with an intensity adequate to improve muscle strength and aerobic capacity were thought to enhance pain and disease activity, and to provoke joint damage. During the last two decades, dynamic exercise forms which are considered to be more efficient in increasing muscle strength and aerobic capacity have been recommended more and more, in particular in patients without active disease [4-6]. These recommendations are based on the results of studies demonstrating the efficacy and safety of dynamic exercises in patients with RA. However, a number of studies conducted on this subject are not randomized. Assigning subjects to treatment or control groups by methods other than randomization will significantly bias the results, because differences between subjects in opportunities and motivation to participate will affect the outcome, particularly in this area of research. Moreover, the studies conducted on this subject differ widely in characteristics of the patients included, exercise forms, methodological aspects and outcome measures [7]. So far, a systematic review summarizing the main outcomes of randomized

trials on the effect of dynamic exercise therapy, taking into account the methodological aspects of the various studies, has not been performed.

The primary aim of this review is to determine the effectiveness of dynamic exercise therapy in improving joint mobility, muscle strength, aerobic capacity and daily functioning in patients with RA. In addition, possible deleterious effects of dynamic exercise therapy, such as an increase in pain, disease activity and radiological progression, will be studied.

MATERIAL AND METHODS

Search strategy

Owing to limited resources for translation, only articles in English, Dutch, French or German were considered for inclusion in the review. The following strategies for identification of controlled trials, all performed by reviewer CHME, were used.

- The MEDLINE (1964-May 1997) database was searched using an optimal sensitive MEDLINE search strategy for identifying controlled clinical trials [8] combined with the terms [(explode 'rheumatoid arthritis') or ('arthritis' in ti,abs)] and [(explode 'exercise therapy') or ('exercis*' or motion therap*' in ti,abs) or (explode 'physical education and training') or ('physical education or training or gymnast*' in ti,abs)].
- The same search strategy was translated by a trained medical librarian to make it applicable for the Embase database (1974-October 1996), the SCISEARCH database (1974-October 1996) and Russmed Articles (1988-October 1996).
- The reference lists of the identified controlled studies on the effect of exercise therapy were scanned.

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- (d) Authors of papers reporting randomized controlled trials were contacted by mail and asked for any published or unpublished studies relevant for this systematic review. A list with trials identified so far was enclosed.
- (e) Authors of abstracts were contacted by mail and asked for a written report.

Selection for inclusion in the review, assessment of the methodological quality of the trials and data extraction were performed in three separate steps. Prior to all three steps, assessment procedures were tested in a sample of three articles. A standard form for extracting data of each separate step was tested and adjusted. The articles were independently assessed by reviewers TVV and MM. The reviewers were blinded in all three steps to the journal, the authors and institution by providing them with edited copies of the articles. In the case of persistent disagreement between the two reviewers, a third reviewer (JMWH) decided.

Selection of trials

Only full-length articles or full-length unpublished reports were considered for inclusion in the systematic review. The articles had to fulfil four sets of criteria concerning the type of study, types of participants, types of intervention and type of outcome measures.

Type of study. Any randomized controlled trial comparing dynamic exercise therapy in patients with another form of exercise therapy or with a non-exercising control group. Studies were identified as randomized if the treatment assignment was described with the use of words such as randomly, random and randomization. Methods such as allocation using date of birth, date of admission, hospital numbers or alternation were not regarded as appropriate [9].

Types of participants. Only trials in which patients with classical or definitive RA according to the 1958 ARA criteria [10] or with RA according to the 1987 ARA criteria [11] were selected.

Types of intervention. Only trials with an exercise programme assumed to be adequate to improve aerobic capacity or adequate to improve both aerobic capacity and muscle strength were selected. The formulated criteria were based on guidelines described elsewhere [12]: exercise frequency at least twice a week; duration of exercise programme at least 6 weeks; a level of intensity such that at least twice a week during at least 20 min exercise forms were used whereby the heart rate might have exceeded 60% of maximal heart rate according to the interpretation of the reviewers.

Types of outcome measures. For the purpose of the present review, outcome measures were selected which have confirmed properties in terms of reliability, validity and sensitivity to change as described in the literature or outcome measures which are generally accepted in the literature. The reviewers agreed on the following relevant outcome measures, categorized by the objectives and possible unwanted effects of exercise therapy:

- aerobic capacity ($\text{VO}_{2\text{max}}$, in ml/kg/min) determined by a maximal or submaximal ergometer test
- muscle strength of the knee extensors in Nm, preferably the isokinetic muscle strength assessed on an isokinetic dynamometer or the isometric strength measured on an isokinetic dynamometer
- joint mobility, preferably measured by the EPM-ROM Scale [13] or Joint Alignment and Motion (JAM) Scale [14]
- functional performance determined by the 50-foot walk test, in seconds
- functional ability assessed by validated questionnaires, preferably by the Health Assessment Questionnaire (HAQ) [15] or by the Arthritis Impact Measurement Scales [16] (AIMS) or any other validated health-related quality of life measure with an incorporated functional ability dimension like the Fries Index [17] or the Functional Status Index (FSI) [18]
- self-reported pain, preferably scored on a visual analogue scale (VAS) in centimetres
- disease activity preferably assessed by the Westergren erythrocyte sedimentation rate (ESR) in mm/h and a swollen joint count.

Any trial reporting data on one or more out of the listed outcome measures fulfilled this inclusion criterion.

Assessing the methodological quality

The methodological quality of the included trials was rated by a list of 10 methodological criteria recommended by Verhagen *et al.* [19], adjusted and combined with criteria considered by the reviewers as relevant for the purpose of the review (Table I). The criteria 'patient blinded' and 'care provider blinded' were not regarded as being suitable because of the character of the intervention, and were removed from the list. The criteria 'sufficient description of intervention', 'comparable cointerventions per group', 'description of rate and reasons for dropping out' and 'description of rate of compliance' were recognized by the reviewers as important factors in the interpretation of the results of exercise trials, and were included in the list. All selected methodological criteria were scored as yes, no or unclear. Equal weight was applied on all items resulting in a range from 0 to 10.

Assessing trial characteristics and outcome data

The following information was systematically extracted by reviewers TVV and MM: number of participating RA patients, sex, age, disease duration, inclusion and exclusion criteria, and the description of experimental and control treatments.

For each outcome measure, baseline values and measures of variability (preferably means and standard deviation) were extracted. If possible, mean changes from baseline with standard deviations in outcome measures assessed directly after finishing the exercise programme were obtained.

Sensitivity analyses. Blinding of outcome assessor was recognized by the reviewers as the most important factor in reducing bias in this area of research. Therefore, the results of the trials fulfilling this criterion

TABLE I
Methodological quality of the trials included in the review of dynamic exercise therapy in rheumatoid arthritis

		Baslund [42]	Hansen [43]	Harkcom [53]	Lyngberg [38]	Minor [50]	Van den Ende [21]
1	Adequate allocation concealment	unclear	unclear	unclear	unclear	unclear	unclear
2	Groups similar at baseline	yes	yes	yes	yes	unclear	yes
3	Specification of eligibility criteria	yes	yes	no	yes	yes	yes
4	Sufficient description of intervention	yes	yes	yes	yes	yes	yes
5	Blinding of outcome assessor	unclear	yes	unclear	yes	unclear	no
6	Comparable co-interventions per group	unclear	yes	unclear	yes	yes	yes
7	Description of rate and reasons for dropping out	yes	no	yes	yes	yes	yes
8	Description of rate of compliance	yes	yes	no	yes	unclear	yes
9	Presentation of point estimates and measures of variability	yes	yes	yes	yes	yes	yes
10	Intention-to-treat analysis	yes	no	no	unclear	no	yes
Total number of criteria fulfilled		7	7	4	8	5	8

will be studied separately. Similarly, the results of trials fulfilling five or less than five out of the 10 methodological criteria will be compared with the summary of the results of all trials. Furthermore, a distinction will be made between programmes with a short duration (≤ 3 months) and long duration (> 3 months).

RESULTS

Selection of included trials

The search strategy for the databases resulted in a list of 682 citations. The other search strategies did not add any reference. Reviewer CHME selected a total of 40 citations of full-length articles and abstracts describing 30 controlled exercise therapy trials [20–59]. Authors of abstracts were contacted and asked for a written report. In one case [23], an article in Korean was obtained, but since a written report in English was not available, the study was not considered for inclusion in the review. None of the other authors of abstracts replied. Thirteen trials reported in 15 full-length articles were identified as randomized controlled trials by the reviewers [21, 30–32, 37–40, 42–44, 49, 50, 53, 54]. Six of these 13 trials [21, 38, 42–44, 50, 53] fulfilled all selection criteria and were included in the review. Trials not included in the review are listed in Table II. One randomized trial [31] was excluded because of the short duration of the intervention (< 6 weeks), five randomized trials because of insufficient or unclear intensity level of the exercise programme [32, 39, 40], and one randomized trial was excluded because of pooling of data of RA and systemic lupus erythematosus (SLE) patients [54], making separate conclusions about RA patients impossible. The first authors of two randomized trials [30, 37] were contacted to ask for more details about the content and level of exercise intensity of the exercise programme, but did not reply.

Methodological quality

None of the studies described the method of treatment allocation precisely, so uncertainty about allocation concealment remained in all included trials. In only two studies was the outcome assessor blinded to the treatment allocation [38, 43]. Two studies performed an intention-to-treat analysis [21, 42]; in three studies, patients who dropped out were described but not included in the analysis [43, 50, 53]. The compliance with the exercise programme was described in four studies [21, 38, 42, 43]. Four studies met seven or more criteria [21, 38, 42, 43]; these four studies were all conducted in 1993 or later.

Outcome data

Study characteristics. In Table III, the characteristics of the included trials are summarized. The number of participating patients varied from 18 to 100, with a median number of 32. The mean age in five of the studies was ~ 50 yr. Age and disease duration were comparable in all included studies except for the exercise trial of Lyngberg *et al.* [38] who evaluated the effect of exercise therapy in elderly patients with a history of corticosteroid treatment. Most of the studies included only patients on stable medication [21, 38, 42, 50] and excluded patients with moderate to severe disability [21, 38, 42, 43]. Consequently, the study populations consisted of patients with non-active to moderately active disease and mildly restricted daily functioning.

Five studies evaluated the effect of exercise programmes lasting for 3 months or less, in one study the exercise programme lasted 2 yr [43]. Four studies compared dynamic exercise therapy with no exercise [38, 42, 43, 53], two studies had a design with range of motion and isometric exercises as control group [21, 50]. All but one study [50] included bicycle exercises

TABLE II
List of studies not included in the review of dynamic exercise therapy in rheumatoid arthritis

First author	Form	Randomization	Reason for exclusion if randomized
Suomi [20]	AB	yes	no written report available
Hart [22]	AB	yes	no written report available
Kim [23]	AB	unclear	no written report in English available
McClure [27]	AB	yes	no written report available
Zischke [28], Wineland [29]	AB	yes	no written report available
Van Deusen [33, 34, 52]	FL	no	
Minor [35]	FL	no	
Noreau [36]	FL	no	
Lyngberg [41]	FL	no	
Landewé [45]	FL	no	
Stenström [46]	FL	no	
Kirsteins [47]	FL	no	
Perlman [25, 48]	FL	no	
Lyngberg [51]	FL	no	
Nordemar [55, 56]	FL	no	
Ekblom [57,58]	FL	no	
Nordström [59]	FL	no	
Andersson [30], Ekdahl [49]	FL	yes	level of exercise intensity unclear
Hall [31]	FL	yes	duration of intervention <6 weeks
Stenström [32]	FL	yes	aerobic conditioning exercises <20 min
Ekdahl [37]	FL	yes	level of exercise intensity unclear
Häkkinen [39]	FL	yes	aerobic conditioning exercises <20 min
Stenström [40]	FL	yes	aerobic conditioning exercises <20 min
Robb Nicholson [24], Daltroy [54]	FL	yes	pooled data of RA and SLE patients

AB, abstract; FL, full-length article.

TABLE III
Characteristics of the trials included in the review of dynamic exercise therapy in rheumatoid arthritis

First author	F/M	Age	Disease duration	Inclusion criteria	Exclusion criteria	Intervention	Duration of intervention
Baslund [42]	16/2	48 (9)	14 (11)	Age: <65 yr Morning stiffness >15 min Stable on medication	IA injections <2 months Inability to perform bicycle training	One dynamic group: 4–5 × weekly bicycle training; one control group; training not allowed	8 weeks
Hansen [43]	49/26	53†	7†	Age: ≥20, ≤60 yr	Steinbrocker III and IV Co-morbidity Training 3 × week	4 dynamic groups, varying in amount of training and condition (water, bicycle); one control group (no exercise)	2 yr
Harkcom [53]	20/0	52 (12)	9 (7)	Not reported	Not reported	3 dynamic groups with bicycle exercise 3 × weekly varying in degree; one control group (no exercise)	12 weeks
Lyngberg [38]	22/2	67 (9)	9 (11)	Corticosteroid treatment >6 months Stable on medication	Heart disease Inability to perform training	One dynamic group: bicycling and strengthening exercises (heel lifting, step climbing), 2 × weekly; one control group: no exercise	3 months
Minor [44, 50]	34/6*	54 (14)	11 (8)	Age: >20 yr Symptomatic weight-bearing joints	Currently exercising Not stable on medication	2 dynamic groups: aerobic pool group and aerobic walk group, 3 × weekly; one control group: ROM exercises 3 × weekly	12 weeks
Van den Ende [21]	63/37	52 (12)	10 (8)	Age: ≥20, ≤70 yr Able to bicycle Stable on medication	Arthroplasties of weight-bearing joints Co-morbidity	One dynamic group: bicycle and weight-bearing exercises 3 × weekly; 3 control groups: ROM+isometric exercises; 2 supervised, one group written instructions	12 weeks

*80 osteoarthritis and 40 RA patients participated in the study.

†Values of the different groups were presented as medians and 25/75 percentiles, in the calculation of the mean age and disease duration, medians were treated as means.

as conditioning exercises in the dynamic exercise programme, the latter study incorporated walking or pool exercises as conditioning exercises. Four studies [21, 38, 43, 50] included dynamic, full weight-bearing exercises in the exercise programme.

Several studies compared the effect of three or more dynamic and control exercise programmes [21, 43, 50, 53]. In one of those studies [50], the authors combined data of two aerobic exercise groups. In the other three studies with multiple exercise programmes [21, 43, 53], reviewers identified the exercise programme with the highest intensity level as the dynamic group and the exercise programme with the lowest exercise intensity level as the control group by consensus, making comparisons between two groups possible.

The reviewers decided by consensus not to pool data of outcome measures because of the differences in presentation of data as well as the wide variety in outcome measures. In two trials, data were presented as medians and ranges or percentiles [38, 43]. In one trial [50], baseline data of RA and osteoarthritis patients were pooled, making an estimate of the magnitude of effect in patients with RA impossible. In only two trials [21, 50] were mean changes from baseline presented with a measure of variability. Furthermore, only a limited number of outcome measures, namely the HAQ, pain scored on a VAS, the 50-foot walk test and ESR, were applied in more than one trial. Test protocols and test equipment of other outcome measures varied widely among the trials.

Instead of pooling data, changes in outcome measures were summarized by the calculation of the percentage of change from baseline. To enable comparisons between trials in the calculation of the percentages, medians were arbitrarily treated as means.

Measures of physical condition, muscle strength and joint mobility (Table IV). All studies incorporating aerobic capacity as an outcome measure reported an increase in $\text{VO}_{2\text{max}}$ after finishing the exercise programme [21, 38, 42, 50, 53]. The improvement in aerobic capacity in the dynamic exercise groups varied between 4 and 33%, and between -4 and 6% in the control groups. In three studies, a significant increase in aerobic capacity as compared to the control group was observed [21, 42, 50]. In two studies, patients in the dynamic group improved more in muscle strength than the patients in the control group [21, 43], whereas in another study evaluating the effect of exercise therapy in elderly patients using corticosteroids, the muscle strength deteriorated more in the control group than in the dynamic exercise group (28% vs 3%). Only two studies evaluated the effect of exercise on joint mobility [21, 50]. In both studies, the flexibility increased in the dynamic group, but differences between groups reached statistical significance in only one study [21].

Measures of functional ability (Table V). In two studies, the time needed to walk a distance of 50 feet improved in the patients in the dynamic group [21, 50], but differences between groups were statistically significant in only one study [50]. A small improvement

in functional ability was observed in four trials on the effect of short-term exercise therapy [21, 38, 42, 50], the improvement in functional ability varied between 5% improvement in the median FSI to 11% improvement in the median Fries Index. The magnitude of improvement of functional ability was unclear in one trial [50]. In one trial on the effect of long-term exercise, the median HAQ score deteriorated more in the dynamic group than in the control group, but the changes were not significant [43].

Measures of pain, disease activity and radiological progression. In none of the studies was a statistically significantly different effect on pain between groups observed (Table V). None of the trials reported negative effects of dynamic exercise therapy on the inflammation of the joints or on the level of the acute-phase reactants (Table VI). In two studies, the number of clinically active joints was decreased statistically significantly within the dynamic exercise group [21, 50] (Table VI). The progression of joint destruction was determined in one exercise trial with a duration of 2 yr [43]. The radiological progression was 19% in the dynamic vs 9% in the control group; the median Larsen score in the dynamic group increased from 37 (25–75 percentiles: 17–76) to 46 (32–89), and from 68 (58–89) to 74 (65–97) in the control group. None of the other studies evaluated the radiological progression.

Sensitivity analyses. Two trials incorporated a blinded assessor in the study design [38, 43]. Considering the results of only those trials, a small beneficial effect of dynamic exercise therapy on aerobic capacity and muscle strength was observed in comparison to the control group, but none of the differences between groups were statistically significant. In both trials, the dynamic exercise group as well as the control group showed a statistically insignificant increase in swollen joints, but the ESR in the dynamic group was decreased after exercising.

The results of the two trials fulfilling five or less methodological criteria [50, 53] were more positive than the results of the other trials. One trial observed statistically significant effects in the dynamic group in all selected outcome measures [50]. In the other trial, only a marked effect of dynamic exercise therapy on aerobic capacity was observed, but sample sizes in this study were very small [53].

DISCUSSION

This study summarized the results of six randomized studies on the effect of dynamic exercise therapy in RA. Only studies with an exercise programme with an intensity level adequate to improve aerobic capacity and muscle strength were included. The results suggest that dynamic exercise therapy is effective in improving aerobic capacity, muscle strength and joint mobility, but less effective in improving functional ability assessed by validated questionnaires. Summarizing the results with respect to side-effects, there is no evidence of deleterious effects of dynamic exercise therapy on joint inflammation and disease activity. These results should be interpreted carefully, however, since pooling

TABLE IV
Results on outcome measures of aerobic capacity, muscle strength and joint mobility of the studies included in the review of dynamic exercise therapy in rheumatoid arthritis

First author	Treatment (n)	Aerobic capacity ($\text{VO}_{2\text{max}}$)			Muscle strength			Joint mobility		
		Mean (s.d.) baseline	% change	P between groups	Mean (s.d.) baseline	% change	P between groups	Mean (s.d.) baseline	% change	P between groups
Baslund [42]	Dynamic (9) Control (9)	Submaximal bicycle test (ml/kg/min)	22	<0.05	—	—		—		
		27.2 (1.7) 20.9 (2.9)	6		—	—		—		
Hansen [43]	Dynamic (15) Control (15)	—	—		Isometric extension (kp)*	83	ns	—		
		—	—		31 (26–38) 29 (19–35)	55		—		
Harkcom [53]	Dynamic (4) Control (6)	Maximal bicycle test (ml/kg/min)	33	ns	Isometric extension (foot pounds)	3	ns	—		
		21.9 (9.0) 18.5 (7.4)	0		60.5 (15.6) 63.6 (15.7)	17		—		
Lyngberg [38]	Dynamic (12) Control (12)	Submaximal bicycle test (l/min)†	4	ns	Isokinetic extension, 30° s ⁻¹ (Nm)‡	-3	ns	—		
		2.6 (1.5–4.2) 2.8 (1.8–3.9)	-4		79 (35–181) 76 (37–178)	-28		—		
Minor [44, 50]	Dynamic (19) Control (9)	Maximal treadmill test (ml/kg/min)	↑	<0.05	—	—		Trunk flexibility (cm) [63]	↑	ns
		? ?	? ?		—	—		? ?	? ?	
Van den Ende [21]	Dynamic (25) Control (25)	Submaximal bicycle test (ml/kg/min)	17	<0.001	Isokinetic extension, 120° s ⁻¹ (Nm)	14	<0.05	EPM-range of motion scale‡ [13]	-16	<0.001
		27.6 (7.1) 25.8 (6.1)	1		81 (35) 78 (48)	0		10.9 (2.8) 8.6 (2.7)	-5	

?, not reported; —, not evaluated.

*Figures are presented as median and 25–75 percentiles. In the calculation of the percentages, medians were treated as means.

†Figures are presented as median and ranges. In the calculation of the percentages, medians were treated as means.

‡Higher score is less flexibility; ↑, increase; ↓, decrease.

TABLE V
Results on outcome measures of pain and functional ability of the studies included in the review of dynamic exercise therapy in rheumatoid arthritis

First author	Treatment (n)	Self-reported pain			50-foot walk time			ADL questionnaire*		
		Mean (s.d.) baseline	% change	P between groups	Mean (s.d.) baseline	% change	P between groups	Mean (s.d.) baseline	% change	P between groups
Baslund [42]	Dynamic (9) Control (9)	—	—		—	—		—	—	
Hansen [43]	Dynamic (15) Control (15)	Pain on visual analogue scale, cm† 1.9 (1.2–2.6) 1.9 (1.5–2.3)	+10 0	ns	—	—		Health assessment questionnaire† 0.50 (0.50–0.75) +74	+24	ns
Harkcom [53]	Dynamic (4) Control (6)	—	—		50-foot walk test, s 11.4 (2.5) 10.9 (1.8)	+10 –10	ns	Functional Status Index (FSI), [18] 16.8 (8.3) 14.8 (10.2)	–5 0	ns
Lyngberg [38]	Dynamic (12) Control (12)	—	—		—	—		Fries Index‡ 18 (6–30) 15 (0–37)	–11 0	ns
Minor [50]	Dynamic (19) Control (9)	Pain (AIMS), 0–10 ? ?	? ↓	ns	50-foot walk test, s ? ?	↓ ?	<0.05	AIMS (physical activity) — —	↓ ?	ns
Van den Ende [21]	Dynamic (25) Control (25)	Pain on visual analogue scale, cm 3.4 (2.0) 2.1 (1.6)	+6 +43	ns	50-foot walk test, s 9.6 (2.3) 10.0 (2.8)	–7 +1	ns	Health assessment questionnaire 0.83 (0.61) 0.70 (0.61)	–6 +23	ns

AIMS, arthritis impact measurement scales.

*For all measures: higher score is more disability; ?, not reported; —, not evaluated.

†Figures are presented as median and 25–75 percentiles. In the calculation of the percentages, medians were treated as means.

‡Figures are presented as median and ranges. In the calculation of the percentages, medians were treated as means; †, increase; ↓, decrease.

TABLE VI
Results on outcome measures of disease activity of the studies included in the review of dynamic exercise therapy in rheumatoid arthritis

First author	Treatment (n)	No. of swollen joints			No. of tender joints			Acute-phase reactant		
		Mean (s.d.) baseline	% change	P between groups	Mean (s.d.) baseline	% change	P between groups	Mean (s.d.) baseline	% change	P between groups
Baslund [42]	Dynamic (9) Control (9)	— —			— —			ESR mm/h 21 (4) 28 (3)	5 —10	ns
Hansen [43]	Dynamic (15) Control (15)	No. of swollen joints (range 0–40)* 2.3 (1.0–5.6) 3.8 (0.5–6.5)	108 40	ns	— —			ESR mm/h* 20 (6–42) 23 (12–32)	—15 18	ns
Harkcom [53]	Dynamic (4) Control (6)	— —			Joint count (pain and swelling graded 0–3) 32.5 (19.4) 27.5 (7.5)	—28 —15	ns	— —		
Lyngberg [38]	Dynamic (12) Control (12)	No. of swollen knees and ankles whole group 13 19	62 58	ns	No. of tender joints (range 0–46)† 9 (2–29) 10 (0–26)	44 40	ns	ESR mm/h† 33 (2–97) 17 (6–48)	—33 35	ns
Minor [50]	Dynamic (19) Control (9)	No. of clinically active joints — —	↓	ns	— —			— —		
Van den Ende [21]	Dynamic (25) Control (25)	No. of swollen joints (range 0–20) 5.2 (3.2) 3.6 (3.3)	—33 5.6	ns	Modified Ritchie articular index (range 0–69) 12.0 (7.9) 12.4 (7.2)	—4 1.6	ns	ESR mm/h 33 (17) 31 (21)	0 —3	ns

ESR, erythrocyte sedimentation rate; †, not reported; —, not evaluated.

*Figures are presented as median and 25–75 percentiles. In the calculation of the percentages, medians were treated as means.

†Figures are presented as median and ranges. In the calculation of the percentages, medians were treated as means; †, increase; ↓, decrease.

of data was not appropriate because of the variety in outcome measures used.

Considering the number of criteria fulfilled per study, the methodological quality of the trials included in this review was moderate to good. All trials met at least four out of 10 methodological criteria and four trials met seven or more criteria. The high number of fulfilled criteria might be explained by the selection procedure. By applying strict selection criteria for inclusion in this review, trials with low methodological quality may have been excluded. We only included randomized trials with a well-described exercise programme with a minimum intensity level. It is likely that trials with a randomized design have a higher methodological quality according to the other criteria than non-randomized controlled trials. On the other hand, the relatively high methodological score might be explained by the way the methodological quality was determined. All criteria contributed equally to the final score. Adequate methodological approaches, such as concealment of allocation, double blinding and inclusion in the analysis of all randomized participants, are recognized as the most important factors in reducing bias [60]. In this systematic review, we substituted the criterion double blinding by blinding of outcome assessor because blinding of care provider and blinding of patient are approaches not suitable in exercise trials. Nevertheless, none of the trials included in this systematic review met more than one of these three methodological criteria, and two trials fulfilled none of these criteria [50, 53]. The latter two trials, rated as having the lowest methodological quality of the trials included in the review, reported a more positive effect of dynamic exercise therapy in comparison to the other trials, which may be explained by bias due to inadequate methodological approaches.

Pooling of data was impeded by lack of appropriate data as well as the wide variety in outcome measures. The HAQ, pain scored on a VAS, the 50-foot walk test and the ESR were the only measures applied in more than one trial. Differences in test protocols and test equipment in measuring aerobic capacity and muscle strength made pooling of data for these outcome measures inappropriate. This large variety underscores the need for a general agreement about assessing outcome measures to be used in exercise trials. Recently, an investigation of outcome measures applied in trials on the effect of physical therapy resulted in a list of 75 methods, of which 39 were arthritis specific, for the assessment of impairments in RA [61]. In addition, 67 methods were found for the assessment of disability in RA. International consensus about a core set of outcome measures to determine the effect of exercise therapy on aerobic capacity, muscle strength, joint mobility and functional ability will enable comparison of the magnitude of the effect of different exercise regimens.

In this systematic review, the results of the included trials were summarized by calculating the percentages of change from baseline in the selected outcome measures. In the interpretation of these figures, one should

keep in mind that the calculation of the percentages of change was hampered by the absence of the presentation of mean values [38, 43] or baseline values [50], and that the sample sizes and methodological quality varied among the studies.

The consistency among the studies about the safety of vigorous dynamic exercises for patients with RA is striking. In none of the studies were detrimental effects of dynamic exercising on pain or other indices of disease activity found. Dynamic exercises against resistance are believed to induce pain and augment the inflammation of the joints, and patients and exercise therapists are advised against vigorous exercises [3, 4]. This systematic review shows that there is no evidence for discouraging patients from vigorous exercising during a short period lasting for 12 weeks. The most important feared sequela of dynamic exercise therapy is acceleration of radiological damage. In the only study evaluating radiological progression, no differences were observed between the dynamic and the control group, but baseline values varied and sample sizes were small [43]. More evidence on this aspect of dynamic exercise therapy is needed and future exercise trials should have sample sizes sufficient to study radiological progression.

The majority of studies included in this review showed a positive effect of dynamic exercise therapy in reducing impairments, e.g. aerobic capacity, muscle strength or joint mobility, but only a small, not significant improvement in functional ability assessed by validated questionnaires. This discrepancy might be explained by methodological consequences related to assessing functional ability. Questionnaires of functional ability applied in the trials included in the review were limited to areas of health status concerned with the performance of daily tasks. Dimensions of health status such as activity level, fatigue, work capacity and endurance are dimensions which might be positively influenced by exercise therapy, but are not included in questionnaires used. Furthermore, significant functional changes may be undetectable at the extremes of a scale because of a 'ceiling' or 'floor' artifact [62]. Baseline values of self-reported measures of functional ability were in general low, and most studies included only mildly disabled patients. These factors may have contributed to the absence of a marked effect of short-term exercise therapy on functional ability.

In conclusion, pooling of data was inappropriate in this systematic review, but the data suggest a positive effect of dynamic exercise therapy on physical capacity. No detrimental effects on disease activity were found. Future research designs should include adequate allocation concealment, blinding of outcome assessor and standardization of outcome measures. Research on the long-term effect of exercise therapy on radiological progression and functional ability is needed.

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