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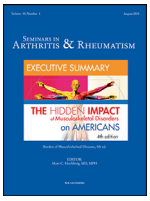

Review Article

What we already know about the effects of exercise in patients with fibromyalgia: An umbrella review

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ABSTRACT

We aimed to analyze the evidence on the effects of physical exercise in patients with fibromyalgia (FM) and to assess the characteristics of published studies, especially the quality of the evidence, through an umbrella review. This umbrella review followed the PRISMA guidelines and was documented in the PROSPERO registry (CRD42017075687). We searched the PubMed, Web of Science, SportDiscus, Scopus, Cinahl, and Cochrane Library databases. The methodological quality of systematic reviews was assessed using AMSTAR 2. We only selected systematic reviews (with or without meta-analyses) investigating the effects of any type of physical exercise in patients with FM syndrome. Thirty-seven systematic reviews (total = 477) fulfilled the criteria. Most studies were rated as being of low or moderate quality. A variety of exercises were used as treatment for FM symptoms, with positive results. Most of the reviews investigated the effects of aerobic exercise and strength training. No serious adverse events were reported. The largest effects of exercise were seen in terms of improved pain intensity and quality of life. Altogether, exercise may be an effective treatment for FM symptoms. Thus, aerobic exercise and strength training are effective programs for the treatment of FM. By summarizing the findings and effect sizes of the reviewed studies, we observed that the evidence for improvement of pain level and quality of life was the strongest. The results have potential to influence evidence-based practice. Future studies should analyze the long-term effects of exercise.

Introduction

Fibromyalgia (FM) syndrome is a complex disease whose pathophysiology is not completely clear, thus making it difficult to diagnose [1]. Currently, FM is characterized as a musculoskeletal disease, with the main characteristic being generalized pain in 4 of the 5 regions (quadrants and axial skeleton) for a period of >3 months. FM also involves the presence of associated psychological disorders [2] such as depression and anxiety, which directly affect the work performance, quality of life [3–5], and social and occupational functions of the affected individuals [6]. These psychological disorders are essential features for the diagnosis of FM [2].

Studies have investigated alternative methods that can help reduce the deleterious symptoms of FM, including cognitive-behavioral therapy, disease education, and physical exercise [7–9]. With respect to exercise, there is evidence indicating that walking, resistance training, and stretching have positive effects on the symptoms of FM [10–14]. Further, some studies have shown that resistance training can improve the muscle strength, pain intensity, sleep, and functional capacity of patients with FM [11,15,16]. Andrade et al. [17] showed that physical exercise can be a protective factor against depressive symptoms, and patients who exercise may be up to 3 times less likely to develop severe depression than physically inactive patients.

Considerable progress has been made in research that seeks to better understand the effect of exercise on patients with FM, considering that there is already a large number of systematic reviews and meta-analyses in this patient population [8,12,18,19]. Because of the already extensive number of published reviews on this topic, there is a need to synthesize the published results, in order to know the most often used and the most efficient exercises and also to establish the gaps in research and the future directions in the treatment of FM. Conclusions based on systematic reviews of randomized controlled trials (RCTs) are considered to be at the top of the evidence hierarchy [20]. Owing to the increasing number of systematic reviews, a new research perspective has emerged in the form of "review of reviews," the so-called umbrella reviews [21], which make it possible to synthesize the findings and guide the future of research on a particular topic.

There is already an umbrella review about exercise and FM, which was published in 2014 and focused on 4 outcomes related to pain,

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physical function, multidimensional function, and adverse effects [22]. However, as the popularity of systematic reviews has increased [23], there is a need for an updated umbrella review of systematic reviews assessing the effects of physical exercise in patients with FM syndrome. In addition, it is important to evaluate the exercise modality that presents the best results in reducing symptoms in terms of several variables.

To assimilate the vast amount of available research on FM and the practice of physical exercise, we performed an umbrella review of existing systematic reviews and meta-analyses, with the aims of (i) analyzing the evidence on the effects of physical exercise in patients with FM; (ii) analyzing the characteristics of the studies, especially the quality of the published evidence; and (iii) summarizing the findings to enable new strategies for the implementation of future policies.

Materials and methods

Registration and guidelines

We conducted an umbrella review (a systematic collection and assessment of systematic reviews and meta-analyses about a specific research topic) [24] of studies analyzing and summarizing the effects of physical exercise in patients with FM syndrome. The review was documented in the PROSPERO (International Prospective Register of Systematic Review) registry (registration no. CRD42017075687) and conducted in accordance with the recommendations of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines and the recommendations for umbrella reviews [21,25]. The PRISMA checklist is provided in Supplementary material.

Search strategy

To perform an expansive search of the worldwide scientific literature, we searched the PubMed, Web of Science, SportDiscus, Scopus, Cinahl, and Cochrane Library databases. The descriptors used for the search are listed in Table 1.

The Web of Science database was prioritized in decisions on duplicate articles, and such searches were carried out in the Web of Science Core Collection by using terms related to FM, exercise, and review, with no restriction with regard to the publication date. Online Supplementary Table S1 shows the search strategy used in the PubMed database.

Two reviewers (SMS and FHD) independently performed the search and assessed the eligibility of each article. Any discrepancies were resolved by a third researcher (AA). The final literature search was conducted in April 18, 2019. To avoid missing any study published after that date, the Email Alert feature of PubMed was used.

Table 1
Search strategy.

Search terms	Descriptors
1. Fibromyalgia	fibromyalgia OR "fibromyalgia-fibromyositis syndrome" OR "muscular rheumatism" OR fibrositis OR "fibromyositis-fibromyalgia syndrome"
2. Exercise	"exercise" OR "muscle stretching exercises" OR "resistance training" OR "exercise isometric" OR "exercise movement technique*" OR "exercise therap*" OR "isometric exercise*" OR "muscle stretching exercise*" OR "physical exercise*" OR "strength training" OR "strength training program*" OR "training resistance" OR "weight bearing exercise" OR "weight bearing strengthening program" OR "weight bearing" OR "weight lifting exercise" OR "weight lifting"
3. Review	"Systematic review" OR meta-analysis
Combination	#1 AND #2 AND #3

Manual search

A manual search of the reference lists of all selected studies was conducted to find additional relevant records. Four additional studies were identified from the manual search.

Eligibility criteria

We only selected systematic reviews (with or without meta-analyses) investigating the effects of any type of physical exercise in patients with FM syndrome, with the abstract and full text available online through April 18, 2019. The eligibility criteria for this umbrella review were based on the PICOS (Population, Intervention, Comparator, Outcome, Study design) statement (Table 2). We did not restrict the search with a start date.

Quality assessment

The methodological quality of each systematic review was assessed using AMSTAR (Assessing the Methodological Quality of Systematic Reviews) 2 [26], which is an update of the AMSTAR tool [27]. The quality assessment was performed by 2 authors (SMS and FHD) and verified by a third author (AA). On the basis of a pilot test with the AMSTAR tool and communication with the AMSTAR developer, the item descriptions were refined and operationalized. The revised instrument (AMSTAR 2) retains 10 of the original domains and has 16 items in total (compared with 11 in the original). The overall quality rating of the systematic reviews evaluated using AMSTAR 2 may be high, moderate, low, or critically low.

The 16 AMSTAR items dichotomously evaluate (yes/no) the appropriateness of the important components of the method: research, selection criteria, validity, and synthesis. Cases of discrepancies between the 2 reviewers were reevaluated, and a consensus decision was reached through a discussion.

Data extraction

Two authors independently extracted the data from all included studies (SMS and FHD). For the analysis and discussion of the results, the following data were extracted: year of publication, country of first author (location of the review), number of times cited (in Web of Science Core Collection), whether the review followed the PRISMA checklist (yes or no), number of databases searched, number of studies included in the review, whether a meta-analysis was performed (yes or no), sample characteristics (number, age, and sex of participants), type of physical exercise analyzed, exercise-related adverse events, outcomes, and conclusions. In addition, we investigated the degree to which the reviews included the same studies (overlap) and the pooled effect sizes (standardized mean difference, effect size, and heterogeneity) across the included studies. Because our objective is focused on the effects of physical exercise, the Discussion section was divided according to the type of physical exercise.

Statistical analysis

Data analysis was conducted using IBM Statistics Package for the Social Sciences (SPSS) for Windows version 20.0 (IBM, Armonk, NY, USA), for descriptive analysis (medians). Reliability analysis was performed using Kappa statistics in SPSS Statistics to determine the consistency between evaluators when using AMSTAR 2 in the quality assessment of the reviews.

Table 2
Eligibility criteria for inclusion of reviews.

		Inclusion Criteria	Exclusion Criteria
P	Participate	Patients with Fibromyalgia Syndrome	Healthy individuals, patients with other hematological disorders, mixed comparisons.
I	Intervention	Resistance exercise, aerobic exercise in ergometer, aquatic exercise, isometric exercise.	Massage, manual therapies, alternative therapies (hot baths, clay).
C	Comparison	Control group, Healthy individuals, rheumatic disease or not.	With individuals of different ages.
O	Outcome	Effects of physical exercise	–
S	Study	Systematic Review	Randomized Control Trial, Non-Randomized Clinical Trial, Cross-sectional, case reports, descriptive study review

Results

Literature search results

The literature search identified 477 relevant articles. Of these, 40 full papers were assessed for eligibility and 37 reviews were selected for synthesis (see Fig. 1 for the PRISMA flowchart). Full references of included studies are provided in Supplementary material.

Overview of the research

Busch et al. published both an initial systematic review in 2001 [28] and a systematic review with meta-analysis in 2002 [29].

The systematic reviews were published mainly in 2017 (6 reviews). The studied population in systematic reviews was predominantly female adults. The number of participants ranged from 107 to 3035, with age ranging from 12.9 to 73 years.

On the basis of the institutional affiliation of the first author, we determined the location of the reviews. We observed that of the 37 reviews, there were 9 from Canada, 8 from Brazil, 7 from Spain, 5 from the United States, and 3 from Germany. Australia, Chile, Colombia, France, and Ireland contributed 1 study each. The number of databases searched in the reviews varied between 1 and 12 (median, 6). The number of included studies ranged from 3 to 46. In studies that performed a meta-analysis, the minimum number of studies included in quantitative synthesis was 2 [30]. The studies were cited 0–178 times in the Web of Science database.

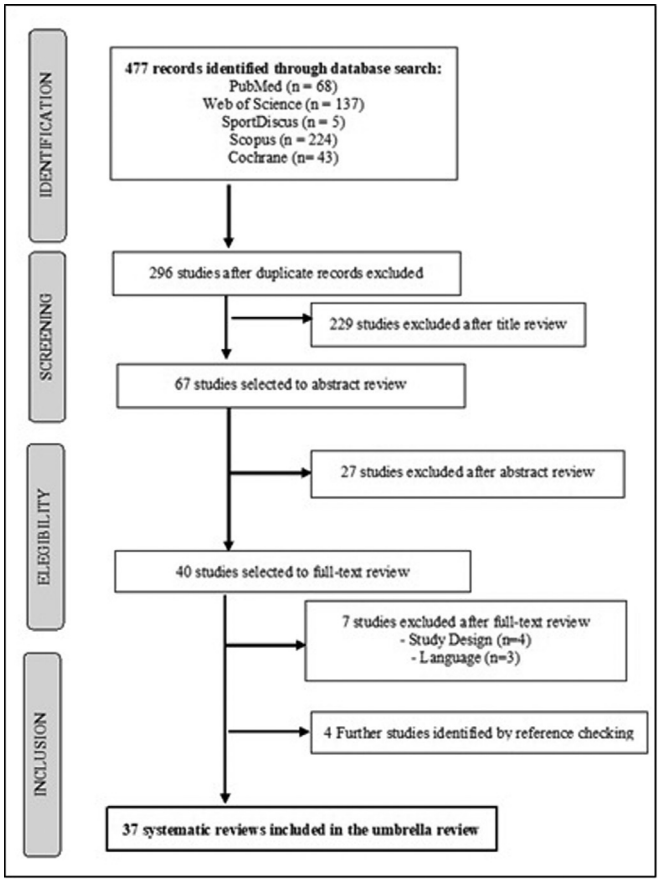

Fig. 1. PRISMA Flow diagram illustrating literature research and selection process.

The most cited study among the included reviews was that of Busch et al. published in 2008, with 178 citations in Web of Science. This study aimed to evaluate the effects of exercise training (multiple exercises) on several variables in individuals with FM.

Of the 37 included reviews, we observed that 22 were systematic reviews with meta-analysis. The most analyzed variables were pain and quality of life. In addition, fatigue, stiffness, depression, anxiety, sleep, well-being, physical function, autonomic dysfunction, and aspects of physical fitness (strength, flexibility, aerobic capacity, and balance) were also investigated in the population with FM.

We found a variety of exercises used as treatment for FM symptoms, with positive results. A total of 21 reviews (involving 161 studies) investigated the effects of aerobic exercise on patients with FM. Fourteen reviews (55 studies) investigated the effects of strength training. Eleven reviews (53 studies) investigated combined exercise (e.g., resistance and aerobic exercise). Eleven reviews (49 studies) investigated movement therapies (qigong, tai chi, and yoga). Nine reviews (49 studies) investigated the effects of aquatic exercise. Eight reviews (19 studies) investigated stretching exercises. Seven reviews (48 studies) investigated exercises performed in water (training in pool, hydrotherapy, hydrokinesiotherapy, or aquatic therapy). It is noteworthy that in this analysis, the same studies may have been included in the systematic reviews (i.e., overlapping studies).

Most reviews (64.8%) did not investigate adverse effects. Of the reviews that investigated adverse events, some still mentioned that the studies either did not report or poorly reported the adverse events [11,31]. Meanwhile, 35.1% of the systematic reviews reported the incidence of exercise-related adverse events. The most commonly reported exercise-related adverse event was muscle pain; however, in general, no serious adverse events were reported.

With respect to the quality of the included systematic reviews, 3 studies were classified as having high quality in the AMSTAR rating scale, 13 as having moderate quality, 17 as having low quality, and 4 as having critically low quality (see Online Supplementary Table S2). We noted that 27 of the 37 reviews (75%) reported any potential conflicts of interest or any funding source. The itemized analysis showed perfect agreements in questions 1, 3, 7, 10, and 11. The agreement among observers for all items was 86.5%. Of the 37 included reviews, 15 were conducted in accordance with the PRISMA statement (only from 2013 to 2019).

We observed that 7 of the studies selected overlapped with the previous umbrella review by Bidonde et al. [22], with 2 classified as having low quality; 4, moderate quality; and 1, high quality. The 30 studies we selected were different from those in the study by Bidonde et al. [22], of which 16 were published after 2014, after the work of Bidonde et al. [22], and showed low-quality evidence in most cases [11].

Table 3 shows the objective of the research, type of physical exercises, whether the PRISMA guidelines were followed, number of

Table 3
Objective the research, type of physical exercises, number of times cited, number of databases searched, number of studies included in the review, whether a meta-analysis was performed, outcomes, number/age/sex of participants and the conclusions of the included systematic reviews.

ID	Review	Objective	Exercises	PRISMA	Times cited (WoS)	Data bases searched	Studies included	Meta-analysis	Outcomes	N. of participants (sex)	Age of participants	Conclusions
1	Andrade et al. (2019)	To verify the effects of physical exercise on autonomic dysfunction in patients with fibromyalgia syndrome.	Multiple exercises	Y	0	5	12	N	Heart rate variability, and Autonomic dysfunction	393 (female)	Range of 37 to 58 years	Aerobic exercise reduces autonomic dysfunction in patients with FM, whereas resistance training reduces psychological symptoms such as anxiety and depression.
2	Bulhões et al. (2018)	To investigate the effects of resistance training in pain reduction of women with FM.	Resistance Exercise	Y	0	4	5	N	Pain	311 (female)	Range of 44.3 to 52.1	The results allow to suggest that resistance training presents satisfactory results in the reduction of the pain of women with FM, from the 8th week of training. The intervention be carried out with a minimum of 30 min, often 2 to 3 times a week, ranging from 2 to 3 sets of 8 to 12 repetitions.
3	Andrade et al. (2018)	To analyze the effects of ST in the treatment of FM through a systematic review of experimental research.	Resistance Exercise	Y	2	5	22	N	Fibromyalgia symptoms, HRQL, pain, and physical aspects	NR	Range of 18 to 65 years	Evidence demonstrates that ST is beneficial and can be used to treat FM.
4	Andrade et al. (2017)	To examine the treble of the exercise on an inflammatory response in patients with FM.	Multiple exercises	Y	0	7	6	N	Biomarkers	112 (female)	Range of mean ages 38.9 to 54 years	It is suggested that patients with FM probably have a low degree of inflammation, and in the studies found higher concentrations of IL-8 and TNF-α and high IL-10 expression were reported in these patients; However, the effects of exercise on inflammatory markers in these patients are unclear.
5	Murillo-Garcia et al. (2018)	To perform a systematic review on the effectiveness of dance-based programs in patients with FM.	Dance	Y	0	3	7*	Y	Pain and HRQL	335	Range of mean ages 51.4 to 57years	Dance-based intervention programs can be an effective intervention for people suffering from fibromyalgia, leading to a significant reduction of the level of pain with an effect size that can be considered as large.
6	Moretti et al. (2017)	To determine the quality of evidence on the use of WBV in controlling pain, fatigue and quality of life in women with FM.	Whole Body Vibration (WBV)	Y	1	5	3*	Y	Pain, fatigue, and HRQL	107	Range of 50 to 60 years	The results, based on very low quality of evidence, were inconclusive regarding pain, and showed no clinically important effects on the control of fatigue and improvement of HRQL.
7	Sosa-Reina et al. (2017)	To summarize the evidence on the efficacy of therapeutic exercise in FM.	Multiple exercises	Y	3	3	15/14*	Y	HRQL, pain, depression, and well being	715 (700 female)	Mean age 42.36 years	Aerobic and muscle strengthening exercises are the most effective way to reduce pain and improve overall well-being in people with fibromyalgia and that stretching and aerobic exercises increase health quality of life. In addition, combined exercise produces the greatest beneficial effect on the symptoms of depression
8	Bidonde et al. (2017b)	To evaluate benefits and harms of WBV exercise training in adults with FM.	Whole Body Vibration (WBV)	N	0	11	4*	Y	HRQL, pain, fatigue, Stiffness, physical function, adverse events, and all-cause withdrawals	150 (female)	57 years (Range of mean ages 52 to 62)	The quality of evidence is very low owing to imprecision, so the effects are still uncertain. These trials did not measure major outcomes such as pain intensity, stiffness, fatigue, and physical function.

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Table 3 (*Continued*)

ID	Review	Objective	Exercises	PRISMA	Times cited (WoS)	Data bases searched	Studies included	Meta-analysis	Outcomes	N. of participants (sex)	Age of participants	Conclusions
9	Sanz-Baños et al. (2017)	To examine adherence to interventions that include walking for FM and to explore its moderators among the characteristics of patients, of the walking prescription and of the interventions.	Walking Exercise	Y	0	6	22*	Y	Characteristics of prescription and of interventions, and adherence to the program	983	Range of mean ages 45 to 60.60	Adherence rates (attendance at sessions) to programs with walking were high. However, a lack of information precludes knowledge of whether participants sustained walking between sessions or after the treatment
10	Bidonde et al. (2017a)	To evaluate the benefits and harms of aerobic exercise training for adults with FM.	Aerobic Exercise	N	8	8	13*	Y	HRQL, pain, fatigue, stiffness, physical function, adverse events, and all-cause withdrawals	839 (89.39% female)	41 years (range of mean 32 to 56)	Moderate-quality evidence indicates that aerobic exercise probably improves HRQL and all-cause withdrawal, and low-quality evidence suggests that may slightly decrease pain intensity, may slightly improve physical function, and may lead to little difference in fatigue and stiffness. Three of the reported outcomes reached clinical significance (HRQL,physical function, and pain). Long-term effects of aerobic exercise may include little or no difference in pain, physical function, and all-cause withdrawal, and we are uncertain about long-term effects on remaining outcomes.
11	McDowell, Cook and Herring (2017)	To evaluate the effects of exercise training on anxiety symptoms in patients with FM, and to examine whether variables of theoretical or practical importance moderate the estimated mean effect.	Multiple exercises	Y	1	5	10*	Y	Anxiety	595 (97.5% female)	47.5 years (mean age)	The results suggests that exercise training improves anxiety symptoms among FM patients and also suggest that larger anxiety symptom reductions will be achieve effects sizes by focusing on longer exercise programs while promoting long term adherence.
12	Cardona-Arias, Mantilla-Gutiérrez and Higuita-Gutiérrez (2016)	To evaluate the efficacy of physical activity in improving the quality of life of people with FM.	Multiple exercises	Y	0	4	10*	Y	FIQ and MOSSF-36	441 (females)	Range of mean 42 to 52 years	The major efficacy of regular physical exercise is evident, compared with conventional treatment, to improve the quality of life of patients with fibromyalgia.
13	Cerrillo-Urbina et al. (2015)	To summarize evidence regarding the effect of physical exercise programs on FM symptoms in peri-menopausal age women, and the characteristics of these programs.	Multiple exercises	N	0	6	12*	Y	Symptoms of FM	1077 (females)	51.53 years (Range of mean 45 to 60)	The meta-analysis indicates that programs based on combined exercise and aquatic exercises have, respectively, a moderate and small effect on functional global well-being. Short-term interventions [12 weeks], including two to three sessions lasting 30–60 min each per week seem to improve symptoms in peri-menopausal age women with FM.
14	García-Hermoso, Saavedra and Escalante (2015)	To summarize evidence for the effectiveness and structure of exercise programs on functional aerobic capacity in patients with FM.	Multiple exercises	N	8	7	10*	Y	Funcional aerobic capacity	859	NR	Aerobic and aquatic exercises at the proper intensity favor the increased functional aerobic capacity of FM patients; however, most works do not adequately detail the intensity of the exercises.

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Table 3 (*Continued*)

ID	Review	Objective	Exercises	PRISMA	Times cited (WoS)	Data bases searched	Studies included	Meta-analysis	Outcomes	N. of participants (sex)	Age of participants	Conclusions
15	Lorena et al. (2015)	To systematize scientific evidences about the use of muscle stretching exercises in the treatment of FM	Stretching Exercises	N	0	5	4	N	Pain, HRQL (FIQ and SF-36), flexibility, and muscular strength	144 (95.83% female)	Range of mean 42 to 48 years	The results are not clear due to the low methodological quality and the number of articles on the subject. But there is a clear trend in benefits of stretching practice in patients with FM.
16	Collado-Mateo et al. (2015)	To review the literature on the effects of whole-body vibration therapy in patients with fibromyalgia.	Whole Body Vibration (WBV)	Y	5	4	8*	Y	Balance, fatigue, disability index, HRQL, and pain.	263	Range of mean 41 to 59	The WBV could be an adequate treatment for FM as a main therapy or added to a physical exercise program as it could improve balance, disability index, HRQL, fatigue, and pain. However, this conclusion must be treated with caution because the paucity of trials and the marked differences between existing trials in terms of protocol, intervention, and measurement tools hampered the comparison of the trials.
17	Bidonde et al. (2014)	To evaluate the benefits and harms of aquatic exercise training in adults with FM.	Aquatic Exercise	N	37	8	16*	Y	Multidimensional function, Patient-rated global, Clinician-rated global, Self-reported physical function, Self-efficacy, Mental health, Pain, Fatigue, Sleep disturbances, Stiffness, Tenderness, depression, dyscognition, physical fitness, safety, and acceptability	519 (98.84% female)	Range of mean 46.3 to 48.3	Low to moderate quality evidence relative to control suggests that aquatic training is beneficial for improving wellness, symptoms, and fitness in adults with fibromyalgia. Very low t low quality evidence suggests that there are benefits of aquatic and land-based exercise, except in muscle strength (very low quality evidence favoring land).
18	Cadenas-Sánchez Ruiz-Ruiz (2014)	To determine what type of physical activity programmes have been developed in patients with FM and what are its effects and benefits on the degree of pain and quality of life.	Multiple Exercises	N	0	3	33	N	Pain, HRQL	1356	Range of mean 18 to 69.5	A multidisciplinary program (in which physical activity is included) may have positive effects on the quality of life of people with fibromyalgia.
19	Latorre-Santiago and Torres-Lacomba (2014)	To determine which exercise is the best to reduce the symptomatology of fibromyalgia.	Multiple Exercises	N	2	5	32	N	Symptoms of FM	NR	NR	Exercise is effective for reducing symptomatology of FM. Aquatic and combined exercise, and alternative activities seem to be more accurate in the treatment of tender points, depression, and they have higher levels of adherence. Relating to the rest of the symptoms, every other type of exercise has similar results.
20	Steffens et al. (2013)	To verify through systematic literature review the effects of exercise on sleep in patients with FM.	Multiple Exercises	Y	0	4	9	N	Sleep	443	NR	The physical exercises analyzed in the study improved the quality of sleep in patients with FM.

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Table 3 (*Continued*)

ID	Review	Objective	Exercises	PRISMA	Times cited (WoS)	Data bases searched	Studies included	Meta-analysis	Outcomes	N. of participants (sex)	Age of participants	Conclusions
21	Langhorst et al. (2013)	To assess the efficacy and safety of the movement therapies on the key symptoms of FM compared with controls.	Movement Therapies (Qigong, Tai chi and Yoga)	Y	56	5	7*	Y	Pain, HRQL, sleep, fatigue, and depression	455	Range of mean 50 to 53.7	Evidence of a short-term relief of four key domains of FMS by Yoga and of one key domain by Tai Chi. No evidence of the efficacy of Qi Gong was found. However, the acceptance and safety of all types of movement therapies were high compared to pharmacological therapies
22	Busch et al. (2013)	To evaluate the benefits and harms of resistance exercise training in adults with FM.	Resistance Exercise	N	49	9	7*	Y	Overall well-being, physical function, pain, fatigue, sleep disturbance, stiffness, tenderness, depression, anxiety, dyscognition, safety, and acceptance	241 (90.87% female)	NR	The evidence (rated as low quality) suggested that moderate and moderate to high-intensity resistance training improves multidimensional function, pain, tenderness, and muscle strength in women with FM. The evidence (rated as low quality) also suggested that eight weeks of aerobic exercise was superior to moderate-intensity resistance training for improving pain in women with FM. There was low-quality evidence that 12 weeks of low-intensity resistance training was superior to flexibility exercise training in women with FM for improvements in pain and multidimensional function and that women with FM can safely perform moderate to high resistance training.
23	Lima et al. (2013)	To assess the effectiveness of aquatic physical therapy in the treatment of fibromyalgia.	Aquatic Therapy	Y	11	12	27/15*	Y	Pain, number of tender points, HRQL, fatigue, sleep disturbances, morning stiffness, depression, anxiety, physical function, and rate of perceived exertion	1265 (most females)	Range of mean 39.4 to 51.9	Three meta-analyses showed statistically significant results in favors of the aquatic physical therapy (Fibromyalgia Impact Questionnaire, stiffness and the 6-minute walk test) during a period of longer than 20 weeks. Due to the low methodological rigor, the results were insufficient to demonstrate statistical and clinical differences in most of the outcomes.
24	Lauche et al. (2013)	To assess short-and long-term efficacy and safety of Qigong in patients with FM compared to control interventions.	Qigong	Y	7	4	7*	Y	Pain, HRQL, sleep, fatigue, depression, and patient's safety	395 (89.11% female, 0.75% not reported)	Range of mean 12.9 to 57.9	Further high quality of RCT's are required for the conclusive judgment of its long-term effects.
25	Mist, Firestone and Jones (2013)	To estimating the effect size of the different modalities, study quality and bias, and adverse events.	Movement Therapies (Qigong, Tai chi and Yoga)	N	40	5	16*	Y	Pain, HRQL, and physical function	832	Range of mean 47.7 to 54	The level of research has been moderately weak to date, but most studies report a medium-to-high effect size in pain reduction. Given the lack of adverse events, there is little risk in recommending these modalities as a critical component in a multimodal treatment plan, which is often required for fibromyalgia management.

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ID	Review	Objective	Exercises	PRISMA	Times cited (WoS)	Data bases searched	Studies included	Meta-analysis	Outcomes	N. of participants (sex)	Age of participants	Conclusions
26	Kelley, Kelley and Jones (2011)	To use the meta-analytic approach to determine the efficacy and effectiveness of randomized controlled exercise intervention trials (aerobic, strength training, or both) on tender points (TPs) in adults with FM.	Aerobic and Resistance Exercises (or both)	N	0	6	9*	Y	Pain (tender points)	481 (98% female)	Range of mean 39 to 60	Exercise is efficacious for reducing TPs in women with FM. However, a need exists for additional well-designed and reported studies on this topic.
27	Thomas and Blotman (2010)	To determine the current evidence to support guidelines for aerobic exercise (AE) and FM in practice, and to outline specific research needs in these areas.	Aerobic Exercises	N	0	1	19	N	Pain (tender points), symptoms of FM, HRQL, physical function, depression, fatigue, and sleep	1392	NR	Data synthesis shows that there is moderate evidence of important benefit of aerobic-only exercise in FM on physical function and possibly on tender points and pain. It appears to be suficient evidence to support the practice of AE as a part of the multidisciplinary management of FM. However, future studies must be more adequately sized, homogeneously assessed, and monitored for adherence, to draw definitive conclusions.
28	Hauser et al. (2010)	To assess whether ongoing exercise is necessary to maintain potential positive effects of AE.	Aerobic Exercises	N	0	5	28*	Y	Pain, sleep, fatigue, depressed mood, HRQL, and physical fitness.	2494	45 years (Range of mean 13 to 59)	An aerobic exercise program for FM patients should consist of land-based or water-based exercises with slight to moderate intensity two or three times per week for at least 4 weeks.
29	Kelley et al. (2010)	To examine the effects of exercise on global well-being as assessed by the FIQ in community-dwelling adults with FM.	Aerobic and Resistance Exercise (or both)	N	36	6	7*	Y	Global well-being, and total FIQ score.	473 (99% female)	Range from 18 to 73 years	The results of this study suggest that exercise improves global well-being in community-dwelling women with fibromyalgia. However, additional research on this topic is needed, including research in men as well as optimal exercise programs for improving global well-being in adults.
30	Ramel et al. (2009)	To systematically review the efficacy of exercise interventions on pain relief in patients with FM.	Multiple Exercises	N	0	8	10*	Y	Pain	767 (98% female)	47 years	Physical exercise may have positive effects on pain reduction in patients with FM. Long-term, rigorous and well-controlled randomized trials are warranted
31	Perraton, Machotka and Kumar (2009)	To summarize the components of hydrotherapy programs used in RCT's	Hydrotherapy programs	N	0	11	11	N	Pain or tenderness, HRQL, and function.	NR	NR	Aerobic exercise, warm up and cool-down periods and relaxation exercises are common features of hydrotherapy programs that report significant FM-related outcomes. Treatment duration of 60 min, frequency of three sessions per week and an intensity equivalent to 60%–80% maximum heart rate were the most commonly reported exercise components. Exercise appears to be the most important component of an effective hydrotherapy program for FM, particularly when considering mental health-related outcomes

(*continued on next page*)

Table 3 (*Continued*)

ID	Review	Objective	Exercises	PRISMA	Times cited (WoS)	Data bases searched	Studies included	Meta-analysis	Outcomes	N. of participants (sex)	Age of participants	Conclusions
32	Brosseau et al.(2008a)	To create guidelines for the use of resistance exercises in the management of adult patients with FM	Resistance Exercise	N	60	6	5	N	Psychosocial measures and physical measures	NR	NR	The Ottawa Panel recommends strengthening exercises for the management of fibromyalgia as a result of the emerging evidence (grades A, B, and C+, although most trials were rated low quality) shown in the literature.
33	Brosseau et al.(2008b)	To create guidelines for the use of aerobic fitness exercises in the management of adult patients with FM.	Aerobic Exercises	N	88	6	16	N	Psychosocial measures and physical measures	NR	NR	The Ottawa Panel recommends aerobic fitness exercises for the management of fibromyalgia as a result of the emerging evidence (grades A, B, and C+, although most trials were rated low quality) shown in the literature.
34	Busch et al. (2008)	To evaluated the effects of exercise training on global well-being, selected signs and symptoms, and physical function in individuals with FM.	Multiple Exercises	N	178	7	34*	Y	Pain, global well-being, physical function, tender points, depression, fatigue, and sleep.	2276	Range of mean 27.5 to 60.2	Aerobic-only training has beneficial effects on physical function and some FM symptoms. Strength-only training may improve FM symptoms, but requires further study. Large, high quality studies of exercise-only interventions that provide detailed information on exercise prescription and adherence are needed.
35	Jones et al. (2006) [33]	To: (1) locate all exercise treatment studies of FM patients from 1988 through 2005, (2) present in tabular format the key details of each study and (3) to provide a summary and evaluation of each study for exercise and health outcomes researchers.	Multiple Exercises	N	0	10	46	N	FM symptoms, health status measure, and fitness markers (strength, flexibility, aerobic capacity)	3035 (2888 FM patients, 79% female)	49.5 years (Range from 18 to 60)	Increased health and fitness, along with symptom reduction, can be expected with exercise that is of appropriate intensity, self-modified, and symptom-limited. Exercise and health outcomes researchers are encouraged to use the extant literature to develop effective health enhancing programs for people with FM and to target research to as yet understudied FM subpopulations,
36	Busch et al. (2002)	To examine the efficacy of exercise training as a treatment for FM.	Multiple Exercises	N	116	6	16	N	Pain, tender points, physical function, global well-being, self-efficacy, fatigue, sleep, and psychological function.	NR	NR	Supervised aerobic exercise training has beneficial effects on physical capacity and FM symptoms. Strength training may also have benefits on some FM symptoms. Further studies on muscle strengthening and flexibility are needed. Research on the long-term benefit of exercise for FM is needed
37	Busch et al. (2001)	To evaluates the effects of exercise training for individuals with FM	Multiple Exercises	N	0	7	14	N	Pain, tender points, physical function, global well-being, self-efficacy, fatigue, sleep, and psychological function	NR	Range of mean 35.5 to 50.8 years	There is moderate benefit in FM from training. Details about dosage for muscle strengthening or flexibility training were insufficient to evaluate the adequacy of the training stimulus. Further research is needed to describe the long-term effects of all types of exercise training and to examine strengthening and flexibility training in FM.

Legend: N, number; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-analyses; Y, yes; N, no; *, studies included in meta-analysis; NR, not reported; HRQQL, health-related quality of life; FIQ, Fibromyalgia Impact Questionnaire.

times cited, number of databases searched, number of studies included in the review, whether a meta-analysis was performed, outcomes, number/age/sex of participants, and the conclusions of the systematic reviews included in the umbrella review.

Summary effect size

Through the analysis of pooled effect sizes across the included studies, it was observed that improvements in pain intensity and quality of life represent the largest effects of exercise in patients with FM.

In the assessment of pain effects between the different studies and exercises, the effect sizes ranged from small to perfect, with a high heterogeneity between them (Table 4). With respect to quality of life, although many studies found a positive effect of exercise on this variable, most of the studies found a small effect, whereas some studies found a moderate, great, or perfect effect. Similar to the pain variable, the heterogeneity found in studies that investigated quality of life was also high in most reviews.

With respect to the effects on depression, the studies found a positive but small effect. In terms of sleep, only 5 reviews analyzed the effects of exercise on this variable, with 2 studies finding a significant and moderate effect (aquatic exercise and qiong).

Eight reviews analyzed the effects of exercise on the patients' fatigue level, with half of them finding significant effects with small (aerobic exercise), moderate (movement therapies and qiong), and perfect (resistance training) effect sizes.

Concerning the physical variables, several isolated parameters were analyzed. Most of the studies found a significant effect, with moderate and perfect effect sizes being predominant. In these analyses, most of the studies had a low heterogeneity (<50%).

Only 2 studies focused on the effect of physical exercise on anxiety, and found significant results with small effect sizes. The effects on the mental component, mental health, self-efficacy, and dyscognition were also analyzed separately. A significant effect was found on the mental component and dyscognition, with a small and perfect effect size, respectively.

Overlapping

The most recent reviews did not present a high number of overlapping studies, with the exception of 2 reviews that evaluated the effects of whole-body vibration (6 studies in common between them) and some other reviews with 4 or 5 common studies. Most of the overlapping occurred in the oldest reviews, including those with up to 22 [34,35], 18 [28,35], 16 [34,36], 14 [27,34], 12 [28,38], and 12 [27,35], overlapping studies. Only 1 review had no overlapping studies [13]. Online Supplementary Table S3 shows the number of overlapping studies among the reviews.

Discussion

This umbrella review identified 37 articles reporting a total of 531 studies (without overlapping analysis) investigating the effects of exercise on the symptoms of patients with FM.

There is growing evidence from systematic reviews on this subject. In an umbrella review in 2014 that focused on 4 outcomes, Bidonde et al. [22] found only 9 systematic reviews, of which 7 were included in our review. Only 5 years later, we found 37 systematic reviews, of which 30 were different from those included in the study by Bidonde et al. [23] and 16 were published after 2014. As noted by Bidonde et al. [23], the number of reviews is proliferating, but the quality of the publications was not observed. With the large number of meta-analyses published on the topic of exercise in patients with FM over the last 10 years (31 studies in 2009–2019), there is a growing need for researchers to analyze the findings of each separate meta-analysis and to determine whether the reported evidence is consistent or contradictory. Corroborating the finding of Bidonde et al. [23], we observed that the incidence of exercise-related adverse events in the studies was low, with no serious adverse events reported. This result confirms that the benefits of exercise in treating symptoms of FM far outweigh any potential harm.

We verified that the studies with more citations in Web of Science were those from the research group of Busch et al. [18,29,35,37,38]. These studies also had better methodological quality, as measured using the AMSTAR tool (moderate to high quality), with the exception of 1 review [35]. The studies of Mist et al. [39] and Langhorst et al. [40] also presented a high number of citations and showed moderate quality. Therefore, we believe that the quality of a study is associated with a high number of citations in the years after its publication. According to other studies, besides being associated with quality, citation counts are also correlated with the citation performance of the cited references, the language of the publishing journal, the chemical subfield, and the reputation of the authors [41–43].

Our findings confirm that there are consistent evidences showing that physical exercise improves the pain intensity, quality of life, and physical and psychological functions of patients with FM. With respect to pain and quality of life (the most studied variables), several studies reported positive effects of physical exercise [9,18,19,36,44,45]. According Sosa-Reina et al. [45], muscle strengthening and aerobic exercises are the most effective way to reduce pain and improve overall well-being in patients with FM, and that stretching and aerobic exercises increase health and quality of life. Cardona-Arias et al. [46] found a positive effect of resistance training on the patients' quality of life; however, their review included mostly studies conducted in Spain and Brazil, which is directly related to the search strategy and databases used (mostly Latin American databases), and this bias may have influenced the results. For the analysis and discussion of the findings, we organized the results below according to the main modalities of physical exercises analyzed in the reviews. Similar to Kelley et al. [47] we observed that aerobic exercise and strength training are the most often used non-pharmacological (physical exercise) modalities in the treatment of FM symptoms.

Aerobic exercise

The effects of aerobic exercise have been investigated for a longer time than those of other modalities. Thus, aerobic exercise was the modality with the largest number of studies and was the topic of studies with the highest methodological quality.

Bidonde et al. [9] published an update of 2 studies from the same research group [29,48]. In this updated review, the focus was aerobic exercise. The authors compared their results with those of other previous reviews analyzing the effects of aerobic exercise [10,34,37], and these were also included in the present umbrella review.

Bidonde et al. [9] compared an aerobic intervention with other interventions, and found evidence of low to very low quality for the benefits in quality of life, pain intensity, fatigue, stiffness, and physical function. The low quality of evidence was due to the risk of bias. Moreover, when comparisons with a control group were made, the authors classified the evidence on quality of life as moderate quality, indicating that aerobic exercise probably improves quality of life. Concerning the other variables, the evidences were classified as low quality. Thus, the authors suggested that aerobic exercise may slightly decrease the intensity of pain, may improve function, and may lead to little difference in fatigue and stiffness.

With respect to the level of evidence of the reviews on aerobic exercises, Brosseau et al. [37] reported that there were 24 positive recommendations (10 A, 1 B, and 13 C+), but only 5 had clinical benefits. They noted that most of the studies were classified as low quality.

Table 4
Analysis of pooled effect sizes across the included studies (at the end of interventions).

Author (date)	N	Exercise	Outcome	SMD (95% CI)	Effect size	I^2
Murillo-Garcia et al. (2018)	598	Dance	Pain	- 1.64 (−2.69 to −0.59)	Large	92%
Sosa-Reina et al. (2017)	782	Multiple Exercises		−1.11 (−1.52 to −0.71)	Moderate	85%
Bidonde et al. (2017b)	41	Whole Body Vibration		1.43 (0.27 to 7.67)	Large	0
Bidonde et al. (2017a)	351	Aerobic Exercise		−11.06 (−18.34 to - 3.77)	Perfect	59%
Bidonde et al. (2014)	382	Aquatic Exercises		−6.59 (−10.71 to −2.48)	Perfect	64%
Busch et al. (2013)	81	Resistance Exercises		−3.30 (−6.35 to −0.26)	Very Large	93%
Langhorst et al. (2013)	327	Movement Therapies		−0.35 (−0.80 to 0.11)	–	75%
Lauche et al. (2013)	166	Qiong		−0.69 (−1.25 to −0.12)	Moderate	63%
	120			−0.22 (−1.04 to 0.6)	–	76%
Kelley, Kelley and Jones (2011)	452	Multiple Exercises		−0.68 (−1.16 to −0.20)	Moderate	75%
Hauser et al. (2010)	567	Aerobic Exercise		−0.31 (−0.46 to.−0.17)	Small	26%
Ramel et al. (2009)	513	Multiple Exercises		.45 (0.09 to 0.80)	Small	72%
Mist, Firestone and Jones (2013)	NR	Qiong	Pain OR FIQ	.47 (0.25 to 0.69)	Small	NR
	NR	Tai Chi		1.13 (0.88 to 1.39)	Moderate	NR
	NR	Yoga		.44 (0.13 to 0.75)	Small	NR
	NR	Other CAM		1.94 (1.57 to 2.31)	Large	NR
Sosa-Reina et al. (2017)	268	Multiple Exercises	Quality of Life	−0.67 (−0.89 to −0.45)	Moderate	64%
Moretti et al. (2017)	67	Whole Body Vibration		.49 (<0.01 to 0.98)	–	0
Bidonde et al. (2017b)	49	Whole Body Vibration		−6.67 (−14.65 to 1.31)	–	0
Bidonde et al. (2017a)	372	Aerobic Exercise		−7.89 (−13.23 to −2.55)	Perfect	58%
Cerrillo-Urbina et al. (2015)	NR	Aerobic Exercise		−0.10 (−0.43 to 0.24)	–	0
	NR	Combined Exercise		−0.63 (−0.99 to −0.27)	Moderate	0
	NR	Alternative		NR	NR	65%
	NR	Aquatic Exercises		−0.41 (−0.68 to −0.14)	Small	30%
Langhorst et al. (2013)	328	Movement Therapies		−0.59 (−0.93 to 0.24)	Small	56%
Lima et al. (2013)	118	Aquatic Exercises		−1.35 (−2.04 to −0.67)	Large	47%
Lauche et al. (2013)	111	Qiong		−0.54 (−1.78 to 0.70)	–	85%
	131			−0.23 (−1.06 to 0.60)	–	77%
Hauser et al. (2010)	526	Aerobic Exercise		−0.40 (−0.60 to −0.20)	Small	63%
Kelley et al. (2010)	329	Multiple Exercise		−0.39 (−0.69 to 0.08)	Small	33.8%
Sosa-Reina et al. (2017)	641	Multiple Exercise	Depression	−0.40 (−0.55 to −0.24)	Small	0
Bidonde et al. (2014)	95	Aquatic Exercises		−0.45 (−0.82 to −0.08)	Small	65%
Busch et al. (2013)	60	Resistance Exercises		−3.70 (−6.37 to −1.03)		NA
Langhorst et al. (2013)	306	Movement Therapies		−0.49 (−0.76 to −0.22)	Small	27%
Lauche et al. (2013)	118	Qiong		−0.40 (−1.07 to 0.27)	–	66%
	56			−0.54 (−1.07 to 0)	–	NA
Hauser et al. (2010)	456	Aerobic Exercise		−0.32 (−0.53 to −0.12)	Small	51%
Bidonde et al. (2014)	104	Aquatic Exercises	Sleep	−0.63 (−1.12 to −0.14)	Moderate	32%
Busch et al. (2013)	21	Resistance Exercises		−7.0 (−20.79 to 6.79)	–	NA
Lauche et al. (2013)	145	Qiong		−0.67 (−1.01 to −0.34)	Moderate	0%
	42			−0.03 (−1.64 to 1.58)	–	81%
Hauser et al. (2010)	184	Aerobic Exercises		.01 (−0.19 to 0.21)	–	0
Bidonde et al. (2017b)	23	Whole Body Vibration	Fatigue	−14.41 (−29.47 to 0.65)	–	NA
Bidonde et al. (2017a)	286	Aerobic Exercise		−6.06 (−12.41 to 0.30)	–	33%
Bidonde et al. (2014)	329	Aquatic Exercise		−0.31 (−0.75 to 0.13)	–	72%
Busch et al. (2013)	81	Resistance Exercises		−14.66 (−20.55 to −8.77)	Perfect	7%
Langhorst et al. (2013)	271	Movement Therapies		−0.66 (−0.99 to −0.34)	Moderate	39%
Lauche et al. (2013)	145	Qiong		−0.67 (−1.01 to −0.34)	Moderate	0
	42			−0.03 (−1.64 to 1.58)	–	81%
Hauser et al. (2010)	364	Aerobic Exercises		.22 (−0.38 to −0.05)	Small	9%
			Physical Measures			
Sosa-reina et al. (2017)	331	Multiple Exercises	Physical Component	.77 (0.47 to 1.08)	Moderate	38%
Bidonde et al. (2017b)	41	Whole Body Vibration	Balance	−0.35 (−0.74 to 0.04)	–	NA
	54		Strength	.77 (0.20 to 1.35)	Moderate	6%
Bidonde et al. (2017a)	256	Aerobic Exercise	Physical Fitness	- 10.16 (−15.39 to −4.94)	Perfect	0
	43		VO_2 MAX	1.60 (−0.06 to 3.26)	–	NA
	169		6 MWT	55.58 (27.20 to 83.96)	Perfect	0
Bidonde et al. (2014)	285	Aquatic Exercise	Physical Function	−4.35 (−7.77 to −0.94)	Perfect	44%
	152		Strength	0.63 (0.20 to 1.05)	Moderate	38%
	194		Submaximal Cardiorespiratory	37.03 (4.14 to 69.92)	Perfect	77%
	368		Tenderness	.47 (−0.80 to −0.13)	Small	58%
	30		Flexibility	1.50 (−2.04 to 5.04)	–	–
	64		Maximal Cardiorespiratory	.23 (−1.00 to 1.47)	–	83%
	162		Muscle Endurance	0 (−0.67 to 0.67)	–	78%
Busch et al. (2013)	107	Resistance Exercises	Physical Function	−6.29 (−10.45 to −2.13)	Perfect	40%
	107		Tenderness	−1.84 (−2.60 to −1.08)	Large	0
	47		Strength	27.32 (18.28 to 36.36)	Perfect	0
	47		Muscle Activation	40.92 (33.50 to 48.34)	Perfect	0
	47		Muscle Size	.48 (−0.11 to 1.06)	–	0
Lima et al. (2013)	88	Aquatic Exercises	6 MWT	43.55 (3.83 to 83.28)	Perfect	22%
Hauser et al. (2010)	339	Aerobic Exercises	Physical Fitness	.65 (0.38 to 0.93)	Moderate	71%
Garcia Hermoso et al. (2015)		Aerobic Exercise	Aerobic Capacity	.85 (0.57 to 1.12)	Moderate	0
		Resistance Exercise		NR	–	48%
		Aquatic Exercise		.44 (0.15 to 0.73)	Small	0

(*continued*)

Table 4 (*Continued*)

Author (date)	N	Exercise	Outcome	SMD (95% CI)	Effect size	I^2
		Multiple Exercises		NR	–	0
Bidonde et al. (2017b)	23	Whole Body Vibration	Stiffness	−12.72 (−26.90 to 1.46)	–	NA
Bidonde et al. (2017a)	143	Aerobic Exercise		−2.00 (−10.53 to 6.53)	–	NA
Bidonde et al. (2014)	230	Aquatic Exercises		−18.34 (−35.75 to −0.93)	Perfect	92%
Lima et al. (2013)	87	Aquatic Exercises		−1.58 (−2.58 to −0.58)	Large	0
McDowell, Cook and Herring (2017)	595	Multiple Exercises	Anxiety	.28 (0.16 to 0.40)	Small	25.30%
Bidonde et al. (2014)	374	Aquatic Exercises		−0.57 (−0.95 to −0.19)	Small	67%
Sosa-reina et al. (2017)	331	Multiple Exercises	Mental Component	.49 (0.27 to 0.71)	Small	0
Bidonde et al. (2014)	243	Aquatic Exercises	Mental Health	−3.03 (−8.06 to 2.01)	–	75%
Busch et al. (2013)	60	Resistance Exercises		−2.86 (−10.35 to 4.63)	–	NA
Bidonde et al. (2014)	88	Aquatic Exercises	Self-efficacy	9.54 (−3.39 to 22.46)	–	69%
Bidonde et al. (2014)	58	Aquatic Exercises	Dyscognition	−4.70 (−9.29 to −0.11)	Perfect	NA

Legend: N, number of study subjects; SMD, standardized mean difference; CI, confidence interval; I^2, heterogeneity; NR, not reported; NA, not applicable; CAM, complementary and alternative medicine; 6MWT, 6-min walk test.

Nevertheless, the authors recommended the practice of this type of exercise [37].

Differences were observed between the studies of Bidonde et al. [9] and Thomas and Blotman [10]. The latter was characterized as a practical review; however, as a systematic review, the quality assessment revealed a critically low quality. This study aimed to analyze the effects of randomized trials on aerobic-only exercise. Nineteen studies evaluating the effects of both low-to-moderate and high-intensity land-based, aerobic-only exercises were included. The authors provided recommendations for patients and their physicians (4 steps), including practical advice for clinical practice and future directions. However, the study did not achieve the initial objective.

Both Bidonde et al. [9] and Hauser et al. [34] observed a significant reduction in pain intensity and fatigue, as well as improvement in the quality of life and some physical parameters. On the other hand, Cerrilho-Urbina et al. [12] did not find significant results and the heterogeneity in this study was null.

It is noteworthy that the studies analyzed only the effects of aerobic exercise and that a significant effect was mostly found in studies with a high heterogeneity, except for the study of Hauser et al. [34], in the analysis of pain, and that of Bidonde et al. [9], in the analysis of aerobic capacity (6-min walk test) and physical fitness.

It has been found that the long-term effects of aerobic exercise may involve little or no difference in pain and physical function. Finally, aerobic exercise seems to be well tolerated by the patients (similar abstinence rates between groups), with few adverse events. For this reason, the authors declared their certainty about the safety of this modality.[9]

Sanz-Baños et al. [49], different from previous authors, aimed to analyze the adherence of patients with FM to walking programs. They raised some important points, as follows: (i) adherence to walking programs is greater if the doctors recommend assistance to the patients; (ii) combining walking with other activities may result in better adherence than a single walking exercise alone; and (iii) it is necessary to improve adherence during treatment, evaluate adherence between sessions, and assess adherence to a single treatment.

Andrade et al. [50], in the most recent systematic review, found that aerobic exercise (twice a week) with moderate to high intensity practiced in the long term increased heart rate variability and was effective in reducing autonomic dysfunction.

Strength training

The second most investigated (14 systematic reviews) type of physical exercise was strength training.

A review that showed good methodological quality in AMSTAR 2 indicated that strength training probably improves the ability of patients with FM to perform normal activities after 16–21 weeks. Pain, tenderness, fatigue, and muscle strength improved after 21 weeks [11]. The authors also stated that the evidence was classified as low quality owing to the low number of studies and the high risk of bias evaluation.

The assessment of risk of bias was hampered by poorly reported information (e.g., concealment of allocation, blindness of outcome assessors). The authors also identified both the lack of protocols and lack of care in blinding providers as methodological concerns. Brosseau et al. [38] reported that strength training had 5 positive recommendations (2 A and 3 *C*+), all of them with clinical benefits.

Compared with aerobic exercise, strength training was most effective in improving the tender points [36]. On the other hand, Andrade et al. [50] found no reduction in autonomic dysfunction in the short- and long-term period in patients with FM after resistance training. A study analyzing the effects of resistance exercise on the quality of life of patients with FM showed homogeneity in the scores between the study groups of the instruments analyzed before the application of the intervention; however, after the intervention, the effects of resistance training showed a favorable significant difference [46]. Busch et al. [35] reported that strength training and stretching are still scarcely investigated.

Finally, the studies by Andrade et al. [15,50] presented numerous benefits, including reduction of pain, fatigue, number of tender points, depression, and anxiety, as well as improved functional capacity and quality of life, in patients who underwent resistance training intervention. Moreover, the authors reported that the mean adherence of patients to the intervention in the included studies was 84% (range, 54–100%). This is a positive result, considering that the majority of this population had a low level physical exercise.

Aquatic exercises

Three reviews aimed to analyze the effects of aquatic exercise on patients with FM [18,51,52]. The results were positive, such as improved quality of life, sleep, and physical parameters (i.e., physical function, strength, submaximal cardiorespiratory function, tenderness, flexibility, maximal cardiorespiratory function, muscle endurance, and stiffness) [18,51,52].

Despite the positive results, Bidonde et al. [18] stated that the results should be analyzed with caution owing to limitations related to imprecision, high statistical heterogeneity, and wide confidence intervals. This review included 16 studies on aquatic exercises (n = 881; 866 women, 15 men). Nine studies compared the aquatic exercise group to the control group; 5 studies compared the aquatic exercise group with the terrestrial exercise group; and 2 studies compared the aquatic exercise group with a group that performed a different aquatic exercise program. The authors concluded that when compared with the control, aquatic exercises seem to be beneficial in improving the well-being, symptoms, and fitness of adults with FM. With respect to the comparison of aquatic versus terrestrial exercises,

the evidence was considered to be from very low to low quality; however, the authors suggested that aquatic exercises have benefits over terrestrial exercises, except in muscular strength (for which there was very low quality evidence favoring terrestrial exercises).

Different from Bidonde et al. [18], Perraton et al. [52] aimed to summarize the components of aquatic exercise interventions in patients with FM. The authors reported that aerobic exercises, warm-up and cool-down exercises, and relaxation exercises are the main components reported in the included studies. They also pointed out that the duration of exercise in the studies was around 60 min, with a frequency of 3 times a week and intensity ranging from 60% to 80%. Concerning the exercise frequency, Bidonde et al. [22] reported similar results, as follows: 3 times a week in 3 studies, 2 times per week in 1 study, and once weekly in 1 study. The average session duration was 60 min. The exercise intensity varied as follows: very light, light to moderate, and light to vigorous. They also mentioned that none of the studies met the American College of Sports Medicine criteria for aerobic exercise or resistance training. These factors influence the results found in the outcomes and should be better analyzed.

Lima et al. [51] initially included 15 studies in their meta-analysis, but reported only the significant analyses, which amounted to only 3 studies. They found favorable results in the aquatic exercise group in terms of quality of life, rigidity, and physical function measured using the 6-min walk test. However, in contrast to the 2 previous reviews on the effects of aquatic exercises considered by the AMSTAR tool to have moderate quality, this review was considered of low quality.

Movement therapies

Some reviews analyzed the effects of movement and alternative therapies (i.e., yoga, pilates, tai chi, and qiong) [39,40,53].

Mist et al. [39] analyzed the effects of these movement therapies on the quality of life and pain intensity of patients with FM. They found significant effects, with small (yoga and qiong), moderate (tai chi), and large (other alternative therapies) effect sizes. In this review, the forest plots were observed to be not self-explanatory, and there was no description of these findings in the Results section. The Results section of the meta-analysis referred to positive outcomes; however, the outcomes analyzed and what were those positive results were not clearly stated. Moreover, the heterogeneity of the studies was also not reported.

Another issue is that the authors argued that only 1 study analyzed juvenile participants, but one of their inclusion criteria for the reviewed studies was that the study participants should be older than 21 years, which shows a certain contradiction to the problem that they raised.

Lauche et al. [53] analyzed the effects of the practice of qiong; however, they only compared qiong versus usual care and qiong versus active treatment, and did not report the overall effect of qiong. None of the outcomes had a favorable effect on the qiong group when compared with the active treatment group. Therefore, the authors declared the need for further studies.

Langhorst et al. [40] found favorable significant differences in sleep, fatigue, depression, and quality of life after movement therapies. However, different from the study by Mist et al. [39] pain did not show favorable differences for any of the groups analyzed, and this variable had the highest values of heterogeneity (both after the intervention and in the follow-up period). It is important to highlight that Langhorst et al. [40] concluded that tai chi and yoga were the exercises that showed improvement in symptoms, although there was no evidence about the efficacy of qiong. In agreement with Bidonde et al. [22], the authors reported that there are still no supporting evidences for new interventions such as qiong. Some studies have investigated the effects of whole-body vibration and found improvements in some symptoms (quality of life, balance, and strength), as well as reduction of pain and fatigue in these patients [19,30,54].

Multiple exercises or combined exercises

Only 1 review examined the acute effects of exercise on the inflammatory response in patients with FM [13]. This review did not present overlap, and the authors reported that the studies presented a high risk of bias in the criteria for reporting selective results in the Cochrane Collaboration's Risk of Bias tool. This factor contributed to the assessment that the findings of the review were inconclusive. The authors also suggested that patients with FM probably have low-grade chronic inflammation, because the studies found high concentrations of interleukin (IL)-8 and tumor necrosis factor-α and high expression of IL-10 in these patients. Thus, the effects of exercise on inflammatory markers in these patients are unclear. None of the studies reported worsening of symptoms with exercise as the recommended treatment. However, more research is needed on the effect of exercise on inflammation. Although an adequate calculation was not made to verify the heterogeneity of the studies, taking into account that no meta-analysis was performed, the authors reported that the methods of analysis of inflammatory markers were very different.

McDowell et al. [55] analyzed the effects of multiple exercises on the anxiety of patients with FM, and reported that further reductions in anxiety symptoms will be achieved by focusing on longer exercise programs and promoting long-term adherence. The authors also pointed out that significantly greater anxiety reductions were achieved in trials in which the samples comprised only women, compared with mixed samples. This factor may be related to the fact that the prevalence of this disease is higher in women [56]. However, it is emphasized that more studies investigating the responses to exercise of male patients with FM are needed. Another subsample that was analyzed in only 1 review was that of patients with FM in perimenopause. The review authors found that exercise in general has a positive effect on the well-being of these patients [12].

One of the studies that evaluated the effects of general exercise programs did not clarify the outcomes, and concluded by making generic recommendations for exercise prescription [57].

Quality assessment of systematic reviews

In our quality assessment, we observed that most systematic reviews did not report the funding sources of the studies included in the review (33 of 37). With respect to methodological problems, we observed that in most of the reviews (31 of 37), the authors did not provide a list of excluded studies and the reasons for the exclusions. In addition, we noted that 28 of the 37 reviews did not contain an explicit statement that the review methods were established before the conduct of the review. The authors also didn't explain their selection of the study designs that were eligible for inclusion. Further, a standardized method for reporting adverse effects is still lacking in the quality assessment [11,22], as only 35.1% of the reviews reported the incidence of exercise-related adverse events.

Moreover, to improve the reporting of systematic reviews and meta-analyses, authors should follow the PRISMA checklist.[25] The PRISMA statement was published in 2009 [58]. However, only 15 of the 31 studies performed after the publication of the statement followed the guidelines. Transparent reporting is an important aspect of how systematic reviews are conducted. According to AMSTAR, at least 2 databases should be searched [59]. We observed that a comprehensive literature search was performed by the authors of most of the selected reviews (a median of 6 databases), with 1 study that searched 12 databases [51] and only 1 study that was based on a single database (PubMed) [10].

Strengths, innovations, and limitations

Determining the precise degree of overlap of studies is difficult [60], which makes this analysis a strength of our study. Umbrella reviews have the intrinsic limitation of potential overlap among studies. The strengths of our study also include providing a summary based on pooled effect sizes across the included studies, allowing better conditions for clinical decision making with respect to the choice of the physical exercise for the treatment of FM.

On the basis of a series of 18 analyses of publications, our findings on methodological characteristics and study results provide a complete overview of the research on FM and exercise. Moreover, the findings of this umbrella review, besides identifying the potential exercises that can be used in the treatment of FM, will not only enable the development of new reviews addressing the observed gaps, but will also guide the development of new RCTs. Future RCTs should analyze the long-term effects (>16 weeks) of physical exercise on the symptoms of patients with FM.

It should also be noted that most of the reviews included in our umbrella review were of low quality. Of the 37 included reviews, more than the half (56.7%) were rated as having a low or critically low quality. However, despite the low quality of most of the studies, as assessed using AMSTAR, several studies analyzed a large number of patients and reported important results about the effects of exercise on the main symptoms of patients with FM. Most of the published umbrella reviews in the literature used the first version of AMSTAR [59] (which had 760 citations in Web of Science). The new instrument, AMSTAR 2 (with 108 citations), has a more comprehensive user guide and an overall rating that is based on weaknesses in critical domains [26].

Despite the increase in the number of RCTs and systematic reviews, care must be taken in interpreting the results owing to the lack of homogeneity among the reviews.

Significant point on methodology and suggestions for further research

Different from the previous umbrella study by Bidonde et al. [22] that affirmed that methodological weaknesses in some of the reviews reduce the applicability of the research to clinical practice, our findings showed the strongest evidence in terms of improvement of pain and quality of life, mainly through aerobic exercise and strength training. However, we have some additional points to discuss.

Busch et al. [32], in the first systematic review with meta-analysis about the topic, found that poor description of exercise protocols was prevalent among studies. Since then, despite the large number of studies that have been published on the effects of exercise on the symptoms of patients with FM syndrome, and although there are guidelines on what should be reported in experimental studies, poor description remains a recurring problem. We suggest that authors should provide a detailed description, as much as possible, of the exercise protocol used in the studies, including the type of exercise, intervention time, and volume and intensity of training, in order to increase the chance of future replication.

How the exercise session for the patients with fibromyalgia was prepared must be discussed. We observed that generally, this review pointed out that the patients needed to exercise 2 to 3 times per week, for 30 to 60 min in each session [15,45,61]. These recommendations are below the general recommendations for adults [62] or elderly people [63], and we do not have a reason for or a discussion about it. In this sense, some questions have emerged such as “What should be considered for the initial exercise session?” and “What is the ideal intensity?”. We observed that the bigger lacuna is that we do not have guidelines that instruct how to track a progression for these patients. Andrade et al. [15] showed in their review that some of the studies about strength training began with a load of 40% 1RM but seem to lack an explanation for using the load and how progression was attained.

We know that for elderly people, baseline health assessment should be implemented to identify at-risk individuals, taking into consideration the patient’s current level of exercise, desired intensity of exercise, diagnosed disease, and signs and symptoms suggestive of disease [63]. The same must be applied for patients with fibromyalgia. Taking this into account, we noticed that one of the important points was that although it has been well established in the literature that patients with FM have lower levels of physical activity, muscular strength, aerobic capacity, and other physical components [64–66], the present umbrella review shows that few reviews have analyzed these parameters, with not one of these parameters having been analyzed in >2 reviews. These components, as we pointed earlier, are essential to plan an ideal prescription of exercise, and they seem not to be considered in the baseline assessment, which is an issue of concern. Thus, we must report how we are evaluating theses parameters to better plan the exercise sessions.

Thus, further investigations are needed to determine whether this gap occurs owing to the lack in RCTs or even in the outcomes analyzed in systematic reviews. Furthermore, there was little evidence on the benefits of exercise in juvenile patients and male patients (explored in only 1 study). Future studies also should analyze these subgroups of patients. Moreover, as a new approach for verifying the significance of scientific publications on a particular topic, the bibliometric analysis [67–69] can be a tool that importantly contributes to enhancing the current knowledge.

Implications for practice and policy, and recommendations

The results of this umbrella review have the potential to influence evidence-based practice, as it provides information about the effectiveness of exercise in the treatment of patients with FM syndrome. This information, provided mainly through the summary of findings and effect sizes, will be useful to students and professionals in the fields of physiotherapy, physical education, medicine, and research, as well as to research groups and policy makers.

The positive results of different modalities of physical exercise in the treatment of FM symptoms suggest that the practice of exercise can be recommended as a therapy. Moreover, the results also suggest the need for more in-depth studies and investigations on different exercise interventions, such as studies comparing the intensities between different modalities. The evidence on the effectiveness of strength training and aerobic exercise as treatment encourages the use of these modalities with greater reliability and expectations. This would also allow the development of strategies based on these modalities for the treatment of FM at the public health level. Further, the low incidence of adverse effects related to physical exercise suggests the safety of its application in different contexts of the disease.

Conclusion

This umbrella review is innovative in that it summarizes the findings of all systematic reviews on the effects of exercise in patients with FM, providing an overall examination of the body of knowledge related to the topic. Our umbrella review contributes toward considering exercise as an effective way to treat the symptoms of FM syndrome, with a low incidence of related adverse events. Moreover, it emphasizes that aerobic exercise and strength training are effective exercise programs for the treatment of FM.

The greatest evidence was observed in terms of the improvement of pain and quality of life. Future studies should analyze the long-term effects of exercise in this population, as well as assess the effects of exercise on physical variables in these patients, which were poorly explored in the reviews.

The results of this umbrella review have a potential to influence evidence-based practice, as they provide information on the effectiveness of exercise in treating the symptoms of FM syndrome, mainly through the summary of findings and effect sizes.

Declaration of Competing Interest

None declared.

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Contributors

AA and SMS contributed to the conception and design of the work. SMS and FHD contributed to collect, analysis and interpretation of data. AA critically revised the manuscript. All the authors gave final approval of the version submitted.

Patient consent for publication

Not required.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.semarthrit.2020.02.003.

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