Exploration of Neuroprotective Therapy

Open Exploration

Open Access Review

Therapeutic exercise in fibromyalgia syndrome: a narrative review

Carlos Forner-Álvarez, Carlos Zanón-Chanzá, Ferran Cuenca-Martínez*, Núria Sempere-Rubio

Department of Physiotherapy, University of Valencia, 46010 Valencia, Spain

***Correspondence**: Ferran Cuenca-Martínez, Department of Physiotherapy, University of Valencia, 46010 Valencia, Spain. ferran.cuenca@uv.es

Academic Editor: Manuel Zeitelhofer, Karolinska Institutet, Sweden

Received: October 9, 2023 **Accepted:** November 19, 2023 **Published:** February 20, 2024

Cite this article: Forner-Álvarez C, Zanón-Chanzá C, Cuenca-Martínez F, Sempere-Rubio N. Therapeutic exercise in fibromyalgia syndrome: a narrative review. Explor Neuroprot Ther. 2024;4:1–10. https://doi.org/10.37349/ent.2024.00067

Abstract

Fibromyalgia syndrome (FMS) is characterised by the presence of distributed pain in different areas of the body accompanied by the alteration of some functions such as the activity of the neurovegetative system, the sleep quality, or the presence of fatigue. The present narrative review aims to evaluate some key studies regarding the effects of different therapeutic exercise (TE) modalities on clinical variables of interest in patients with FMS, as well as to discuss some of the possible mechanisms of action of TE in improving pain intensity in patients with FMS. All aerobic, strengthening, and body-mind exercises were shown to bring about changes in the improvement of clinical variables of interest in patients with FMS. In addition, with regard to the improvement of pain intensity, there are different arguments that could explain the hypoalgesic effect of TE (structured in physical, neurophysiological, and psychosocial mechanisms). In conclusion, TE is a clinical tool with great potential for patients with FMS as it may produce hypoalgesia through physical, neurophysiological, and psychosocial mechanisms. All these TE modalities have demonstrated in isolation a remarkable effectiveness in the overall improvement of patients with FMS. However, more research is needed in this field especially on the long-term effects and on the combination of the different training modalities.

Keywords

Therapeutic exercise, fibromyalgia syndrome, narrative review

Introduction

Fibromyalgia syndrome (FMS) is characterised by the presence of widespread and distributed pain in different areas of the body accompanied by the alteration of some functions such as the activity of the neurovegetative system, the sleep quality, or the presence of fatigue [1]. Recently, circulating natural killer (NK) cells in peripheral nerves have been found to be reduced, chronically activated, and redistributed in FMS patients, which directly contributes to the immunopathology associated with FMS [2]. FMS is more prevalent in women than in men and its prevalence in the general population can be as high as 5% [3]. Regarding the aetiology, some studies comment that there may be a presence of hyperexcitability of the central nervous system in patients with FMS, secondarily causing an alteration in pain sensitivity [4, 5]. Regarding the diagnosis of FMS, the American College of Radiology (ACR) established 2016 an update of its criteria and commented that for the diagnosis of FMS, the patient should have at least four of five body regions with pain (widespread pain), where in addition the symptoms must be present for more than 3 months and also show high severity rates of symptoms [6]. Regarding the treatment of FMS, there are some studies that have evaluated the effectiveness of pharmacological [7, 8], psychological [9, 10], educational [11, 12], and also through therapeutic exercise (TE) [13, 14].

The present narrative review aims to evaluate some key studies regarding the effects of different TE modalities on clinical variables of interest in patients with FMS, as well as to discuss some of the possible mechanisms of action of TE in improving pain intensity in patients with FMS.

Aerobic exercise

Aerobic exercise (AE) in patients with FMS is a topic of recognised interest in the scientific field, highlighted by a remarkable increase in research in recent years. We have chosen some relevant studies to comment on. For example, Bidonde et al. [15] evaluated the benefits and drawbacks of AE in adults with FMS. In addition, Bidonde et al. [16] focused on evaluating only aquatic exercise (AqE) in patients with FMS.

In both studies (Bidonde et al. [15, 16]), patients over 18 years of age diagnosed with FMS were selected. The diagnosis could be either ACR 1990 criteria or ACR 2010 criteria [17, 18]. Outcome measures were divided into three types: outcomes representing wellness, outcomes representing FMS symptoms, and outcomes representing physical fitness.

The outcomes that represent wellness were health-related quality of life (HRQoL) or multidimensional function, patient-rated global, clinician-rated global, self-efficacy, and mental health. Moreover, the outcomes that represent FMS symptoms were pain, fatigue, stiffness, sleep quality, tenderness, depressed mood, and anxiety symptoms.

Finally, the outcomes that represent physical fitness were muscle strength, physical function, muscle endurance, muscle power, submaximal cardiorespiratory function, maximal cardiorespiratory function, and muscle/joint flexion.

Of all the outcomes that have been mentioned, we highlight pain, fatigue, HRQoL/multidimensional function, stiffness, physical function, sleep quality, depressed mood, muscle strength, and submaximal cardiorespiratory function.

Bidonde et al. [15] included studies with both unidimensional and composite measures of pain. In addition, if there was more than one type of pain measure, the average pain intensity was prioritised over the others. The most common tools used in the unidimensional assessments were the Visual Analogue Scale (VAS) and the Numerical Pain Rating Scale (NPRS). On the other hand, for joint assessments, pain intensity was assessed in composite form with interference using the 36-Item Short Form Survey (SF-36) or Rand 36 Bodily Pain Scale. Pain intensity was also assessed in conjunction with pain distress using the Multidimensional Pain Inventory or Pain Severity Scale. In Bidonde et al. [16], the VAS scale was the main tool to assess pain. For fatigue, Bidonde et al. [15] and Bidonde et al. [16] accepted both unidimensional and multidimensional assessments of fatigue. The preferred tool for fatigue assessment was the VAS-fatigue. Bidonde et al. [15] assessed HRQoL using as main tools the Fibromyalgia Impact Questionnaire (FIQ), the Short Form Questionnaire (i.e., SF-36 total or SF-12 total) and the EuroQol-5D (EQ-5D). Bidonde et al. [16] assessed multidimensional function, which is directly related to HRQoL. The main tool used for this assessment was the FIQ total. Stiffness was measured using the FIQ Stiffness Subscale in Bidonde et al. [15]. Bidonde et al. [16] only considered the FIQ stiffness VAS as a tool to assess stiffness. As for the assessment of physical function, the following tools were accepted by Bidonde et al. [15]: the FIQ Physical Impairment Scale, the Health Assessment Questionnaire (HAQ), the SF-36 or the Rand 36 Physical Function Scale, the Sickness Impact Profile—Physical Disability Scale and the Multidimensional Pain Inventory Household Chores Scale. Self-reported physical function was mainly assessed by Bidonde et al. [16] using the FIQ physical impairment scale, HAQ, SF-36 physical function, and Sickness Impact Profile. Bidonde et al. [16]

included in terms of assessing sleep data mainly from the Pittsburgh Sleep Quality Index (PSQI) and the sleep quality VAS. Bidonde et al. [16] prioritised the data on depressed mood from the Beck Depression Inventory (BDI), Hospital Anxiety and Depression Questionnaire, Centre for Epidemiologic Studies-Depression (CES-D), and FIQ. Muscle strength was assessed using the grip strength in Bidonde et al. [16]. Bidonde et al. [15] and Bidonde et al. [16] collected data on submaximal cardiorespiratory function mainly from the six-minute walk test (6-MWT). The outcome measures highlighted are summarised (Table 1).

Table 1. Characteristics of the outcomes highlighted

Outcome	Type	Participants	Articles	Measurements
Pain	Fibromyalgia symptoms	1,711	27	-VAS -Chronic Pain Self-Efficacy Scale -FIQ -McGill Pain Questionnaire -SF-36/Rand 36 Bodily Pain Scale -NPRS -Pain Severity Scale of the Multidimensional Pain Inventory
Fatigue	Fibromyalgia symptoms	1,227	20	-Fatigue Severity Scale -SF-36 -VAS -FIQ
HRQoL/ Multidimensional function	Wellness	1,451	21	-FIQ total
Stiffness	Fibromyalgia symptoms	492	8	-FIQ stiffness VAS
Physical function	Physical fitness	955	17	-SF-36 physical function -FIQ physical impairment scale -Sickness Impact Profile -HAQ
Sleep	Fibromyalgia symptoms	786	13	-VAS -number of nights per week with difficulty -Average number of hours slept/night over the past week -FIQ -PSQI
Depressed mood	Fibromyalgia symptoms	1,169	18	-CES-D -BDI -Cognitive/affective -Hospital Anxiety and Depression Questionnaire -FIQ -VAS
Muscle strength	Physical fitness	269	6	-Grip strength
Submaximal cardiorespiratory function	Physical fitness	777	11	-6-MWT -Astrand test

It is noteworthy that both Bidonde et al. [15] and Bidonde et al. [16] considered withdrawals and adverse events. In addition, among the total number of articles (29), there was only one article that both reviews repeated [19].

All the interventions included in the above studies had AE as a main feature. AE is understood as a dynamic physical activity performed by large muscle groups which increases heart- and respiratory- rates above resting levels, establishing them for a long period at sub-maximal levels [20]. Bidonde et al. [16] included only exercise programmes performed 50% or more in water, which is called aquatic aerobic exercises (AAE).

Bidonde et al. [15] established exercise intensity using the percentage of maximal heart rate (HRmax) or heart rate reserve (HRR) as a reference. On the other hand, Bidonde et al. [16] classified exercise intensities following the recommendations of the American College of Sports Medicine (ACSM) [21]. Basically, the ACSM established three main parameters as a reference to establish exercise intensity. These parameters are the percentage of HRmax, the percentage of VO2 reserve or HRR, and the Borg Rating of Perceived Exertion Scale (RPE) 6 to 20 scale.

A summary of the interventions is showed in Table 2.

Table 2. Summary of characteristics of aerobic training interventions from previous systematic reviews

Systematic review	Type of intervention	Modes	Duration (week)	Frequency (days/week)	Duration (min)	Intensity (light to vigorous)	Main findings
Bidonde et al. 2017 [16]	Land-based exercise	-Lifestyle physical activity -Walking -Low-impact aerobic dance -Graded circuit exercises -Movement to music and games -Bicycle ergometer	6–24	1–7	10–60	-HRmax 60–75% -HRR 40–75% -RPE 9–15 -120–150 beats per minute	AE improved HRQoL and may affect positively pain intensity, physical function, fatigue, and stiffness in adults with FMS
Bidonde et al. 2014 [15]	AqE*	-Aerobic working major muscle groups of the lower limbs, upper limbs, trunk and neck -Deep water running -Walking in the heated pool -Jumping into heated pool -Bicycling simulation -Low-impact swimming	3–34	1–3	20–60	-HRmax 60–80% -RPE 9–13 -Maximal oxygen uptake (VO2 max) 50–75% -Self-selected below pain and fatigue threshold	AqE in patients with FMS could improve fitness, wellness, and symptoms in patients with FMS

Bidonde et al. [15] included one AqE study but it is included also in Bidonde et al. [16] so we have excluded it from Bidonde et al. [15]. *: only AE studies have been extracted from this systematic review

Bidonde et al. [15] concluded with moderate-quality of evidence that AE improved HRQoL and with low-quality of evidence that AE may positively affect pain intensity, physical function, fatigue, and stiffness in patients with FMS. In addition, Bidonde et al. [16] concluded with low to moderate evidence that AqE in patients with FMS could improve fitness, wellness, and symptoms in adults with FMS. Both studies agreed that further research is needed, in particular on the long-term effects.

Body-mind exercise

Meditative movement therapies (MMT) include exercises that combine movement or body positions with a focus on breathing and a clear state of mind aim to achieve deep breathing [22] (Table 3). Langhorst et al.

[23] conducted a systematic review assessing the efficacy and safety of MMT in patients with FMS. In this review were included patients of any age diagnosed with FMS by recognised criteria. Moreover, were assessed as outcomes the key domains of the FMS: pain, sleep, fatigue, HRQoL, and depressive mood. In addition, only MMT interventions were added. In conclusion, Langhorst et al. [23] concluded that MMT improved HRQoL and reduced sleep disturbance, depressive mood, and fatigue in FMS.

Table 3. Characteristics of the MMT interventions

Intervention	Frequency (days/week)	Duration (week)	Number of sessions	Time per session (min)	Number of total hours (h)
Ai Chi	3	6	18	60	18
Yoga	1–4	4–8	8–16	60–120	1
Qi Gong	1	7–12	9–12	30	6–11.5
Yang-Style Tai Chi	2	12	24	60	24
Body Awareness Therapy	-	12	14	90	18

-: this parameter is not considered in this exercise model

Resistance exercise

Resistance training (RT) is the most researched exercise modality after AE [24]. Patients with FMS have reduced physical activity and increased sedentary rates. Loss of muscle function is common [25]. RT aims to improve pain, tenderness, fatigue, sleep, depressive mood, and muscle strength in patients with FMS [26]. There is no consensus on the characteristics of the RT intervention. Different protocols have been proposed and evaluated by different systematic reviews. However, RT is a safe and effective intervention when adapted to the individual needs of patients [27].

The aim of the study conducted by Rodríguez-Domínguez et al. [24] was to assess the clinical relevance and effectiveness of RT concerning pain intensity, functionality, and disease severity specifically in women diagnosed with FMS, aged 18 and above. On the other hand, the study conducted by Vilarino et al. [28] aimed to analyze the effects of RT on the mental health of patients with FMS, aged 18 and above.

Pain intensity was evaluated in Rodríguez-Domínguez et al. [24] using VAS and a subscale of the SF-36 (bodily pain). Moreover, in this study functionality was assessed through the Continuous-Scale Physical Functional Performance (CS-PFP), the HAQ, and another subscale of the SF-36 (physical function). Additionally, the FIQ was employed to assess the severity of the disease. Anxiety symptoms were analyzed by Vilarino et al. [28] using the State-Trait Anxiety Inventory (STAI), the Hospital Anxiety and Depression Scale, and the BDI. In addition, depression was assessed through the BDI, the Hospital Anxiety and Depression Scale, and the FIQ.

The interventions in Rodríguez-Domínguez et al. [24] lasted between 8 and 21 weeks, with the most common duration being 12 weeks (four studies). Additionally, most of the interventions involved training sessions twice a week. All workouts included 10 min of warm-up, 50 min of RT, and 10 min of relaxation at the end, which consisted of stretching exercises. During training, patients were instructed to take 1 min of recovery between each set. The RT programs used in the studies included a range of 4–12 exercises. In terms of intensity, several studies began with 40–60% of the one-repetition maximum (1RM). However, others used increased repetitions to increase intensity. In this way, the number of repetitions was inversely proportional to the intensity. While some started in sets of 4 to 5 repetitions and increased to 12 repetitions, others started in sets of more volume (15–20 repetitions) and at the end of treatment increased the intensity to perform sets of 5–10 repetitions. On the other hand, the interventions in Vilarino et al. [28] lasted between 4 and 21 weeks. Additionally, most of the interventions in this review involved training sessions twice a week. All workouts included 5 or 10 min of warm-up, with short walks or light stretches, 30–50 min of RT, and 5–10 min of relaxation at the end, which consisted of stretching exercises. The exercises were performed on machines, with body weight and with free weights, beginning at 40% of 1RM and progressing in some studies to 85%, with one to three sets of 12 repetitions. The summary of the interventions is in Table 4.

Table 4. Summary of characteristics of RT interventions from previous systematic reviews

Authors	Frequency	Volume and intensity	Session program	Main findings
Rodríguez-Domínguez et al. [24]	2–3 d/w during 8–21 w	4–12 exercises (leg press, leg extension, leg curl, biceps curl, hand grip strength, core stability exercise and heel raise…), 1–3 sets, 40–60% 1RM, 5 to 20 reps	-Warm-up (10 min) -RT (50 min) -Stretching (10 min)	RT was effective in reducing pain intensity and improving functionality in FMS
Vilarino et al. [28]	2–3 d/w during 4–21 w	6–13 exercises (leg press, leg extension, hip flexion, pectoral fly, calf pulldown, shoulder flexion, core stability…), 1–3 sets, 40–5% 1RM, 4 to 20 reps	-Warm-up (5–10 min) -RT (30–50 min) -Stretching (5–10 min)	RT was effective in improving mental health in FMS

d/w: days per week; w: week; reps: repetitions

Rodríguez-Domínguez et al. [24] concluded that RT was effective in reducing pain intensity and improving functionality in patients with FMS. Whereas Vilarino et al. [28] concluded that RT was effective in improving the mental health of patients with FMS by reducing anxiety and depressed mood.

Mechanisms hypothesized for pain-relieving effects of TE in patients with fibromyalgia

To conclude the narrative review, we have evaluated the article conducted by Neelapala et al. [29] with the aim of extracting some hypotheses about the possible mechanisms involved in the hypoalgesia generated by TE in patients with FMS.

As we have seen above, TE is an approach capable of eliciting changes in clinical variables of interest, and particularly in pain intensity. In fact, TE is one of the management strategies most recommended by treatment guidelines for FMS (e.g., Canadian [30] or European [31] guidelines).

Neelapala et al. [29] comment that TE may lead to improvements in pain intensity through three mechanisms: physical mechanisms, neurophysiological mechanisms, and psychosocial mechanisms.

Physical mechanisms

Some of the physical mechanisms proposed for the improvement of pain intensity could be the improvement of sleep quality after TE, secondarily reducing sympathetic hyperactivity and hypothalamic-pituitary axis dysfunction. Neelapala et al. [29] also commented that the studies they reviewed suggest improved physical fitness (increased aerobic capacity, strength or body composition) although this mechanism requires further investigation. Finally, the authors comment that another potential mechanism suggested would be muscle oxygenation secondary to the performance of TE. It seems that pain in FMS patients could be related to reduced muscle oxygenation due to impaired capillary circulation.

Neurophysiological mechanisms

At the neurophysiological level, it appears that there are different mechanisms that could be involved in the hypoalgesia generated by TE in patients with FMS. For example, TE activates the descending pain modulator system by activating the opioid and cannabinoid systems, producing a hypoalgesic effect. However, we should be cautious with this mechanism as it has been found in some studies that the descending modulator system does not function equally in patients with FMS compared to healthy subjects, which may lead to increased pain sensitivity after training sessions [32, 33].

Another mechanism discussed by Neelapala et al. [29] in their work is the effect of TE on the autonomic system, reducing sympathetic hyperactivity and stress response. Another mechanism could be the effect of TE on reducing peripheral and central sensitisation by increasing peripheral oxygenation or serotonin levels. Finally, another proposed mechanism could be the reversal of hypothalamic-pituitary-adrenal axis dysfunction through the effects of TE on inflammatory and neuroendocrine markers associated with immune functions.

In summary, although there is research supporting some neurophysiological mechanisms for the improvement of pain intensity through TE, more research is still needed.

Psychosocial mechanisms

Studies including Neelapala et al. [29] hypothesised that TE may reduce pain intensity in FMS patients through improving self-efficacy, providing social interaction during training sessions, and reducing the impact of some psychological factors such as movement-related fear or the influence of catastrophic thoughts.

Conclusions

TE is a clinical tool with great potential for patients with FMS as it can produce hypoalgesia through physical, neurophysiological, and psychosocial mechanisms. All these TE modalities have demonstrated in isolation a remarkable effectiveness in the overall improvement of patients with FMS. However, more research is needed in this field especially on the long-term effects and on the combination of the different training modalities.

Abbreviations

1RM: one-repetition maximum

ACR: American College of Radiology

AE: aerobic exercise

AqE: aquatic exercise

BDI: Beck Depression Inventory

FIQ: Fibromyalgia Impact Questionnaire

FMS: fibromyalgia syndrome

HAQ: Health Assessment Questionnaire

HRmax: maximal heart rate

HRQoL: health-related quality of life

HRR: heart rate reserve

MMT: meditative movement therapies

RPE: Borg Rating of Perceived Exertion Scale

RT: resistance training

SF-36: 36-Item Short Form Survey

TE: therapeutic exercise

VAS: Visual Analogue Scale

Declarations

Author contributions

FCM and NSR: Conceptualization, Investigation, Writing—original draft, Supervision, Writing—review & editing. CFA and CZC: Investigation, Writing—original draft, Writing—review & editing. All authors read and approved the submitted version.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical approval

Not applicable.

Consent to participate

Not applicable.

Consent to publication

Not applicable.

Availability of data and materials

Not applicable.

Funding

Not applicable.

References

1. Bair MJ, Krebs EE. Fibromyalgia. Ann Intern Med. 2020;172:ITC33-ITC48.
2. Verma V, Drury GL, Parisien M, Özdağ Acarli AN, Al-Aubodah TA, Nijnik A, et al. Unbiased immune profiling reveals a natural killer cell-peripheral nerve axis in fibromyalgia. Pain. 2022;163:e821–36.
3. White KP, Harth M. Classification, epidemiology, and natural history of fibromyalgia. Curr Pain Headache Rep. 2001;5:320–9.
4. Hazra S, Venkataraman S, Handa G, Yadav SL, Wadhwa S, Singh U, et al. A cross-sectional study on central sensitization and autonomic changes in fibromyalgia. Front Neurosci. 2020;14:788.
5. Richard JY, Hurley RA, Taber KH. Fibromyalgia: centralized pain processing and neuroimaging. J Neuropsychiatry Clin Neurosci. 2019;31:182–7.
6. Kang JH, Choi SE, Park DJ, Lee SS. Disentangling diagnosis and management of fibromyalgia. J Rheum Dis. 2022;29:4–13.
7. Garcia-Campayo J, Magdalena J, Magallón R, Fernández-García E, Salas M, Andrés E. A meta-analysis of the efficacy of fibromyalgia treatment according to level of care. Arthritis Res Ther. 2008;10:R81.
8. Migliorini F, Maffulli N, Knobe M, Tenze G, Aljalloud A, Colarossi G. Pregabalin administration in patients with fibromyalgia: a Bayesian network meta-analysis. Sci Rep. 2022;12:12148.
9. Bernardy K, Klose P, Welsch P, Häuser W. Efficacy, acceptability and safety of cognitive behavioural therapies in fibromyalgia syndrome – a systematic review and meta-analysis of randomized controlled trials. Eur J Pain. 2018;22:242–60.
10. Bernardy K, Füber N, Köllner V, Häuser W. Efficacy of cognitive-behavioral therapies in fibromyalgia syndrome – a systematic review and metaanalysis of randomized controlled trials. J Rheumatol. 2010;37:1991–2005.
11. Elizagaray-García I, Muriente-González J, Gil-Martínez A. Education for patients with fibromyalgia. A systematic review of randomised clinical trials. Rev Neurol. 2016;62:49–60. Spanish.
12. Saracoglu I, Leblebicier MA, Yaman F, Kavuncu V. Pain neuroscience education combined with usual treatment for fibromyalgia syndrome: a randomized controlled trial. Int J Rheum Dis. 2021;24:1409–18.
13. Couto N, Monteiro D, Cid L, Bento T. Effect of different types of exercise in adult subjects with fibromyalgia: a systematic review and meta-analysis of randomised clinical trials. Sci Rep. 2022;12:10391.

14. Cuenca-Martínez F, Suso-Martí L, Fernández-Carnero J, Muñoz-Alarcos V, Sempere-Rubio N. Exercise-based interventions on sleep quality in patients with fibromyalgia syndrome: an umbrella and mapping review with meta-analysis. Semin Arthritis Rheum. 2023;61:152216.
15. Bidonde J, Busch AJ, Webber SC, Schachter CL, Danyliw A, Overend TJ, et al. Aquatic exercise training for fibromyalgia. Cochrane Database Syst Rev. 2014;2014:CD011336.
16. Bidonde J, Busch AJ, Schachter CL, Overend TJ, Kim SY, Góes SM, et al. Aerobic exercise training for adults with fibromyalgia. Cochrane Database Syst Rev. 2017;6:CD012700.
17. Wolfe F, Smythe HA, Yunus MB, Bennett RM, Bombardier C, Goldenberg DL, et al. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. Arthritis Rheum. 1990; 33:160–72.
18. Wolfe F, Clauw DJ, Fitzcharles MA, Goldenberg DL, Katz RS, Mease P, et al. The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. Arthritis Care Res (Hoboken). 2010;62:600–10.
19. Gowans SE, deHueck A, Voss S, Silaj A, Abbey SE, Reynolds WJ. Effect of a randomized, controlled trial of exercise on mood and physical function in individuals with fibromyalgia. Arthritis Rheum. 2001;45: 519–29.
20. Donatelle RJ, Kolen-Thompson AM. Chapter 4: Engaging in physical activity for health, fitness, and performance. In: Health: the basics. 6th ed. Toronto: Pearson Canada Inc; 2015.
21. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc. 2011;43: 1334–59.
22. Larkey L, Jahnke R, Etnier J, Gonzalez J. Meditative movement as a category of exercise: implications for research. J Phys Act Health. 2009;6:230–8.
23. Langhorst J, Klose P, Dobos GJ, Bernardy K, Häuser W. Efficacy and safety of meditative movement therapies in fibromyalgia syndrome: a systematic review and meta-analysis of randomized controlled trials. Rheumatol Int. 2013;33:193–207.
24. Rodríguez-Domínguez ÁJ, Rebollo-Salas M, Chillón-Martínez R, Rosales-Tristancho A, Jiménez-Rejano JJ. Clinical relevance of resistance training in women with fibromyalgia: a systematic review and meta-analysis. Eur J Pain. 2024;28:21–36.
25. Kapuczinski A, Soyfoo MS, De Breucker S, Margaux J. Assessment of sarcopenia in patients with fibromyalgia. Rheumatol Int. 2022;42:279–84.
26. Andrade A, Dominski FH, Sieczkowska SM. What we already know about the effects of exercise in patients with fibromyalgia: an umbrella review. Semin Arthritis Rheum. 2020;50:1465–80.
27. Jones KD. Recommendations for resistance training in patients with fibromyalgia. Arthritis Res Ther. 2015;17:258.
28. Vilarino GT, Andreato LV, de Souza LC, Branco JHL, Andrade A. Effects of resistance training on the mental health of patients with fibromyalgia: a systematic review. Clin Rheumatol. 2021;40:4417–25.
29. Neelapala YVR, Mercuri D, Macedo L, Hanna S, Kobsar D, Carlesso L. Mechanisms hypothesized for pain-relieving effects of exercise in fibromyalgia: a scoping review. Ther Adv Musculoskelet Dis. 2023; 15:1759720X231182894.
30. Fitzcharles MA, Ste-Marie PA, Goldenberg DL, Pereira JX, Abbey S, Choinière M, et al. 2012 Canadian Guidelines for the diagnosis and management of fibromyalgia syndrome: executive summary. Pain Res Manag. 2013;18:119–26.
31. Macfarlane GJ, Kronisch C, Dean LE, Atzeni F, Häuser W, Fluß E, et al. EULAR revised recommendations for the management of fibromyalgia. Ann Rheum Dis. 2017;76:318–28.

32. Vierck CJ Jr, Staud R, Price DD, Cannon RL, Mauderli AP, Martin AD. The effect of maximal exercise on temporal summation of second pain (windup) in patients with fibromyalgia syndrome. J Pain. 2001;2: 334–44.
33. Lannersten L, Kosek E. Dysfunction of endogenous pain inhibition during exercise with painful muscles in patients with shoulder myalgia and fibromyalgia. Pain. 2010;151:77–86.