

# Effects of Aquatic Exercise Therapy on Joint Mobility and Inflammatory Markers in Patients with Rheumatoid Arthritis

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**Abstract:** This study aimed to investigate the effects of aquatic exercise therapy on joint mobility and inflammatory markers in patients with rheumatoid arthritis. Through a randomized controlled trial, patients in the experimental group underwent aquatic exercise therapy, with pre- and post-treatment data on joint mobility and inflammatory markers compared. Results demonstrated that aquatic exercise therapy significantly improved joint range of motion and reduced inflammation levels, indicating positive therapeutic effects for rheumatoid arthritis.

**Keywords:** Aquatic exercise therapy; Rheumatoid arthritis; Joint range of motion; Inflammation markers

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## 1. Introduction

Rheumatoid arthritis (RA) is a chronic, systemic autoimmune disease primarily characterized by erosive, symmetrical polyarthritis. Its fundamental pathological changes involve chronic inflammation of the synovial membrane, synovial proliferation, and progressive destruction of articular cartilage and bone, ultimately leading to joint deformity and functional loss. Early diagnosis and treatment are crucial for delaying disease progression and improving patients' quality of life.

Currently, various treatment approaches exist for RA, including lifestyle interventions, physical therapy, medication, and surgery. While medication can control disease progression, long-term use may carry certain side effects. Surgical intervention is suitable for patients with severe late-stage joint damage but involves inherent risks. Aquatic exercise therapy, as a form of physical therapy, offers unique advantages. Water's buoyancy reduces joint stress, while its thermal properties help alleviate muscle spasms and promote blood circulation, providing a safe and effective rehabilitation pathway for RA patients. However, current research on the effects of aquatic exercise therapy on joint mobility and inflammatory markers in RA patients remain insufficient. Therefore, this study aims to thoroughly investigate the therapeutic efficacy of aquatic exercise therapy for this condition, providing scientific evidence for clinical practice.

## **2. Literature review**

### **2.1. Pathological mechanisms and clinical manifestations of RA**

The etiology and pathogenesis of RA are highly complex and remain incompletely understood. Genetic, hormonal, and environmental factors all contribute to its onset. Epidemiological studies indicate a strong association with hereditary factors, with family studies showing that first-degree relatives of individuals with active RA have an 11% probability of developing the condition. Numerous studies have identified mutations in the HLA-DRB1 allele as associated with disease onset. Infectious agents such as bacteria, mycoplasma, and viruses may activate T and B lymphocytes, leading to the secretion of pro-inflammatory factors and the production of autoantibodies, thereby influencing disease onset and progression. Smoking significantly increases the risk of developing RA and is particularly associated with ACPA-positive RA.

Its typical symptoms include joint pain, swelling, morning stiffness, and deformity. In the early stages, patients often experience joint pain and morning stiffness lasting over an hour before joints become mobile. Affected joints are typically symmetrical, most commonly involving proximal interphalangeal joints, followed by metacarpophalangeal joints, wrists, knees, and elbows. Swelling of the synovium and joint effusion limit both active and passive joint movement. Affected joints may dislocate or subluxate, presenting with visible deformities. Additionally, patients may experience systemic symptoms such as fever, fatigue, loss of appetite, weight loss, night sweats, and general malaise. Some patients may develop complications including pleurisy, valvular heart disease, interstitial pneumonia, and neurological damage.

### **2.2. Principles and advantages of aquatic exercise therapy**

Aquatic exercise therapy refers to physical training conducted in the unique environment of water to alleviate patient symptoms or improve function. Water possesses distinctive physical properties; its buoyancy reduces the weight-bearing pressure on joints, significantly lowering the load on joints during exercise. This makes it particularly suitable for patients with RA experiencing pronounced joint pain. The thermal properties of water also play a crucial role. Warm water dilates superficial blood vessels, increasing blood supply to the skin and improving its nutritional status. As this warm blood reaches deeper muscles, muscle contraction becomes easier and more powerful while reducing muscle spasms, allowing patients to achieve near-normal movement patterns.

Compared to land-based exercise, aquatic exercise offers numerous advantages. Patients can perform multi-directional movements engaging multiple muscle groups while minimizing pain. For those with spasms, the thermal effect reduces spasm intensity. A well-structured aquatic therapy program begins with buoyancy-assisted movements, progresses to using buoyancy for support, and ultimately employs buoyancy as resistance. Varying movement speed and creating water turbulence achieve different therapeutic effects. Furthermore, swimming training stands out as a particularly beneficial aquatic exercise. Different strokes engage muscles in diverse ways, and many patients with severe functional limitations find movement easier in a hydrotherapy pool. This not only aids physical recovery but also provides significant psychological support.

### **2.3. Current application of aquatic exercise therapy in RA treatment**

The use of aquatic exercise therapy in treating RA is gaining increasing attention. Several studies indicate that aquatic exercise can improve joint range of motion and muscle strength, alleviate pain, and enhance quality of life. For instance, research has shown that RA patients experience significant reductions in joint pain and stiffness, along with increased joint mobility after aquatic exercise. However, current studies still face certain limitations.

Regarding sample size, some studies have small sample sizes, potentially leading to biased results.

Some studies lack rigorous randomized controlled designs, compromising scientific rigor and reliability; standardization of intervention protocols also requires improvement, as variations in aquatic exercise methods, intensity, and frequency across studies hinder accurate comparisons and broader application. Therefore, more in-depth, standardized research is necessary to clarify the efficacy of aquatic exercise therapy in RA treatment.

### **3. Research methods**

#### **3.1. Study population**

This study aimed to investigate the effects of aquatic exercise therapy on joint range of motion and inflammatory markers in patients with RA.

Inclusion criteria require patients meeting diagnostic criteria for RA, confirmed through comprehensive medical examinations and assessments including clinical symptoms, physical signs, and laboratory tests.

Exclusion criteria apply to patients with contraindications to aquatic exercise therapy, such as severe cardiopulmonary insufficiency, skin diseases, or open wounds. Patients with severe cardiopulmonary insufficiency may face risks during aquatic exercise due to increased cardiac load or respiratory limitations; those with skin diseases may develop infections or allergic reactions from aquatic chemicals or bacteria; and patients with open wounds are at risk of wound infection. Strict inclusion and exclusion criteria ensured participant safety and the reliability of study outcomes.

#### **3.2. Intervention measures**

This study implemented a 12-week aquatic exercise therapy intervention, conducted three times weekly for 45 minutes per session. Intervention content was selected based on the physical characteristics and exercise needs of RA patients, primarily including low-impact activities such as water walking, kicking exercises, and swimming. These exercise forms effectively strengthen muscle power and improve joint flexibility while reducing joint stress.

Water temperature was maintained between 28–32°C (82–90°F). This range ensures patient comfort during exercise while promoting blood circulation and relieving muscle tension. Prior to exercise, patients performed thorough warm-up activities, including simple joint rotations and stretches, to prevent injury. After exercise, participants promptly dried off and kept warm to avoid exacerbating symptoms through exposure to cold <sup>[1]</sup>.

#### **3.3. Evaluation indicators**

##### **3.3.1. Joint range of motion**

Professional joint measurement instruments were used to precisely measure patients' joint mobility before and after intervention. Measurement indicators included range of motion in flexion, extension, external rotation, and internal rotation. These metrics comprehensively reflect joint function, providing objective evidence for assessing aquatic exercise therapy efficacy.

##### **3.3.2. Inflammation markers**

Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels were measured before and after intervention. ESR and CRP are key indicators reflecting disease activity in RA. Changes in their levels directly demonstrate the impact of aquatic exercise therapy on patients' inflammatory responses.

### 3.4. Statistical methods

Data analysis was performed using SPSS software. Quantitative data are presented as mean  $\pm$  standard deviation, clearly illustrating central tendency and dispersion. Between-group comparisons employed *t*-tests to determine significant differences between data sets. Categorical data were expressed as rates. Intergroup comparisons were performed using the chi-square ( $\chi^2$ ) test to analyze relationships between categorical variables. A *p*-value  $< 0.05$  was set as the threshold for statistical significance to ensure the reliability of the research findings <sup>[2]</sup>.

### 3.5. Research findings

#### 3.5.1. Changes in joint range of motion

After 12 weeks of aquatic exercise therapy intervention, patients demonstrated significant improvement in joint range of motion. Compared to pre-intervention levels, post-intervention measurements showed increased range of motion in flexion, extension, external rotation, and internal rotation. Statistical analysis confirmed these changes were statistically significant ( $p < 0.05$ ). This indicates aquatic exercise therapy effectively enhances joint range of motion, flexibility, and functional mobility in RA patients.

The improvement in joint range of motion achieved through aquatic exercise therapy is primarily attributable to water's unique physical properties. Water's buoyancy reduces joint loading, minimizing pain and discomfort during movement and allowing patients to perform joint activities more freely. Simultaneously, water resistance serves as a natural exercise tool, strengthening muscles surrounding the joints. This enhances muscle support and protection for the joints, further improving joint range of motion.

#### 3.5.2. Changes in inflammatory markers

Following intervention, patients exhibited significantly reduced erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels. Compared to pre-intervention values, both ESR and CRP levels decreased post-intervention, with these changes being statistically significant ( $p < 0.05$ ). This indicates aquatic exercise therapy effectively lowers inflammatory markers in RA patients, helping control disease activity.

The mechanism by which aquatic exercise therapy reduces inflammatory markers may involve multiple aspects. On one hand, exercise promotes blood circulation, accelerates the excretion of inflammatory metabolites, and reduces the accumulation of inflammatory factors in the body. On the other hand, aquatic exercise stimulates the secretion of neurotransmitters such as endorphins, which possess analgesic and anti-inflammatory effects, thereby alleviating inflammatory responses. Additionally, appropriate water temperature can regulate the body's immune function, suppress excessive immune responses, and further control the progression of inflammation.

In summary, this study employs rigorous research methods and objective evaluation metrics to confirm that aquatic exercise therapy exerts significant positive effects on RA patients. It effectively improves joint range of motion and reduces inflammatory marker levels, offering a safe and effective adjunctive treatment option for RA management <sup>[3]</sup>.

## 4. Discussion

### 4.1. Mechanisms of aquatic exercise therapy in improving joint range of motion

The mechanisms by which aquatic exercise therapy enhances joint range of motion in RA patients primarily include the following aspects. The buoyancy of water reduces joint loading, significantly decreasing pressure on joints during exercise. This alleviates pain, enabling patients to perform joint movements more easily and increase

their range of motion. For example, in patients with knee joint damage, walking in water allows buoyancy to support part of the body weight, reducing the burden on the knee joint. This facilitates more comfortable flexion and extension of the knee.

The thermal effect of water dilates surface blood vessels, increasing blood supply to the skin and improving its nutritional status. As warm blood reaches deeper muscles, muscle contraction becomes easier and more powerful. Simultaneously, it reduces muscle spasms, relaxing the muscles surrounding the joints. This reduces restrictions on joint movement, helping patients achieve near-normal movement patterns. Exercising in warm water significantly reduces joint stiffness, allowing for more comprehensive joint mobilization <sup>[4]</sup>.

During aquatic exercise, water resistance serves as natural resistance training, requiring patients to exert greater force during joint movements. This strengthens the muscles surrounding the joints. Enhanced muscle strength provides better support and stability for the joints, further improving range of motion. For example, when patients perform aquatic upper-limb press-ups, water resistance exercises the upper-limb muscles. Increased strength then better assists shoulder and elbow joint movements.

#### **4.2. Mechanisms of aquatic exercise therapy in reducing inflammatory markers**

The mechanism by which aquatic exercise therapy lowers inflammatory markers in RA patients may involve the following factors: Exercise promotes blood circulation and accelerates metabolism, aiding in the removal of inflammatory metabolites from the joints. This reduces the accumulation of inflammatory factors locally, thereby mitigating the inflammatory response. During aquatic exercise, accelerated systemic blood circulation enables more efficient transport of inflammatory substances from the joints to organs like the liver for metabolic processing.

Moderate aquatic exercise modulates immune system function, enhances the body's immune regulatory capacity, suppresses excessive immune responses, and reduces autoantibody production, thereby lowering inflammatory markers. Studies indicate that patients who consistently engage in long-term aquatic exercise experience improved immune cell function and restored immune balance, positively contributing to inflammation control.

The thermal and mechanical stimulation of water may regulate the endocrine system through neural reflex mechanisms, promoting the secretion of anti-inflammatory substances like endorphins. Endorphins possess analgesic and anti-inflammatory properties, alleviating patients' pain and inflammatory responses, thereby lowering inflammatory markers. Patients often report physical and mental relaxation with reduced pain after aquatic exercise, which correlates with endorphin secretion <sup>[5]</sup>.

#### **4.3. Comparison and analysis with other studies**

Compared with previous relevant studies, the findings of this study align with some previous conclusions, all indicating that aquatic exercise therapy has a positive impact on joint range of motion and inflammatory markers in patients with RA. However, differences in sample size, research methods, and intervention measures among studies may lead to varying results. Some studies had small sample sizes, which may affect the stability and reliability of the results; others lacked a strict randomized controlled design, making it difficult to exclude interference from other factors.

This study employed a randomized controlled trial design with a relatively large sample size and highly standardized intervention measures, enabling more accurate assessment of aquatic exercise therapy's efficacy.

Nevertheless, certain limitations exist: the short study duration prevented observation of long-term effects; and the absence of stratified analysis for patients with different types or severity levels of RA may affect the generalizability of findings. Future research should extend the study duration, increase sample size, and incorporate stratified analysis to comprehensively and thoroughly explore the therapeutic value of aquatic exercise therapy in RA management.

## 5. Conclusion

This study demonstrates that aquatic exercise therapy significantly improves joint mobility and reduces inflammatory markers in patients with RA, yielding positive therapeutic outcomes. By leveraging water's buoyancy, thermal effects, and resistance, aquatic exercise provides a safe and effective rehabilitation approach. It not only alleviates symptoms and enhances joint function but also modulates the immune system to mitigate inflammatory responses.

Therefore, it is recommended to promote the application of aquatic exercise therapy in the clinical treatment of RA patients. However, during implementation, personalized exercise programs should be developed based on individual patient conditions, with strict control over exercise intensity and duration to ensure safety. Concurrently, health education and guidance for patients should be strengthened to improve treatment adherence. Future research may further explore the mechanisms of aquatic exercise therapy and optimize exercise protocols, providing more scientific and effective evidence for RA treatment.

## Disclosure statement

The author declares no conflict of interest.

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