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Moderately intensive exercise in a temperate pool for patients with rheumatoid arthritis: a randomized controlled study

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***Objectives*. The aim of this study was to evaluate the effects of moderately intensive pool exercise therapy on patients with rheumatoid arthritis (RA).**

***Methods*. Forty-six patients with chronic RA were randomly assigned to a treatment group and a control group. The treatment group ($n = 20$) exercised in a temperate pool twice a week for 12 weeks. The control group ($n = 23$) continued with their previous activities. Aerobic capacity, measured by means of a submaximum bicycle test, and the physical component of the SF-36 were chosen as the primary outcome measures. Two tests of muscle endurance were chosen as the secondary outcome measure. Additional functional tests and instruments were included.**

***Results*. No significant differences between the groups were found for the primary outcome measures. Significant improvements in the following aspects of muscular function ($P < 0.05$) were found in the treatment group when their performance was compared with that of the control group: isometric shoulder endurance, grip force, dynamic endurance of lower extremities (chair test) and muscle function of lower extremities. Significant improvements were also found for vitality (SF-36) compared with the control group. The improvements in the training group were maintained for 3 months.**

***Conclusions*. Pool exercise therapy of moderate intensity significantly improved muscle endurance in the upper and lower extremities in patients with RA, while no impact on aerobic capacity was found. However, the study population was small and there is a need for further studies with larger populations.**

KEY WORDS: Pool exercise training, Rheumatoid arthritis, Physical therapy, Aerobic capacity, Muscle endurance, SF-36, Function.

Rheumatoid arthritis (RA) is a chronic syndrome characterized by non-specific, symmetric inflammation of the peripheral joints, potentially resulting in the progressive destruction of articular and peri-articular structures, with or without generalized manifestations [1–4]. The clinical picture of RA is dominated by pain, fatigue, stiffness, reduced range of motion in the joints and muscle weakness. A combination of these symptoms, together with deterioration in physical condition, often leads to difficulty in the activities of daily living and poor quality of life [5].

A reduced level of physical performance has been found to be associated with RA. Patients with RA have been shown to have reduced muscle strength [6, 7] and aerobic capacity [6–9]. A reduction in muscle strength and endurance can be due to several factors, such as the intra-articular and extra-articular inflammatory process, side-effects of medication, inactivity, reflex inhibition due to pain and joint swelling, reduced proprioception and the loss of mechanical stability around the joint. However, studies indicate that patients with RA engaging in physical exercise can improve their physical ability, aerobic endurance and muscle strength without worsening the inflammatory process [10, 11]. Several studies have documented improvements in aerobic capacity [12–14] and one study reported a reduction in disease activity after an exercise period [15].

Exercise in a temperate pool is a common mode of treatment for patients with RA. Physical properties such as buoyancy and temperature facilitate training in water [16] and reduce a subjective feeling of stiffness and the load on the joints. Patients with RA participating in pool exercise usually say that their function improves during a treatment period, but only two randomized, controlled studies evaluating the effects for patients with RA were found [17, 18]. A significant reduction in joint tenderness after intervention was found in one of these studies [17], while an improvement in active joint count and erythrocyte sedimentation rate (ESR) was found in the other [18]. Two uncontrolled studies reported improvements in grip strength, physical activity [19] and muscle strength [20]. It has been suggested that patient-relevant outcome measures should also be applied in further studies [21, 22].

The purpose of this study was to evaluate the effects of pool exercise on patients with RA. We hypothesized that pool exercise for 3 months would improve their aerobic capacity, functional ability and perception of physical health.

Patients and methods

Patients

A total of 91 patients with RA [23] at the Department of Rheumatology at Sahlgrenska University Hospital in Göteborg were invited by mail and 47 patients (42 women and five men) accepted. They all fulfilled the criteria for inclusion and were included in the study. The criteria for inclusion were: duration of RA ranging from 1 to 5 yr, stable medication for the past 3 months, functional class I, II or III [8] and age ranging between 20

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and 65 yr. The criteria for exclusion were other severe diseases or functional limitations that would make pool training impossible. The patients were randomly assigned [24] to the training group or the control group using optimal allocation with a computer programme for a minimization procedure to balance for the background variables age, disease duration, DAS 28 and aerobic capacity. All the patients were asked to maintain the type and dosage of pre-entry medication and not to start any other treatment (pool exercise or strength training), as far as was ethically possible during the study period. The study was approved by the ethics committee at the Sahlgrenska Academy, Göteborg University. Written and oral information was given to all the patients, but no informed consent was required at that time and thus was not obtained for this study.

Treatment programme

The treatment group exercised twice a week for 12 weeks in groups of eight or nine patients in a temperate pool. Each session was 45 min long and of moderate aerobic intensity. It comprised exercises for aerobic capacity, dynamic (eccentric and concentric) and static muscle strength, and muscle endurance in the upper and lower extremities, flexibility, coordination and relaxation. The pace of the exercises was guided by music. The sessions were led by two alternating physiotherapists, who gave individual instructions to each patient if needed. The mean attendance rate at the sessions was 78%. The patients in the control group continued their daily activities, which included the home exercise programme introduced to them on admission to the clinic. Two patients in the training group and two in the control group dropped out, one before the start of the study and the other after seven pool sessions. The reasons for dropping out were lack of time due to commitments relating to work. Two patients in the control group started exercising in other pool groups and were excluded. As a result, 20 patients in the training group and 23 in the control group completed the study. The median age of the patients was 49 yr (range 32–62 in the training group) and 46 yr (range 21–65) in the control group. The mean duration was 31 months (S.D. 15.8) and 35 months (S.D. 17.1) respectively. Only one patient in the study population consulted a physiotherapist during the study period, because of knee pain.

Outcome measures

A physiotherapist blinded to group membership during the whole study conducted the examinations. Aerobic capacity, estimated using a submaximum ergometer cycle [25], and the physical component of the SF-36 [26] were chosen as the primary outcome measures. Two tests of muscle endurance, one for the lower extremities and another for the upper extremities, were chosen as the secondary outcome measurements; they were the chair test and the shoulder endurance test [27, 28]. Additional functional tests assessing limitations in the upper and lower extremities were included, as well as self-administered generic and disease-specific instruments assessing quality of life, disease activity and disabilities.

The outcome measurements were applied at baseline and directly at post-treatment for the training patients (3 months) and after the control period (3 months) for the control patients. The patients in the training group were also followed up 6 months after the start of the study.

Self-administered instruments

The SF-36 [26] is a generic, multidimensional, health status instrument comprising eight subscales ranging from 0 to 100. The instrument gives an index for a physical component and a mental component. The SF-36 has been validated for Swedish populations [29].

The Arthritis Impact Measurement Scales (AIMS 2) [30] is a multidimensional health status instrument designed for patients with arthritis. The instrument comprises 12 subscales ranging from 0 to 10. The physical dimension, including the subscales of mobility, physical activity, dexterity, household activity, activities of daily living and pain, was applied. The AIMS 2 has been validated for Swedish arthritis patients [31].

The Health Assessment Questionnaire (HAQ) [32] is a disease-specific instrument that measures disability with scores ranging from 0 to 3. The instrument possesses satisfactory reliability and validity and sensitivity to change in long-term studies for patients with RA [33].

Performance-based tests and clinical investigation

The performance-based tests used in this study have been shown to possess satisfactory reliability in arthritis populations [25, 27, 28, 34–38] and they are described in the order in which they were performed.

Aerobic capacity was estimated by means of a submaximum test according to Åstrand's principle [25]. An ergometric bicycle (Monark) was used. The heart rate was measured using Polar Electro Oy, Kempele, Finland. The examiner recorded the patient's heart rate once a minute. The patient estimated his or her exertion using Borg's exertion scale [39].

Active forward and lateral elevation of the shoulder were recorded in degrees using a universal full-circle goniometer [34].

Functional arm movements—hand to neck and hand to back [27, 28]—were rated on a scale of 0–4, where 0 represented the best and 4 the most decreased function.

Isometric endurance of the shoulder abductor muscles [27, 28] was measured as the maximum time a person was able to hold his/her arm at 90° abduction with a 1-kg cuff attached proximally to the wrist joint.

Muscle endurance for the lower extremities (chair test) [27, 28] was assessed by counting the maximum number of times the patient was able to get up from a chair during 1 min.

The Index of Muscle Function (IMF) [35, 36] comprises 11 tests for the lower extremities, including tests of muscle strength, balance, coordination and endurance. The IMF ranges from 0 to 40 and the highest score represents serious disability.

Hand grip force (N) [37, 38] was measured as the maximum and mean strength using an electronic instrument (Grippit). The best performance of three was recorded.

DAS 28 (disease activity score) [40], an index based on 28-joint status, the ESR and the patient's assessment of global health, was used to determine RA disease activity. The examination was conducted by a trained physiotherapist under the supervision of a rheumatologist.

Statistical methods

Fisher's non-parametric permutation test was used to compare changes between the two groups, while Fisher's non-parametric permutation test for matched pairs was used to analyse changes within groups over time [41]. The following two null hypotheses were tested: no changes will be found between the two groups or over time within the groups. Fisher's exact test was used to compare proportions between the groups. In the follow-up study, two null hypotheses were tested: no changes will be found between the baseline and the follow-up values, or between the post-test and the follow-up values. The significance level was set at 0.05.

TABLE 1. Demographic data at study entry

	Treatment group ($n=20$)		Control group ($n=23$)	
	Median	Range	Median	Range
Age (yr)	49	(32–62)	46	(21–65)
	Mean	(S.D.)	Mean	(S.D.)
RA duration (months)	31	(15.8)	35	(17.1)
DAS 28	4.1	(1.5)	4.0	(1.3)
Tender joints (*n*)	6	(5.2)	6	(6.0)
Swollen joints (*n*)	5	(3.7)	5	(14.4)
ESR (mm/h)	16	(13.1)	19	(19.0)
Haemoglobin (g/l)	138	(10.4)	136	(14.9)
Patient global assessment (VAS)	45.5	(25.0)	39.4	(26.6)
	n	(%)	*n*	(%)
Sick leave				
Full time	7	(35)	3	(23)
Part time	3	(15)	9	(23)
Retirement pension	4	(20)	5	(25)
Drugs				
Analgesic	13	(65)	10	(43)
DMARD	18	(75)	20	(87)
Oral steroids	3	(15)	4	(17)

Results

Baseline data

The means and standard deviations at baseline are shown in Table 1. There were no significant baseline differences between the two groups in terms of age, duration of RA, disease-specific measures, such as DAS 28, and the total HAQ score. Nor were there any significant baseline differences between the two groups in the functional tests or in the self-administered instruments.

Missing values

Twenty-two patients in the control group and 19 patients in the training group fully completed the SF-36 on both test occasions. Twenty-one patients in the control group and 20 patients in the training group fully completed the AIMS 2. Twenty-one patients in the control group and 18 in the training group completed the HAQ. All 43 patients completed the shoulder range of motion, the functional arm movements test, the isometric endurance of the shoulder abductor muscles test, the IMF and the hand grip force test. Twenty-two patients in the control group and 19 in the training group performed the bicycle test (missing data due to knee pain). Twenty-two patients in the control group and 20 patients in the training group performed the chair test. The data analysis was done by protocol, implying that when data were missing for any test or subscale for patient, these patients were removed from the analysis.

Between-group differences, 0–3 months

The differences between the post-treatment and baseline values are shown in Tables 2 and 3. No significant differences between the groups in medication or injections occurred during the study period. No significant changes were found for the primary outcome measures—the aerobic capacity and the physical component of the SF-36. All the secondary outcome variables, measuring muscle endurance [the chair test ($P=0.005$), and the isometric shoulder endurance of the left and the right arm ($P<0.001$)] increased significantly in the training group compared with the control group. The maximum and mean grip strength of the left hand ($P<0.001$) increased significantly in the training group compared with the control group. The IMF score ($P=0.006$) increased significantly for the patients in the training group compared with the control group. The active lateral shoulder elevation for the left ($P=0.009$) and right ($P=0.047$) arms, and the active forward elevation of the left arm ($P=0.03$) increased significantly in the training group compared with the control group (Table 3).

Within-group differences in the training group, 0–3 months

Significant within-group changes are marked with asterisks in Tables 2 and 3. The following scores on the SF-36 improved: the SF-36 physical function ($P=0.0001$), bodily pain ($P=0.003$), vitality ($P=0.004$) and the physical component ($P=0.01$). The chair test ($P=0.008$), the AIMS 2 physical dimension ($P=0.007$) and the HAQ score ($P=0.04$) also improved. The lateral elevation of the left arm ($P=0.04$), the shoulder endurance of the right and left arm ($P<0.001$), Grippit maximum force of the left side ($P<0.001$) and IMF score ($P=0.007$) also improved.

Within-group differences in the control group, 0–3 months

Significant within-group changes are marked with asterisks in Tables 2 and 3. At the post-treatment examination, the maximum ($P=0.04$) and mean force ($P=0.03$) in the left hand was found to have decreased and the SF-36 bodily pain ($P=0.03$) had increased.

Follow-up for the training group, 0–6 months

The differences between the follow-up and the baseline values for the training group are shown in Tables 4 and 5. No significant differences in medication or injection occurred during the period of 6 months for the training group. For the primary outcome measures, the aerobic capacity did not change, while the SF-36 physical component revealed significant improvements compared with baseline values (Table 4). The secondary outcome measures, the chair test and the shoulder endurance test, also displayed significant improvements at follow-up. Moreover, 10 of the 13 functional measures had improved significantly ($P<0.05$) at follow-up (shoulder forward elevation and shoulder lateral elevation for both arms, hand to neck and hand to scapula for the right

TABLE 2. Instruments assessing health at baseline and the post-test in the training and control group

	Training group ($n=20$)			Control group ($n=23$)			
	Baseline Mean (S.D.)	Post-test Mean (S.D.)	Difference within the group Mean (S.D.)	Baseline Mean (S.D.)	Post-test Mean (S.D.)	Difference within the group Mean (S.D.)	Differences between the groups *P*-value
SF-36							
Physical functioning	56.0 (20.9)	64.7 (20.0)	9.5 (10.6)***	60.7 (18.8)	64.9 (21.4)	4.2 (11.8)	NS
Role physical	20.2 (40.9)	39.5 (37.6)	17.1 (44.1)	48.9 (41.6)	48.9 (38.0)	0.0 (40.6)	NS
Bodily pain	40.7 (21.0)	50.8 (23.4)	10.7 (15.0)**	45.9 (22.3)	50.9 (21.0)	5.0 (10.0)*	NS
Social functioning	68.1 (29.1)	73.7 (22.4)	6.6 (21.8)	72.3 (23.2)	71.2 (21.1)	−1.1 (18.4)	NS
Mental health	68.4 (23.5)	72.4 (15.9)	5.5 (19.5)	76.9 (18.6)	72.7 (16.9)	−3.3 (19.9)	NS
Role emotional	48.3 (43.9)	69.6 (36.1)	10.5 (45.9)	60.9 (46.7)	69.6 (36.1)	8.7 (36.5)	NS
Vitality	41.5 (23.9)	51.8 (22.6)	12.1 (17.6)**	51.8 (22.1)	49.1 (17.6)	−1.6 (18.8)	0.021
General health	46.0 (26.3)	49.8 (19.3)	6.3 (17.8)	59.8 (19.6)	59.3 (16.1)	−0.5 (16.0)	NS
Physical component	33.0 (9.6)	37.1 (10.5)	4.8 (7.1)**	37.1 (8.9)	38.3 (9.6)	1.5 (7.5)	NS
Mental component	43.1 (13.7)	45.1 (11.5)	2.8 (11.8)	47.6 (12.5)	46.2 (10.8)	−0.6 (12.6)	NS
AIMS 2							
Physical	2.6 (1.5)	2.1 (1.4)	−0.6 (1.0)**	2.2 (1.3)	2.1 (1.2)	−0.2 (0.7)	NS
HAQ score	0.9 (0.5)	0.7 (0.5)	−0.2 (0.3)*	0.7 (0.5)	0.8 (0.6)	0.0 (0.2)	0.045

Mean and S.D. for the ratings and the differences within and between the groups are given.
*$P<0.05$; **$P<0.01$; ***$P<0.001$.

TABLE 3. Functional tests at baseline and the post-test in the training and control group

	Training group ($n=20$)			Control group ($n=23$)			
	Baseline Mean (S.D.)	Post-test Mean (S.D.)	Difference within the group Mean (S.D.)	Baseline Mean (S.D.)	Post-test Mean (S.D.)	Difference within the group Mean (S.D.)	Differences between the groups *P*-value
Vo2 ml/(kg × min)	34.0 (10.9)	33.8 (10.0)	−0.26 (5.4)	34.2 (6.7)	32.4 (7.3)	−1.8 (5.0)	NS
Forward shoulder elevation (°)							
Right	156.0 (29.8)	165.0 (26.3)	9.0 (28.8)	161.5 (25.4)	158.9 (27.2)	−2.6 (15.1)	NS
Left	156.8 (28.7)	166.0 (19.6)	9.3 (23.7)	166.1 (19.0)	161.5 (19.8)	−4.6 (15.6)	0.027
Lateral shoulder elevation (°)							
Right	148.8 (34.7)	160.5 (35.9)	11.8 (35.4)	159.1 (31.0)	154.4 (30.4)	−4.8 (14.8)	0.047
Left	142.8 (38.8)	158.5 (38.2)	15.8 (31.1)*	160.9 (28.6)	155.0 (31.9)	−5.9 (21.7)	0.009
Hand to neck (0–4)							
Right	0.3 (0.5)	0.4 (0.8)	0.0 (0.7)	0.2 (0.5)	0.3 (0.7)	0.1 (0.4)	NS
Left	0.2 (0.4)	0.2 (0.4)	−0.10 (0.45)	0.3 (0.8)	0.2 (0.5)	−0.09 (0.7)	NS
Hand to scapula (0–4)							
Right	0.6 (0.9)	0.2 0.6)	−0.4 (0.8)	0.4 (0.9)	0.4 (0.9)	−0.04 (0.4)	NS
Left	0.6 (0.7)	0.3 (0.7)	−0.3 (0.6)	0.2 (0.5)	0.1 (0.5)	−0.1 (0.3)	NS
Shoulder endurance (s)							
Right	59.8 (54.1)	90.3 (52.2)	30.5 (26.0)***	70.9 (40.4)	58.2 (35.4)	−12.7 (31.4)	<0.001
Left	54.8 (51.6)	80.5 (54.6)	25.8 (23.6)	65.4 (34.3)	59.8 (32.4)	−5.7 (27.3)	<0.001
IMF score	5.4 (7.3)	2.2 (3.6)	−3.2 (5.2)**	2.3 (2.8)	2.2 (3.5)	0.3 (2.6)	0.006
Chair test	20.6 (6.6)	23.7 (7.0)	3.2 (4.5)**	24.3 (6.4)	23.7 (62)	−0.7 (3.6)	0.005
Grippit, max. (N)							
Right	179.0 (115.2)	181.1 (91.0)	2.1 (48.4)	178.7 (109.6)	180.7 (103.3)	2.0 (36.0)	NS
Left	152.4 (106.7)	182.8 (116.7)	30.3 (34.5)***	188.5 (105.3)	172.6 (88.4)	−15.9 (34.6)*	<0.001
Grippit, mean (N)							
Right	140.5 (96.5)	139.0 (72.7)	−1.6 (41.9)	145.1 (89.8)	142.0 (86.7)	−3.1 (30.3)	NS
Left	114.3 (89.4)	142.9 (100.4)	28.6 (33.5)***	153.6 (87.3)	137.6 (70.2)	−15.9 (32.8)*	<0.001

Mean and S.D. for the ratings and the differences within and between the groups are given.
*$P<0.05$; **$P<0.01$; ***$P<0.001$.

arm, IMF score, the Grippit maximum force for the left hand and the Grippit mean force for both hands) (Table 5). Seven of the eight subscales on the SF-36 showed significant improvements ($P<0.05$) (physical functioning, role physical, bodily pain, social functioning, mental health, role emotional, vitality and the mental component). In addition, the AIMS 2 physical dimension and the HAQ score displayed significant improvements (Table 4). No significant deterioration was found for any variables when compared with the post-treatment values (Tables 4 and 5).

Discussion

The purpose of this study was to evaluate the effects of temperate pool exercise on patients with RA. We were not able to confirm our hypotheses that aerobic capacity and the SF-36 physical component would improve significantly when the training group was compared with the control group. However, a significant improvement in the treatment group was found for all measures of muscle endurance and flexibility.

TABLE 4. Baseline and 6-month follow-up data for the generic and disease-specific instruments in the training group

	$n=20$ Baseline Mean (S.D.)	$n=18$ Follow-up Mean (S.D.)	Difference within the group Mean (S.D.)
SF-36			
Physical functioning	56.0 (20.9)	65.6 (20.5)	9.7 (14.2)*
Role physical	20.2 (40.9)	54.4 (46.1)	35.3 (46.0)**
Bodily pain	40.7 (21.0)	55.3 (18.7)	17.8 (15.7)***
Social functioning	68.1 (29.1)	82.4 (17.2)	16.2 (22.4)**
Mental health	68.4 (23.5)	77.5 (17.6)	10.2 (16.1)**
Role emotional	48.3 (43.9)	66.7 (42.5)	21.6 (37.2)*
Vitality	41.5 (23.9)	58.5 (22.1)	19.1 (19.4)***
General health	46.0 (26.3)	51.5 (22.3)	6.4 (19.0)
Physical component	33.0 (9.6)	38.4 (10.2)	6.4 (8.0)**
Mental component	43.1 (13.7)	49.0 (10.0)	6.7 (8.6)**
AIMS 2			
Physical	2.6 (1.5)	1.9 (1.5)	−0.8 (1.3)*
HAQ			
Score	0.9 (0.5)	0.7 (0.5)	−0.3 (0.5)*

Mean and S.D. for the ratings and the differences within the group are given.
*$P<0.05$; **$P<0.01$; ***$P<0.001$.

TABLE 5. Functional tests at baseline and at the 6-month follow-up for the training group

	$n=20$ Baseline Mean (S.D.)	$n=18$ Follow-up Mean (S.D.)	Difference within the group Mean (S.D.)
Vo2 ml/(kg × min)	34.0 (10.9)	30.8 (10.1)	−2.7 (7.8)
Forward shoulder elevation (°)			
Right	156.0 (29.8)	171.0 (13.1)	17.2 (28.4)*
Left	156.8 (28.7)	169.7 (22.7)	15.0 (24.7)*
Lateral shoulder elevation (°)			
Right	148.8 (34.7)	168.6 (20.1)	20.6 (32.2)*
Left	142.8 (38.8)	166.1 (30.1)	22.5 (30.2)**
Hand to neck (0–4)			
Right	0.3 (0.5)	0.0 (0.0)	−0.3 (0.5)*
Left	0.2 (0.4)	0.1 (0.5)	−0.7 (0.5)
Hand to scapula (0–4)			
Right	0.6 (0.9)	0.1 (0.3)	−0.6 (0.8)*
Left	0.6 (0.7)	0.2 (0.7)	−0.4 (0.7)
Shoulder endurance (s)			
Right	59.8 (54.1)	88.1 (59.9)	29.3 (40.2)**
Left	54.8 (51.6)	76.5 (56.0)	28.4 (39.3)*
IMF			
Total score	5.4 (7.3)	2.9 (5.5)	−2.4 (4.0)**
Chair test	20.6 (6.6)	25.2 (6.4)	4.4 (5.3)**
Grippit, max. (N)			
Right	179.0 (115.2)	190.4 (107.9)	20.2 (51.1)
Left	152.4 (106.7)	191.8 (120.8)	44.2 (42.5)***
Grippit, mean. (N)			
Right	140.5 (96.5)	170.3 (121.8)	37.8 (75.6)**
Left	114.3 (89.4)	162.1 (111.1)	50.4 (63.4)***

Mean and S.D. for the ratings and the differences in changes within the group are given.
*$P<0.05$; **$P<0.01$; ***$P<0.001$.

The aerobic exercise part of the training programme had been designed to achieve and maintain a target heart rate of 70% of the maximum heart rate, which is considered to improve aerobic capacity [25]. We measured the heart rate at two training sessions to ensure the exercise intensity. It is possible that the exercise intensity should have been monitored more frequently to ensure that it was maintained throughout the study period. Also, this study population, with fairly good pretreatment aerobic capacity (Table 3), might have needed a higher training intensity to attain improvement in aerobic capacity. The frequency of the sessions might have been at the lower limit to improve aerobic capacity. However, the failure to improve aerobic capacity found in this study is in line with the results reported in a previous study of pool exercise for patients with RA [18].

The other primary outcome measure, the physical component index of the SF-36, revealed no significant difference in the between-group analyses, but it improved significantly in the within-group analysis of the training group. No improvements in the primary outcome measures were found in the control group.

Both muscle endurance tests selected as secondary outcome measures, the chair test and shoulder endurance test, revealed a significant improvement in the treatment group when compared

with the control group, as did the additional endurance tests, the Grippit and IMF. These findings support previous reports of increased muscle strength after pool exercise therapy in patients with RA [10, 11, 18, 19]. The results of improved endurance in upper and lower extremities were probably produced by the resistance exercises included in the training program comprising both eccentric and concentric exercises for the muscles in upper and lower extremities. Recent studies indicate that patients with impaired muscle function can improve their muscle endurance also by low impact programmes [42, 43].

Moreover, shoulder range of motion showed an improvement. The between-group differences were supported by several within-group improvements in the treatment group.

Two self-administered, disease-specific instruments (the AIMS 2 physical dimension and the HAQ), focusing on physical function, indicated that the patients' perceptions of their function improved significantly in the training group. The generic health instrument (SF-36) revealed a significant improvement in vitality for the training group compared with the control group, which is in line with previous pool exercise studies [44].

A follow-up study was conducted 3 months after the patients had completed the training programme. Eighteen of the total of 20 patients in the training group participated in the follow-up examinations. The SF-36 index physical component, one of the primary outcome measures, revealed significant improvements at this follow-up, while the aerobic capacity did not, when compared with the baseline values. Interestingly, seven of the total of eight SF-36 subscales now showed significant improvements in the training group, together with the AIMS 2 physical dimension and the total score for the HAQ. The results indicate that changes in quality of life and disability measures may take a longer time to attain than changes in functional tests. The measures of muscle endurance still showed significant improvements.

When the patients included in this study were admitted to the clinic, they had been offered a home exercise programme comprising range of motion and isometric muscle exercises. No patient reported any strength or aerobic training at the inclusion or at the end of the study period, except that the training group reported pool training at the end of the period. At the 6 months follow-up, nine of the total of 18 training group patients reported habitual physical exercise being pool training ($n = 8$), twice a week, and group training on land ($n = 1$) once a week. This might partly explain why the health status of the patients improved during the follow-up period. In this study, we compared the treatment group attending the pool sessions with the control group, which continued with their previous activities and exercise. We cannot exclude the possibility that the interaction between the physiotherapists and the patients in the training group during the treatment period may have influenced some of the outcomes, as it is known that health can be improved as a result of both specific and non-specific effects of treatment. These non-specific effects can be related to a therapist's attention and interaction skills and/or a patient's expectations, motivation and experience of the meaningfulness of the treatment [45]. However, we did not monitor the adherence of the home training programme. The dropout rate in this study was low, as only four patients, two in the training group and two in the control group, did not participate in the post-test analysis. As a result, 91% of the patients in the training group and 92% of the control group completed the study. The main limitations of this study are the small number of patients and the lack of a control group in the follow-up study. For ethical reasons, no long-term control group was available at the follow-up, because the patients initially randomized to the control group were offered a similar treatment programme directly after they had completed their control period.

To conclude, exercise in a temperate pool twice a week significantly improved muscle endurance in the upper and lower extremities of patients with RA, while aerobic capacity did not improve. However, studies with larger populations are needed to obtain more knowledge about the effects of pool exercise therapy.

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