

## Original Article

# The Effect of Home Hand Exercise on Joint Pain and Range of Motion in Patients with Rheumatoid Arthritis: A Randomized Clinical Trial

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## Abstract

**Background:** Rheumatoid arthritis (RA) is a chronic autoimmune disease characterized by persistent joint inflammation, pain, and reduced functional capacity. Hand involvement is one of the most common and debilitating manifestations of RA, leading to progressive stiffness, weakness, and limited range of motion. While pharmacological treatments remain the cornerstone of RA management, non-pharmacological interventions such as therapeutic exercises have gained attention for their potential benefits. However, evidence on the effectiveness of home-based hand exercises in improving pain and joint function remains limited.

**Materials and Methods:** A randomized controlled trial (RCT) was conducted at Imam Hossein Hospital in Tehran, Iran, from 2023 to 2024. A total of 154 RA patients were enrolled and randomly assigned to either the intervention group (n = 77), which received standard pharmacological treatment along with a structured home-based hand exercise program, or the control group (n = 77), which received only standard pharmacological treatment. The intervention lasted four weeks, during which patients in the exercise group performed specific hand exercises designed to improve joint mobility and grip strength. Pain intensity was assessed using the Visual Analog Scale (VAS), while range of motion (ROM) and hand grip strength were measured using a goniometer and a dynamometer, respectively. Baseline and post-intervention assessments were compared within and between groups.

**Results:** Both groups experienced a significant reduction in pain intensity after four weeks ( $P < 0.001$ ). However, the difference in VAS score reduction between the intervention and control groups was not statistically significant ( $P = 0.870$ ). Hand grip strength significantly improved in both the right and left hands in the intervention group compared to the control group ( $P < 0.001$ ). Additionally, ROM in flexion and extension significantly increased in both hands in the intervention group, whereas no significant improvements were observed in the control group ( $P < 0.001$ ).

**Conclusion:** Home-based hand exercise therapy effectively improved hand grip strength and joint mobility in RA patients, although it did not result in a statistically significant reduction in pain compared to standard treatment alone. Given its accessibility and potential benefits, integrating structured hand exercises into routine RA management is recommended to enhance functional outcomes and promote patient independence. Further studies with longer follow-up periods are needed to assess the sustainability of these benefits.

**Keywords:** Rheumatoid arthritis, Hand exercises, Joint pain, Range of motion

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## Introduction

Rheumatoid arthritis (RA) is a chronic autoimmune disease characterized by persistent and progressive joint inflammation, leading to pain, stiffness, and progressive loss of function. RA is the most common form of inflammatory polyarthritis, affecting approximately 1% of the global population, with a higher prevalence among women compared to men<sup>1-3</sup>. In this disease, Synovial inflammation plays a crucial role in the progression of RA, leading to excessive synovial fluid volume and alterations in its composition. Prolonged inflammation promotes the abnormal growth of synovial tissue that contributes to joint destruction. This process results in mechanical damage due to increased intra-articular pressure and the erosive effects on the joint surfaces<sup>4-5</sup>. The most affected joints in RA patients are the small joints of the hands with restricted joint mobility, combined with external mechanical stress on the joints, which contributes to the development of hand deformities in these patients<sup>6</sup>. These factors result in significant disability and reduced quality of life for patients. Effective management strategies are crucial for alleviating symptoms and maintaining hand function, particularly in individuals whose disease interferes with daily activities<sup>7, 8</sup>.

In addition to usual medical treatments, which play the main role in the management of RA, exercise therapy is widely recognized as a novel component of RA management<sup>8</sup>. Supervised physical therapy programs have shown improvements in pain relief, joint mobility, and functional outcomes<sup>8, 9</sup>. However, access to professional rehabilitation services may be limited due to financial constraints, geographical barriers, or time restrictions. As a result, the accessibility and cost-effectiveness of home-based exercise therapy have attracted attention as an accessible alternative that enables patients to engage actively in the treatment<sup>9, 10</sup>.

Many studies have highlighted the benefits of

structured exercise interventions for RA patients. However, there is limited evidence on the effectiveness of home-based exercise therapy in improving pain and joint range of motion in this population<sup>9, 10</sup>. Understanding the impact of home-based exercise programs could provide valuable insights into self-management strategies for RA, potentially reducing the need for clinical interventions. This study aims to evaluate the effectiveness of a structured home-based exercise program on reducing pain and improving joint range of motion in patients with RA.

## Methods

**Study Design:** This study was conducted as a randomized controlled trial (RCT) with a control group, without blinding. A computer-generated randomization process was performed using the Ralloc package. The sequence generation was conducted by a biostatistician independent of the research team to maintain allocation concealment. Participant enrollment and assignment to intervention and control groups were carried out by a separate clinical coordinator who was blinded to the randomization sequence, ensuring unbiased allocation. Participants were assigned to either the intervention group or the control group in a 1:1 ratio, allowing for equal distribution of participants across both groups. Randomization was performed independently to minimize selection bias, ensuring the validity and reliability of the study outcomes. A total of 154 patients diagnosed with RA were enrolled, with 77 patients in each group. This study was conducted over four weeks from 2023 to 2024 at Imam Hossein Hospital in Tehran, Iran.

**Inclusion Criteria:** Participants met the following criteria:

1. Age 18 years or older.
2. Diagnosis of rheumatoid arthritis according to the ACR/EULAR 2010 classification criteria.
3. No joint pain in the wrist, metacarpophalangeal (MCP), or proximal interphalangeal (PIP) joints at the time of enrollment.

4. A stable medication regimen for at least three months before study entry.
5. Documented functional impairment in daily activities.

**Exclusion Criteria:** Patients were excluded if they met any of the following criteria:

1. Diabetes mellitus.
2. Body Mass Index (BMI)  $\geq 30$  kg/m<sup>2</sup>.
3. Significant osteoarthritis (OA) in the hands.
4. History of hand surgery in the past six months.
5. Active disease phase (acute RA exacerbation) at the time of enrollment.

**Intervention Group:** Patients in the intervention group received standard pharmacological treatment along with a home-based exercise program designed to improve hand function. The exercise regimen includes:

- Three daily sessions, consisting of:
  - Three sets of 10 repetitions for a range of motion and pain management.
  - One set of 10 repetitions, performed twice daily, for hand grip strengthening.
- The intervention lasted for four weeks, with adherence monitored by self-reported exercise logs and weekly follow-ups.

**Control Group:** Patients in the control group received only standard pharmacological treatment without any prescribed hand exercises. The follow-up period for this group was also four weeks, from the beginning of the study.

**Baseline Assessments:** Before the intervention, all participants underwent a comprehensive baseline assessment to determine their initial condition. Pain intensity was measured using the Visual Analog Scale (VAS), while range of motion (ROM) and hand grip strength were evaluated using a goniometer and a dynamometer, respectively. These measurements were recorded to establish a reference for comparison after the intervention.

**Implementation of the Intervention:** Participants in the intervention group received detailed instructions from a sports medicine specialist on the prescribed home-based exercise program. The program aimed to enhance joint mobility and reduce pain, with proper demonstrations provided to ensure correct execution. The control group continued their standard pharmacological treatment without any additional

exercise intervention. Adherence to the exercise program was monitored through self-reported exercise logs and weekly follow-up calls to encourage compliance and track progress.

**Follow-up and Data Collection:** After the four-week intervention period, all participants underwent follow-up assessments using the same evaluation methods as at baseline. Pain intensity, ROM, and hand grip strength were reassessed to identify probable changes following the intervention. Data from pre- and post-intervention assessments were compared to evaluate the effectiveness of the home-based exercise program in improving hand function in RA patients.

**Ethical Considerations:** This study has received approval from the Ethics Committee of Shahid Beheshti Medical Sciences (Ethical code: IR.SBMU.MSP.REC.1403.048), ensuring compliance with ethical guidelines and best practices for clinical research. All participants were fully informed about the study objectives, procedures, and potential risks before providing written informed consent. Participation was voluntary, and individuals will retain the right to withdraw at any stage without facing any negative consequences in their medical treatment. Confidentiality and privacy of patient data were strictly maintained throughout the study, in accordance with ethical and regulatory standards.

**Statistical Analysis:** Data collected from the study were analyzed to determine the significance of the intervention's effects. Data analysis was performed using SPSS software (version 26; IBM Corp., Armonk, NY, USA). Before conducting the statistical tests, the normality of data distribution was assessed using the Shapiro-Wilk test. Descriptive statistics, including mean and standard deviation, were used to summarize patient characteristics and outcome variables. Independent t-tests (for normally distributed data) or Mann-Whitney U tests (for non-normally distributed data) were performed to compare differences between the intervention and control groups. Additionally, repeated measures ANOVA was utilized to analyze within-group changes over time, providing insight into the progress and efficacy of the intervention. A p-value of less than 0.05 was considered statistically significant, ensuring robust conclusions about the effectiveness of home-based exercise therapy in RA patients.

The proposal of this study was approved by the Ethics Committee of the School of Medicine, Shahid Beheshti University of Medical Sciences, with the following approval ID: IR.SBMU.MSP.REC.1403.048. IRCT Code: IRCT20240619062183N

## Results

**Participant Characteristics:** A total of 154 patients diagnosed with RA were enrolled in this study. Participants were randomly assigned into two equal groups, with 77 patients (50%) allocated to the intervention group, receiving hand exercise therapy, and 77 patients (50%) assigned to the control group, receiving only standard pharmacological treatment. The majority of participants were female (97.40%), and the overall mean age of patients was 51.11±10.61 years. There were no statistically significant differences between the two groups in terms of age (P=0.348) and gender distribution (P=1.000). Additionally, the overall mean body weight at baseline was 76.29±13.18 kg, and the mean body mass index (BMI) was 29.73 ± 5.08 kg/m<sup>2</sup>. No significant differences were observed in weight and BMI between the two groups (P>0.05). The detailed baseline characteristics of the participants are summarized in Table 1.

**Baseline and Post-intervention Assessments:** Before the intervention, ROM was significantly lower in right-hand flexion in the intervention group (72.33±12.55) compared to the control group (76.25±10.70, P=0.031). This was the only statistically significant difference observed between the two groups, and there was no significant difference between other assessment factors in the first visit.

The mean VAS score, representing joint pain intensity, significantly decreased in both the intervention and control groups after one month (P<0.001). Although the reduction in pain was greater in the intervention group (-0.89±1.76) compared to the control group (-0.54±0.80), the difference between the two groups was not statistically significant (P=0.870). In the assessment of right-hand function, grip strength showed a significant increase in both groups after one month (P<0.05). However, the improvement was significantly greater in the intervention group (2.98±3.30) compared to the control group (0.39±1.08, P<0.001). ROM in right-hand flexion also considerably improved in both groups (P<0.05), with a greater increase in the intervention group (3.98±5.27) compared to the control group (0.24±0.99, P<0.001). Similarly, ROM in right-hand extension significantly increased in both groups (P<0.05), with a more pronounced improvement in the intervention group (3.67±4.44) compared to the control group (0.47±1.03, P<0.001).

**Table 1.** Baseline characteristics of all participants.

Variables	Control (n=77, 50%)	Hand exercise (n=77, 50%)	Total (n=154, 100%)	P value
Age (years)	50.31 ± 10.67	51.92 ± 10.56	51.11 ± 10.61	0.348
<b>Gender</b>				
Female	75 (97.40)	75 (97.40)	150 (97.40)	1.000
Male	2 (2.60)	2 (2.60)	4 (2.60)	
Weight (kg)	76.66 ± 13.63	75.92 ± 12.78	76.29 ± 13.18	0.729
Height (cm)	160.26 ± 6.12	160.29 ± 6.57	160.28 ± 6.33	0.969
Body Mass Index (kg/m <sup>2</sup> )	29.87 ± 5.25	29.59 ± 4.95	29.73 ± 5.08	0.734
<b>Dominant hand</b>				
Right	71 (92.21)	71 (92.21)	142 (92.21)	1.000
Left	6 (7.79)	6 (7.79)	12 (7.79)	

Data presented as mean ± standard deviation or frequency and percentages (%)

**Table 2.** Comparison of VAS score, grip strength, and ROM in patients before and after intervention between the hand exercise (intervention) group and the control group.

Variables	Groups	Mean difference <sup>1</sup>	Within-group (paired) comparison P_value <sup>2</sup>	Between-group comparison P_value <sup>3</sup>
<b>Joint pain</b>				
VAS score	Control	-0.54 ± 0.80	<0.001*	0.870
	Hand exercise	-0.89 ± 1.76	<0.001*	
<b>Hand grip and range of motion</b>				
<b>Right hand</b>				
Hand grip	Control	0.39 ± 1.08	0.003*	<0.001*
	Hand exercise	2.98 ± 3.30	<0.001*	
ROM, Flexion	Control	0.24 ± 0.99	0.008*	<0.001*
	Hand exercise	3.98 ± 5.27	<0.001*	
ROM, Extension	Control	0.47 ± 1.03	<0.001*	<0.001*
	Hand exercise	3.67 ± 4.44	<0.001*	
<b>Left hand</b>				
Hand grip	Control	0.005 ± 0.74	0.359	<0.001*
	Hand exercise	2.42 ± 3.05	<0.001*	
ROM, Flexion	Control	-0.11 ± 1.05	0.381	<0.001*
	Hand exercise	2.66 ± 6.07	<0.001*	
ROM, Extension	Control	0.17 ± 1.65	0.683	<0.001*
	Hand exercise	3.76 ± 5.55	<0.001*	

Values described as mean ± standard deviation

<sup>1</sup>Difference = after value – before value

<sup>2</sup> Comparison of the intervention value with the intervention value (paired comparison)

<sup>3</sup> Comparison of the differences in values between two groups of intervention

\*Statistically significant, P\_value<0.05

ROM: Range of Motion

Regarding the left hand, grip strength significantly increased in the intervention group after one month ( $P<0.001$ ), whereas no significant change was observed in the control group. The improvement in grip strength was significantly higher in the intervention group ( $2.42\pm 3.05$ ) compared to the control group ( $0.005\pm 0.74$ ,  $P<0.001$ ). ROM in left-hand flexion also showed a significant improvement in the intervention group after one month ( $P<0.001$ ), whereas no significant change was observed in the control group. The difference in ROM flexion was significantly higher in the intervention group ( $2.66\pm 6.07$ ) compared to the control group ( $-0.11\pm 1.05$ ,  $P<0.001$ ). Similarly, ROM in left-hand extension significantly improved in the intervention group after one month ( $P<0.001$ ), while no significant change was observed in the control group. The

difference in ROM extension was significantly greater in the intervention group ( $3.76\pm 5.55$ ) compared to the control group ( $0.17\pm 1.65$ ,  $P<0.001$ ). The detailed clinical outcomes and statistical comparisons are presented in Tables 2 and 3.

## Discussion

RA significantly affects patients' quality of life, often leading to physical and functional disabilities <sup>9, 11, 12</sup>. Hands and fingers are the most commonly affected areas in patients, where RA can cause weakness, reduced range of motion, and persistent pain. These complications interfere with daily activities and compromise patients' independence<sup>13</sup>. The primary goal of RA management is to alleviate symptoms, prevent joint damage and consequent joint movement

**Table 3.** Comparison of VAS score, grip strength, and ROM in patients before and after intervention between the hand exercise (intervention) group and the control group.

Variables	Control (n=77, 50%)	Hand exercise (n=77, 50%)	Total (n=154, 100%)	P value
<b>Joint pain</b>				
VAS score (before)	5.37 ± 1.88	5.57 ± 2.73	5.47 ± 2.34	0.495
VAS score (after)	4.83 ± 1.77	4.67 ± 2.61	4.75 ± 2.23	0.808
<b>Hand grip and range of motion</b>				
<b>Right hand</b>				
Hand grip (before)	21.80 ± 7.23	22.52 ± 6.76	22.16 ± 6.98	0.527
Hand grip (after)	22.19 ± 6.92	25.50 ± 6.23	23.85 ± 6.77	<b>0.003*</b>
<b>Flexion</b>				
ROM (before)	76.25 ± 10.70	72.33 ± 12.55	74.29 ± 11.79	<b>0.031*</b>
ROM (after)	76.49 ± 10.76	76.32 ± 10.88	76.40 ± 10.78	0.747
<b>Extension</b>				
ROM (before)	68.55 ± 10.14	71.18 ± 12.67	69.86 ± 11.52	0.065
ROM (after)	69.02 ± 9.90	74.85 ± 11.23	71.94 ± 10.95	<b>&lt;0.001*</b>
<b>Left hand</b>				
Hand grip (before)	21.46 ± 5.06	21.06 ± 6.05	21.26 ± 5.56	0.378
Hand grip (after)	21.47 ± 4.94	23.49 ± 5.66	22.48 ± 5.39	<b>0.043*</b>
<b>Flexion</b>				
ROM (before)	76.07 ± 10.88	73.45 ± 14.61	74.76 ± 12.91	0.478
ROM (after)	75.96 ± 10.78	76.11 ± 12.46	76.04 ± 11.61	0.670
<b>Extension</b>				
ROM (before)	68.24 ± 10.97	67.15 ± 11.43	67.70 ± 11.18	0.374
ROM (after)	68.42 ± 11.24	70.92 ± 10.77	69.67 ± 11.04	0.118

Data presented as mean ± standard deviation

\*Statistically significant, P-Value<0.05

ROM: Range of Motion

limitations, and preserve functional capacity. In recent years, both pharmacological and non-pharmacological treatments have focused on achieving these objectives. Among non-pharmacological approaches, therapeutic exercises have been widely recognized as an effective strategy to promote hand function. These exercises are specifically designed to strengthen muscles, improve joint mobility, and alleviate pain<sup>4, 13, 14</sup>.

In the present study, findings indicate that therapeutic hand exercises significantly improved hand strength and range of motion. Although pain reduction was observed in all participants, with a greater reduction in the VAS pain score in the intervention group compared to the control group, the difference between these groups was not statistically significant. This finding is consistent with previous studies that have reported a positive impact of therapeutic exercises on pain reduction<sup>1, 15, 16</sup>. The potential mechanisms underlying this effect may include increased local blood circulation, improved joint function, and reduced mechanical stress on the joints<sup>17</sup>. However, a

study reported that exercise therapy did not have any significant effect on pain intensity in RA patients<sup>18</sup>. The variability in findings across studies may be attributed to differences in exercise type and intensity, intervention duration, and patient characteristics<sup>10, 18</sup>.

The results of this study showed that hand grip strength significantly improved in both the right and left hands in the intervention group compared to the control group. This finding is in line with prior research that has reported increased hand strength following therapeutic exercise interventions<sup>18-20</sup>. Muscle strengthening, enhanced joint function, and reduced joint stress may explain this beneficial effect. Improved hand strength is significant for RA patients, as it contributes to better functional performance and greater independence in daily activities<sup>21</sup>. In addition, the present study found that both flexion and extension ROM in the right and left hands significantly improved in the intervention group compared to the control group. These findings align with previous studies demonstrating joint mobility improved following therapeutic hand

exercises<sup>16, 19, 22</sup>. Increased range of motion is a major factor in maintaining functional hand use and preventing progressive stiffness and deformities in RA patients, resulting in an improvement in patients' quality of life and independence.

This study has several limitations that should be acknowledged. The study was conducted without blinding, which may have introduced potential biases in data collection and outcome assessment. Participants were aware of their group allocation, which may have potentially affected their self-reported adherence to the exercise regimen and subjective pain assessments. Adherence to the exercise program was monitored through self-reported exercise logs. This method is susceptible to recall bias and may not accurately reflect actual exercise performance, potentially overestimating the intervention's effect. The participant pool consisted predominantly of female patients (97.4%), limiting the generalizability of the findings to the broader RA population, particularly male patients. Future studies should aim to recruit a more balanced sample to assess gender-related differences in response to hand exercise therapy. Finally, the short follow-up period of one month in this study was another limitation. Assessing the long-term effects of hand exercise therapy, particularly regarding the sustainability of the observed improvements, remains an important area for future research. Further studies should also explore the combined effects of hand exercises with other non-pharmacological interventions, such as joint manipulation techniques or assistive devices, to optimize treatment outcomes.

## Conclusion

As far as we know, this study is the first of its kind conducted in Iran, aiming to evaluate the effects of home-based hand exercise therapy on pain intensity, hand strength, and range of motion in patients with RA. The findings of this study suggest that home-based hand exercise therapy can serve as an effective complementary treatment for improving pain intensity, hand strength, and range of motion in RA patients. Given its accessibility and potential benefits, incorporating these exercises into routine RA management is recommended to enhance functional outcomes and patient well-being.

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## Conflict of interest

The authors further declare that they have no conflict of interest.

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