

## **The effectiveness of aerobic exercise for pain management in patients with fibromyalgia**

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### **Abstract**

The effectiveness of exercise therapy is being increasingly studied in patients with fibromyalgia. The aim of our systematic review was to determine the effectiveness of different types of aerobic exercise programs for pain management in patients with fibromyalgia. The literature search was performed by two independent researchers in the PubMed, CINAHL and PEDro databases using various combinations of the following keywords: fibromyalgia, pain and aerobic exercise. Studies were eligible if they included adults diagnosed with fibromyalgia and examined the effectiveness of at least one aerobic exercise program on pain management. A total of 14 randomized controlled trials were screened in full-text, nine of which were included in the systematic review. Overall, our results indicate that aerobic exercise is effective for pain management in patients with fibromyalgia. The results of the aerobic exercise programs were more effective for pain management than stretching exercises, but did not differ significantly from those of pilates, muscle strengthening exercises, relaxation techniques and stress management treatment. Additional high-quality studies are warranted to determine accurate clinical guidelines in terms of aerobic exercise programs for pain management in patients with fibromyalgia.

**Key Words:** myofascial pain syndrome; cardio-respiratory exercise; chronic pain.

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Fibromyalgia (FM) is a syndrome characterized by chronic musculoskeletal pain that can be felt in different parts of the body.<sup>1</sup> FM affects about 2-7% of the world's population.<sup>2-4</sup> and its prevalence is similar in different countries, cultures and ethnic groups.<sup>5</sup> The main symptoms of the disease are widespread musculoskeletal pain, muscle and joint stiffness, insomnia, fatigue, mood disorders, cognitive dysfunction, anxiety, depression, general sensitivity and inability to perform daily activities.<sup>6,7</sup> Although factors contributing to the development of FM include neuroendocrine disorders, genetic predisposition, oxidative stress, environmental and psychosocial changes, clear factors leading to the onset of FM are still unclear and are the subject of numerous studies.<sup>8,9</sup> FM seems to be triggered by central and peripheral mechanisms of excessive excitability, which can cause changes in pain perception, such as hyperalgesia and allodynia, muscle stiffness, reduced functional capacity, and sleep disturbances.<sup>10,11</sup> Several features of FM suggest an autoimmune component in the pathogenesis. Altered levels of inflammatory and immunoregulatory cytokines have been found in FM patients. Although these changes do not follow a

consistent pattern, they may indicate that the patients' immune processes are impaired.<sup>12</sup> Both trauma and infections that can trigger autoimmunity are among the most common causes of FM.<sup>13</sup> A significantly increased prevalence of FM has been found in individuals with COVID-19, herpes simplex, hepatitis C, and Epstein-Barr viral infections, as well as in individuals with autoimmune rheumatologic diseases.<sup>14-16</sup> Chronic pain may affect an individual in various ways. These often include physical, psychological, social, or economic distress.<sup>17</sup> Pain has a significant impact on an individual's quality of life, self-esteem and emotions. Normal participation in everyday and work activities is often limited for the patient. Research of chronic pain usually begins with the assumption that the patients' primary goal is to reduce pain and increase control over their condition.<sup>18</sup> However, complete and/or permanent pain relief is rarely achieved, nor does it lead to better functioning and quality of life for patients with FM.<sup>19,20</sup> Sometimes, the goal of reducing pain can have the opposite effect if coping methods are perceived as pain avoidance.<sup>21</sup> Avoidance is associated with increased pain intensity, greater anxiety and depression, as well as mental and work disability.<sup>22</sup> Therefore, accepting pain is

particularly important, defined as the willingness to constantly experience pain without efforts to reduce, avoid, or otherwise change it.<sup>21</sup> The authors found that a higher level of pain acceptance is associated with better daily functioning and less disability and symptoms.<sup>23</sup> A multidisciplinary approach is recommended for the treatment of FM, based on the management of physical, psychological, and social factors.<sup>19,24</sup> The treatment of FM involves the use of pharmacological and non-pharmacological therapy. Several pharmacological interventions have solid evidence of efficacy in treating FM symptoms, including tricyclic antidepressants, gabapentinoids, and serotonin - noradrenaline reuptake inhibitors.<sup>25-28</sup> However, no pharmacological intervention is effective in managing all FM symptoms, as they can only alleviate individual symptoms.<sup>29</sup> Accordingly, authors suggest that non-pharmacological interventions may be more effective in increasing the quality of life as they relieve pain, improve physical function and the overall status of patients with FM.<sup>30,31</sup>

Non-pharmacological therapy includes patient education, exercise therapy, and cognitive-behavioral therapy. Exercise therapy is an important part of treatment, as patients often report impaired everyday function due to poor cardiovascular fitness, muscle strength and endurance.<sup>32</sup> Aerobic exercise is one of the most common type of exercise intervention used for pain management in patients with FM, as it has many positive effects when dealing with chronic pain conditions.<sup>29,32,33</sup> During aerobic exercise, the hypothalamus releases an increased level of neurotransmitters, including endorphins, which lead to reduced pain. Furthermore, a higher level of neurotransmitters is linked to improvements in mood and sleep quality. Aerobic exercise is also effective in reducing the inflammatory process and oxidative stress in the body, resulting in reduced anxiety, depression, and stress responses.<sup>32</sup> A recent systematic review of 18 studies concluded that aerobic exercise, resistance training, and stretching exercise have positive effects on pain, depression, and quality of life in adults with FM.<sup>34</sup> Although aerobic exercise is associated with pain reduction, the effectiveness of different aerobic exercise protocols for pain management in FM patients, compared to other exercise interventions, has not been thoroughly investigated. Therefore, we conducted a systematic review that combines previous findings and provides the latest clinical guidelines for the use of aerobic exercise in patients with FM.

## Materials and Methods

### *Information sources and search strategy*

The search for relevant studies was conducted in March 2023. We searched the PubMed, CINAHL and PEDro databases for all papers published in English language, regardless of the year of publication. We used the following search strategy: fibromyalgia AND pain AND ("aerobic exercise" OR "aerobic training"). The search was conducted by two reviewers independently and the

results were combined. The search strategy was carried out in two phases: 1) the assessment of eligible articles based on title and abstract, and 2) the assessment of eligible articles based on the full text.

### *Eligibility criteria*

The eligibility criteria were structured according to the PICOS tool:<sup>35</sup>

- Population (P): The population included both women and men of all age groups who had been diagnosed with FM. Studies with less than 40 subjects were excluded, as were studies that examined other pathologies.
- Intervention (I): Studies were included if at least one experimental group was included in an aerobic exercise program. No exclusion criteria were established based on the intensity of aerobic exercise. However, studies where the intervention lasted less than three weeks were excluded. Studies were also excluded if aerobic exercise was performed in combination with other types of exercise programs and the effectiveness of the aerobic exercise program could not be clearly determined.
- Comparison (C): Studies were included if they assessed the effectiveness of aerobic exercise compared to a control group that received other forms of therapeutic or exercise intervention or received no intervention at all.
- Outcomes (O): Studies were included if they assessed pain intensity according to the Visual Analogue Scale (VAS), number of painful regions, number of tender points, pain pressure thresholds at all 18 specified sites measured with an electronic algometer, Short Form-36 Health Survey (pain category), pain severity subscale of the Multidimensional Pain Inventory (MPI), Fibromyalgia Impact Questionnaire Pain scale (FIQ Pain) and short form McGill pain questionnaire (MPQ) as an outcome measure.
- Study Design (S): Randomized controlled trials including at least one experimental and control group were included.

### *Study extraction and analysis*

Data extraction included the following items: sample characteristics (gender and age range of participants), intervention characteristics (treatment groups, type of intervention, total weeks, duration, frequency), outcome variables and main findings. Data collection was carried out by one researcher, with the supervision of the second researcher.

### *Methodological quality*

The quality of the included studies was assessed independently by two researchers, using the PEDro scale, which rates the quality of studies from 0 to 10.<sup>31</sup> Studies scoring from 9-10 were considered as "excellent", 6-8 as "good," 4-5 as "fair," and <4 as "poor" quality. The average quality of the studies was rated as "good" (mean = 6.33). Four studies were rated as being of "fair" quality,

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**Table 1.** Assessment of the methodological quality of the included studies by the PEDro scale.<sup>36</sup>

N	Criteria	de Medeiros et al. <sup>11</sup>	Sevimli et al. <sup>37</sup>	Hooten et al. <sup>38</sup>	Mannerkorpi et al. <sup>39</sup>	Assis et al. <sup>40</sup>	Valim et al. <sup>41</sup>	Schachter et al. <sup>42</sup>	Richards and Scott <sup>43</sup>	Wigers et al. <sup>44</sup>
1	Random allocation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Concealed allocation	Yes	No	Yes	Yes	Yes	No	No	No	No
3	Groups similar at baseline	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
4	Subject blinding	No	No	No	No	No	No	No	No	No
5	Therapist blinding	No	No	No	No	No	No	No	No	No
6	Assessor blinding	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
7	Adequate follow-up	Yes	Yes	Yes	Yes	Yes	No	No	No	No
8	Intention-to-treat analysis	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
9	Between-groups comparisons	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10	Point estimates and variability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	PEDro scale scoring	8	5	7	8	8	5	5	5	6

whereas the remaining five were rated as being of “good” quality.

Results from the PEDro scale are summarized in Table 1.

### Results

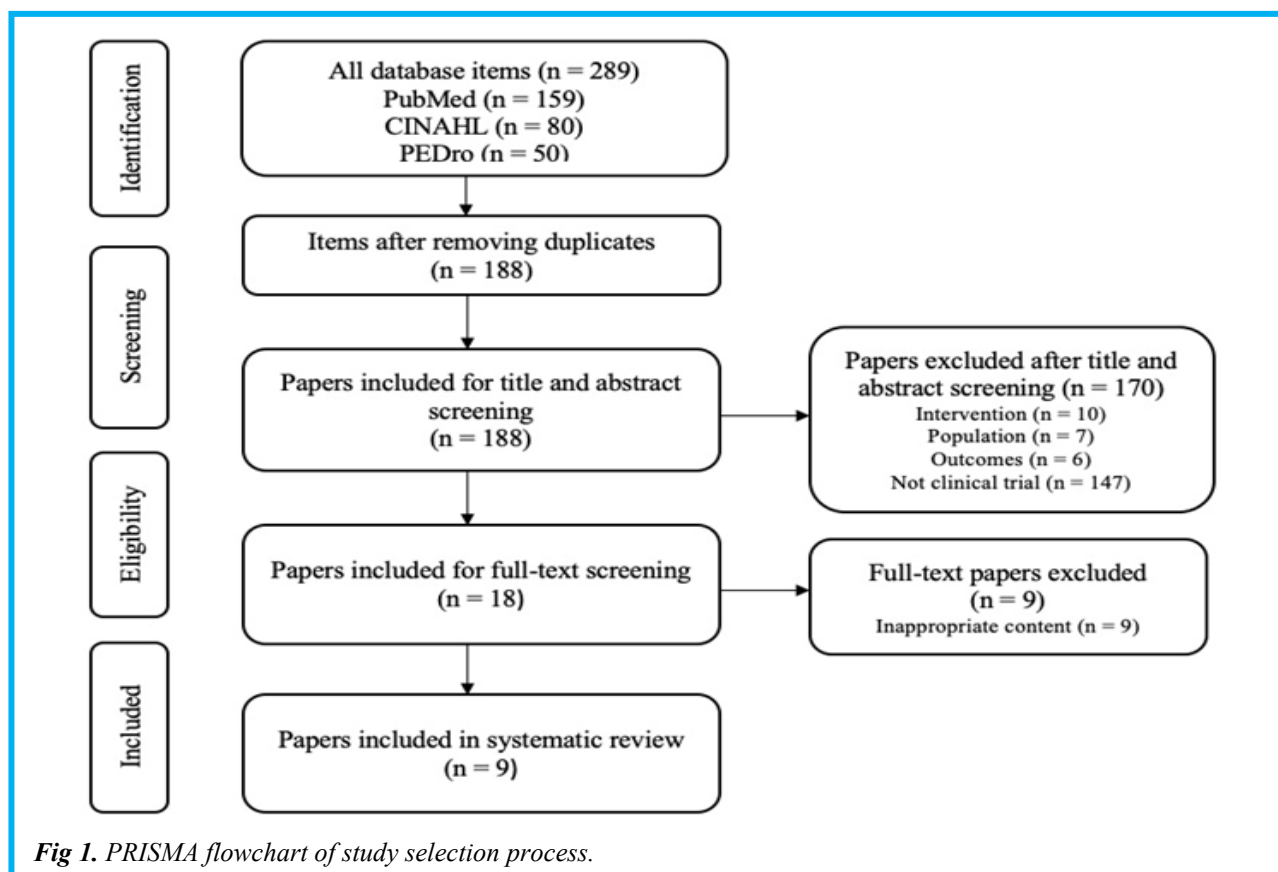
With the initial search strategy, we found 289 potential articles, of which 159 were in the PubMed database, 80 in CINAHL and 50 in PEDro databases. After removing the duplicates, a total of 188 studies were exported to MS Excel (Microsoft, Redmond, USA) where key information about the studies were recorded. All studies were screened by title and abstract in order to exclude those not meeting the inclusion criteria. Finally, 18 studies were reviewed in full text and nine of them were excluded due to inappropriate content. Thus, a total of nine appropriate studies were included in the systematic review. The literature search process is presented in Figure 1.

Basic information of the nine studies included in the systematic review are presented in the Table 1 of Supplementary Materials. It was found that gymnastic-based aerobic exercise program and pool-based aquatic aerobic exercise program provides better results for pain management compared to isometric strength and stretching exercise program.<sup>37</sup> Aerobic exercise was also superior to stretching exercise in terms of reducing the number of tender points and pain during palpation of the tender point.<sup>41</sup> However, four studies have reported that

aerobic exercise is effective in reducing pain, although the results did not significantly differ compared to mat pilates, strengthening exercise, relaxation techniques, and stress management treatment.<sup>11,38,40,43,44</sup> On the other hand, pain intensity did not significantly decrease over time in the Nordic walking and low-intensity walking group.<sup>39</sup> It was also found that there was no reduction in pain, number of painful regions and increase in pain pressure threshold in the progressive aerobic exercise group.<sup>42</sup>

### Discussion

The aim of our systematic review was to assess the effectiveness of aerobic exercise for pain management in patients with FM. Studies included in the systematic review investigated the effectiveness of aerobic exercise in comparison with various forms of exercise interventions on pain management in patients with FM. Pain threshold has been found to increase in individuals exercising at an intensity of at least 75% of maximal aerobic capacity.<sup>45</sup> This is due to the activation of potent opioidergic and other pain inhibitory mechanisms controlled by the central nervous system.<sup>46</sup> Although regular exercise programmes can have beneficial effects in people with chronic pain, some patients report worsening of symptoms.<sup>47,48</sup> In chronic pain conditions characterised by central sensitization, such as FM and chronic fatigue syndrome, impairment of endogenous



**Fig 1.** PRISMA flowchart of study selection process.

pain inhibition has been reported with excessively intense exercise and worsening of symptoms after exercise.<sup>47-49</sup>

Sevimli et al.<sup>37</sup> concluded that aquatic aerobic exercise and gymnastics are more effective methods for pain management in patients with FM compared to isometric resistance exercise and stretching exercises. Similar findings were reported by Valim et al.<sup>41</sup> who compared walking and stretching exercises for pain management in patients with FM. Aerobic exercise was found to be more effective than stretching exercises in pain management, number of tender points, and increasing pressure tolerance. Assis et al.<sup>40</sup> examined the effectiveness of water running, walking, and running on land. Authors reported that pain scores decreased in both groups, with an average reduction of 40% in water running and 30% in walking and running on land. However, it is emphasized that although walking is a practical form of exercise for most patients, it may be difficult and painful for some with concurrent diseases (e.g. arthritis). Therefore, aerobic exercise in water is particularly suitable for people with lower limb limitations.<sup>40</sup> It is assumed that hydrostatic pressure and higher water temperatures may increase sensory input and block nociceptors, thereby contributing to pain relief.<sup>50</sup> Accordingly, De Medeiros et al.<sup>11</sup> reported the positive effects of aerobic exercise in water on pain management, although the results did not differ significantly compared to the control group that performed mat pilates. The main

finding of Hooten et al.<sup>38</sup> was that aerobic exercise and strength training had comparable effects on pain management and increasing pain pressure threshold. Previous studies suggest that aerobic exercise and strength training may improve muscle oxygenation, leading to a reduction in peripheral and central sensitization and thus a reduction in pain intensity.<sup>51,52</sup> Richards and Scott<sup>43</sup> compared the results of aerobic exercise and relaxation techniques and found that both methods were equally effective for pain management and in reducing the number of painful points three months after the conclusion of the intervention. At the one year follow up, the reduction in the number of painful points was maintained in both groups, although the difference was greater and in patients that were included in the aerobic exercise program. Wigers et al.<sup>44</sup> found that both aerobic exercise and stress management treatment were short-term effective methods for pain management, number of painful regions, and increasing pain pressure threshold, but no significant long-term changes were observed in symptom severity. Mannerkorpi et al.<sup>39</sup> investigated the effectiveness of moderate-to-high-intensity Nordic walking and low-intensity walking program. Surprisingly, some patients in the Nordic walking group as well as in the low-intensity walking group reported temporary increases in pain, which could be due to dysfunctions in peripheral and central pain mechanisms in FM.<sup>39</sup> In a study that evaluated the effectiveness of aerobic dance, it was found that there

was a worsening of FM symptoms, particularly an increase in pain intensity.<sup>53</sup> Van Santen et al.<sup>54</sup> also concluded that pain intensity increased in the group that performed high-intensity aerobic exercise compared to the control group that underwent low-intensity exercise. Within high-intensity walking, the use of poles was advised, which facilitates walking and relieves the lower extremities. Walking in short intervals, allowing for a short rest after each intense interval, can also be beneficial in reducing the risk of pain.<sup>39</sup> Schachter et al.<sup>42</sup> compared the effectiveness of progressive low-intensity aerobics with a control group that did not receive any intervention. They found that pain intensity, the number of painful regions, and pain pressure threshold did not significantly change between groups. This could be attributed to the lack of supervision during the exercise program, as patients performed exercises independently at home. Therefore, it was not possible to verify the reported data on exercise duration and whether patients exercised at the targeted intensity.<sup>42</sup>

Despite the lack of agreement on the most effective form of exercise, authors assume that combined exercise with two to three moderate-intensity training sessions per week lasting 30-45 minutes, is most effective in reducing FM symptoms.<sup>33</sup> It is important to adjust the type, duration, frequency, and exercise intensity according to the individual's goals and abilities.

Our systematic review has several limitations. Firstly, it is difficult to determine clear clinical recommendations because of the high heterogeneity of the included studies in terms of the aerobic exercise type, duration of the program, differences in volume (number of repetitions, sets or exercises) and the intensity of aerobic exercise. Therefore, further studies are needed to limit the high variability of exercise programs. Secondly, most of the included studies did not directly investigate the effectiveness of aerobic exercise for pain management in FM patients, but instead compared the effectiveness of different intervention on both physical and psychological parameters. Additionally, in none of the included studies was the therapist or the subject blinded to group allocation. One of the limitations is also the lack of studies comparing the effectiveness of aerobic exercise with a control group that did not receive the intervention. Finally, the findings of most studies were based on short-term measurements and further studies are needed to clarify the long-term effectiveness of aerobic exercise for pain management in patients with FM. In conclusion, our systematic review indicate that aerobic exercise is effective for pain management in patients with FM. The results indicate that aerobic exercise programs are more effective for pain management in patients with FM compared to stretching exercises. However, the results showed no significant difference between aerobic exercise and pilates, muscle strength training, relaxation techniques or stress management treatment in terms of pain management in patients with FM. Due to the favorable effects on pain, aerobic exercise programs are

warranted to be included in daily clinical practice when treating patients with FM. However, high-quality studies with large numbers of participants and long-term follow-up are needed to clearly determine clinical guidelines for implementing aerobic exercise program for pain management in patients with FM.

### List of acronyms

CINAHL - cumulative index to nursing and allied health literature

FIQ Pain - fibromyalgia impact questionnaire pain scale

FM - Fibromyalgia

MPI - multidimensional pain inventory

MPQ - McGill pain questionnaire

PEDro - physiotherapy evidence database

PRISMA - preferred reporting items for systematic reviews and meta-analyses

SF-36 - short form-36 health survey

VAS - visual analogue scale

### Contributions of Authors

EIK: Substantial contributions to the conception and design of the work; EIK, DM: acquisition, analysis, or interpretation of data for the work, drafting the work and revising it critically for important intellectual content; EIK, DM: Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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### Conflict of Interest

The authors have no conflict of interest to declare.

### Ethical Publication Statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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*Supplementary Materials Table 1. Overview of the studies included in the systematic review.*

Authors	Population	Intervention	Outcome measures for pain	Findings
de Medeiros et al. <sup>11</sup>	N=42 F (48,1 ± 10,2y)	EG: Aquatic aerobic exercise (n=21); 12 weeks, twice a week, each session lasted 40 min  CG: Mat pilates (n=21); 12 weeks, twice a week; each session lasted 40 min	VAS; SF-36	There was a statistically significant reduction in pain in EG and CG (p < 0.05). The measurements showed no statistically significant differences between the groups (p > 0.05).
Sevimli et al. <sup>37</sup>	N=75 F (35 ± 8,8y)	EG: Group 1: Gymnastic-based aerobic exercise program (n=25); 3 months, twice a week, each session lasted 40-50 min  Group 2: Pool-based aquatic aerobic exercise program (n=25); 3 months, twice a week, each session lasted 40-50 min  CG: Home-based isometric strength and stretching exercise program (n=25); 3 months, once a day, each session lasted 15 min	VAS	There was a statistically significant reduction in pain in EG (p < 0.001) compared to CG (p > 0.05). No statistically significant difference was found between EG (p > 0.05).
Hooten et al. <sup>38</sup>	N=72 (65 F, 7 M) (46,6 ± 10,8y)	EG: Aerobic exercise – stationary bicycle (n=36); 3 weeks, 10 min daily during week 1; 15 min daily during week 2; 20-30 min daily during week 3  CG: Strengthening exercise (n=36); 3 weeks, once a day, each session lasted 25-30 min	MPI; Pain pressure threshold	There was a statistically significant reduction in pain and increase in pain pressure threshold in EG and CG (p < 0.01). There were no statistically significant differences between between the groups (p > 0.05).

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Mannerkorpi et al. <sup>39</sup>	N=67 F (49 ± 7,7y)	EG: Moderate-to-high intensity Nordic walking (n=34); 15 weeks, twice a week, each session lasted 40-45 min  CG: Low-intensity walking (n=33); 15 weeks, once a week, each session lasted 40-45 min	FIQ Pain	No statistically significant reduction in pain was found in EG and CG (p > 0.05).
Assis et al. <sup>40</sup>	N=52 F (40 ± 9,6y)	EG: Deep water running (n=26); 15 weeks, 3 times a week, each session lasted 60 min  CG: Land-based exercises (walking or jogging) (n=26); 15 weeks, 3 times a week, each session lasted 60 min	VAS	There was a statistically significant reduction in pain in EG and CG (p < 0.01). There were no statistically significant differences between the groups (p > 0.05).
Valim et al. <sup>41</sup>	N=60 F (45,5 ± 10,5y)	EG: Aerobic exercise – walking (n=32); 20 weeks, 3 times a week, each session lasted 45 min  CS: Stretching exercise (n=28); 20 weeks, 3 times a week, each session lasted 45 min	VAS; Number of tender points; Pain score during palpation of the tender point SF-36	The reduction of pain, number of tender points and pain during palpation of the tender point was statistically significant in EG (p < 0.05). There was a statistically significant difference between the groups (p < 0.05).
Schachter et al. <sup>42</sup>	N=143 F (41,9 ± 7,97y)	EG: Progressive low-impact aerobic program; 16 weeks, progressed from 3 to 5 times a week and 10 to 30 min Group 1: Long bouts of exercise – once daily (n=56) Group 2: Short bouts of exercise – twice daily (n=51)  CG: No exercise (n=36)	VAS; Pain distribution; Pain pressure threshold	There was no statistically significant reduction in pain, number of painful regions and increase in pain pressure threshold in EG (p > 0.05). In the CG, pain was statistically significantly reduced (p > 0.05). There were no statistically significant differences between EG and CG (p > 0.05).

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Richards and Scott <sup>43</sup>	N=136 (126 F, 10 M) (46,5y)	EG: Aerobic exercise – walking on a treadmill or stationary bicycle (n=69); 12 weeks, twice a week, each session lasted 60 min  CG: Relaxation techniques and stretching exercise (n=67); 12 weeks, twice a week, each session lasted 60 min	Number of tender points; MPQ	There was a statistically significant reduction in pain ( $p < 0.05$ ) and number of tender points ( $p < 0.001$ ) in the EG and CG at three months. The reduction in number of tender points persisted for 12 months ( $p < 0.001$ ), though by then the difference between the two groups was greater and favoured the exercise group ( $p < 0.05$ )
Wigers et al. <sup>44</sup>	N=60 (55 F, 5 M) (44y)	EG: Aerobic exercise (n=20); 14 weeks, 3 times a week, each session lasted 45 min  CG: Group 1: Stress management treatment (n=20); 6 weeks – 2 times a week, 8 weeks – once a week, each session lasted 90 min  Group 2: Treatment-as-usual (n=20); Aquatic therapy, psychomotor treatment, tricyclic antidepressants, analgesics, muscle relaxants, hypnotics, tranquilizers	VAS; Pain pressure threshold	In EG, there was a statistically significant reduction in pain ( $p < 0.05$ ), number of painful regions ( $0 < 0.01$ ) and increase in pain pressure threshold ( $p < 0.001$ ). Results also showed a statistically significant reduction in pain ( $p < 0.05$ ), number of painful regions ( $p < 0.05$ ) and increase in pain pressure threshold ( $p < 0.01$ ) in CG.

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Legend: CG = control group; EG = experimental group; F = female; FIQ = Fibromyalgia Impact Questionnaire; M = male; MPI = Multidimensional Pain Inventory; MPQ = McGill Pain Questionnaire; n = number of participants; SF-36 = Short Form-36 Health Survey; VAS = Visual analogue scale.

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