ORIGINAL ARTICLE

Evaluation of the presence of sarcopenia and the relationship with disease activity in fibromyalgia

Evaluación de la presencia de sarcopenia y su relación con la actividad de la enfermedad en la fibromialgia

Pınar Ö. Başaran and Dilek E. Büyükşireci*

Department of Physical Medicine and Rehabilitation, Hitit University Erol Olçok, Education and Research Hospital, Çorum, Turkey

Abstract

Objective: *The objective of this study was to investigate the presence of sarcopenia in fibromyalgia and whether there is any relationship between physical performance, disease activity, pain levels, and the existence of sarcopenia.* **Method:** *Fifty female patients diagnosed with fibromyalgia syndrome (FMS) based on the classification criteria of the 2016 American College of Rheumatology and 50 healthy controls were admitted. Disease activity was evaluated with the Fibromyalgia Impact Questionnaire (FIQ) and pain level was evaluated with the Numerical Rating Scale. Sarcopenia was screened by the SARC-F questionnaire and the presence of sarcopenia was evaluated according to ISarcoPRM criteria. Furthermore, right-hand grip strength was evaluated with a dynamometer. Ultrasound was used to measure the anterior thigh muscle thickness on the quadriceps femoris.* **Results:** *SARF-C scores were significantly higher in patients with FMS ($p < 0.001$). The presence of sarcopenia was found as 20 (40%) in FMS patients and 6 (12%) in healthy controls ($p < 0.001$). Right-hand grip strength was significantly different in patients with FMS ($p = 0.007$). Right anterior thigh muscle thickness was similar in the two groups ($p = 0.875$). A positive correlation was observed between FIQ score and SARF-C score in FMS patients with sarcopenia ($r = 0.708$, $p < 0.001$).* **Conclusion:** *Sarcopenia was thought of as a common problem in patients with FMS. Evaluating sarcopenia in patients with FMS could enhance the effectiveness of FMS treatment.*

Keywords: *Disease activity. Fibromyalgia. Sarcopenia. Ultrasonography.*

Resumen

Objetivo: *Investigar la presencia de sarcopenia en la fibromialgia y si existe alguna relación entre el rendimiento físico, la actividad de la enfermedad, los niveles de dolor y la existencia de sarcopenia.* **Método:** *Ingresaron 50 mujeres diagnosticadas de síndrome de fibromialgia (SFM) según los criterios de clasificación del American College of Rheumatology de 2016 y 50 mujeres sanas como controles. La actividad de la enfermedad se evaluó con el Fibromyalgia Impact Questionnaire (FIQ) y el nivel de dolor con la Numerical Rating Scale. La sarcopenia se detectó mediante el cuestionario SARC-F y su presencia se evaluó según los criterios ISarcoPRM. También se evaluó la fuerza de prensión de la mano derecha con un dinamómetro. Se utilizó ecografía para medir el grosor muscular de la cara anterior del muslo en el cuádriceps femoral.* **Resultados:** *Las puntuaciones SARC-F fueron significativamente mayores en las pacientes con SFM ($p < 0.001$). Se detectó presencia de sarcopenia en 20 (40%) de las pacientes con SFM y en 6 (12%) de las controles sanas ($p < 0.001$). La fuerza de prensión de la mano derecha fue significativamente diferente en las pacientes con SFM ($p = 0.007$). El grosor del músculo anterior derecho del muslo fue similar en los dos grupos ($p = 0.875$). Se observó una correlación positiva entre las puntuaciones FIQ y SARC-F en las*

***Correspondence:**
Pınar Ö. Başaran
E-mail: pinarozge@yahoo.com

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pacientes con SFM y sarcopenia (r = 0.708; p < 0.001). **Conclusiones:** *La sarcopenia se consideró un problema común en las pacientes con SFM. La evaluación de la sarcopenia en pacientes con SFM podría mejorar la eficacia del tratamiento del SFM.*

Palabras clave: *Actividad de la enfermedad. Fibromialgia. Sarcopenia. Ultrasonografía.*

Introduction

Fibromyalgia syndrome (FMS) is a chronic rheumatic condition characterized by numerous symptoms, including tenderness in specific areas of the body, reduced pain threshold, fatigue, psychological issues, and sleep disturbances[1]. FMS affects approximately 2% of the general population, predominantly middle-aged women[2]. In a study conducted with 1930 females in Türkiye, the prevalence of fibromyalgia was found to be 3.6%[3]. Patients were diagnosed with FMS based on the 2016 diagnostic criteria established by the American College of Rheumatology (ACR)[4]. The etiology and pathogenesis of FMS are not fully known. Furthermore, genetic disorders, and causal factors such as the occurrence of trauma, the inflammation process, mental stress, and infections may change the neuroendocrine mechanisms related to pain or can trigger deterioration[5].

Sarcopenia is characterized as a progressive and generalized musculoskeletal disorder involving accelerated muscle mass decline and functional impairment[6]. It is a relatively uncommon condition in the musculoskeletal spectrum. The European Working Group on Sarcopenia in Older People (EWGSOP)[6] established a consensus definition and clinical diagnostic criteria for sarcopenia in 2010, later updated as EWGSOP2 in January 2019[7]. There is limited research exploring the association between fibromyalgia and sarcopenia. Within the International Society of Physical and Rehabilitation Medicine (ISPRM) framework, Kara et al.[8] determine the diagnostic algorithm for sarcopenia (ISarcoPRM). And also Kara et al.[9] used the ultrasonographic evaluation to clarify the diagnoses of sarcopenia.

Because of widespread body pain, physical activity level decreases in FMS. A small number of studies in the literature have examined the relationship between fibromyalgia and sarcopenia[10,11]. Our study aims to explore the prevalence of sarcopenia in fibromyalgia patients using the new ISarcoPRM criteria and to investigate potential correlations between physical performance, disease activity, pain levels, and sarcopenia presence.

Method

This cross-sectional study was conducted in the Turkish population and included 50 female patients diagnosed with FMS based on the 2016 ACR criteria, along with 50 healthy controls matched for age and sex. The participants were recruited from the Physical Medicine and Rehabilitation outpatient clinic for routine health check-ups, including physical examinations and hemogram measurements, between August 2023 and December 2023. The study received ethical approval from the Local Ethics Committee of the University (decision number 114, 2023) and adhered to the principles of the Declaration of Helsinki. All participants provided informed consent before enrollment, and they were thoroughly briefed about the study protocol.

Female subjects between 25-65 years old, diagnosed with fibromyalgia for at least 6 months were included in the study. Patients undergoing physical therapy in the past 3 months, had a history of concomitant rheumatic disease, diabetes mellitus, hypertension, myopathies, diseases that affect ambulation such as lower extremity operations, peripheral or central nervous system disease, severe lung or heart failure, kidney or liver diseases, malignancy, pregnancy or breastfeeding or any psychiatric disorder, and any medications that could influence muscle function, such as steroids were excluded from the study. After the demographic characteristics of the patients were recorded, physical examinations were performed and body mass indexes (BMI) were noted. All evaluations were made by the same physician.

The Fibromyalgia Impact Questionnaire (FIQ) was used to evaluate the disease activity and it comprises ten items organized into three domains: functional, physical symptoms, and mental symptoms. Each item is rated on a scale (0-10), where lower scores indicate better disease activity. Sarmer et al.[12] established the reliability of the FIQ in the Turkish population.

The numerical rating scale (NRS)[13] was employed to evaluate pain levels, where patients rated their pain on a scale from 0 to 10, high scores describe more severe pain.

Sarcopenia was screened by the SARC-F questionnaire[14]. It includes five questions, each question scores 0-2 points. Five domains are rising from chair strength, stair climbing, walking ability, and history of falls. A score of 4 points or higher is indicative of sarcopenia.

The presence of sarcopenia was evaluated according to ISarcoPRM[8]. According to ISarcoPRM diagnostic algorithm for sarcopenia, the first hand grip strength was measured with a Jamar dynamo meter in kilograms (Saehan hydraulic hand dynamometer)[15]. Patients performed the test 3 times with each hand, with 30 s rest between trials then an average of three trials calculated separately for the right and left hands. Results under 19 kg were assessed as probable sarcopenia. Then, anterior thigh muscle thicknesses were evaluated with ultrasonography. Ultrasound was used to measure the anterior thigh muscle thickness on the quadriceps femoris. All measurements were conducted by the same researcher. A multi-frequency probe (6-12 MHz: Philips purewave) was utilized for ultrasound examinations. Participants were positioned supine with legs extended and muscles relaxed, and images were captured midway between the superior border of the patella and the anterior superior iliac spine. Sonographic Thigh Adjustment Ratio (STAR) is already suggested for the diagnosis of sarcopenia[8]. If the ratio was under 1.0 in females, this was accepted as sarcopenia. The presence of sarcopenia was recorded.

Physical performance was assessed with the test of five times sit-to-stand test (FTSST) and usual gait speed with 6 meters walk test (6MWT). At FTSST subjects sit down without touching the back of the chair and stand up fully for 5 times and time was measured in seconds[16]. The 6MWT, a 6-m flat path, was marked on the hospital corridor, participants walked on the path and walking time was measured in seconds[17]. Above 15 s was accepted as a disability according to the ISarcoPRM diagnostic algorithm[8].

Statistical analysis

SPSS for Windows version 16.0 software was used for statistical analysis. The normal distribution of variables was assessed visually and with the Kolmogorov–Smirnov test. Continuous data were presented as mean ± standard deviation or median with interquartile range, while categorical data were summarized as frequencies and percentages. Parametric data were compared using the Student t-test, and non-parametric data using the Mann-Whitney U-test. Correlations between patient characteristics and clinical parameters were evaluated using Spearman and Pearson correlation coefficients. Statistical significance was set at $p < 0.05$

Results

Age, weight, height, and BMI were similar in FMS patients and the control group (Table 1). SARF-C score, 6MWT, and FTSST tests were significantly higher in patients with FMS ($p < 0.001$). The presence of sarcopenia was found as 20 (40%) in FMS patients and 6 (12%) in healthy controls according to ISarcoPRM criteria ($p < 0.001$). Right-hand grip strength was significantly different in patients with FMS ($p = 0.007$). Right anterior thigh muscle thickness is similar in the two groups ($p = 0.875$). FTSST and 6MWT were significantly decreased in FMS patients ($p < 0.001$).

NRS and FIQ scores were not different between FMS patients with sarcopenia and FMS patients without sarcopenia (Table 2). A positive correlation was found between FIQ score and SARF-C score in FMS patients with sarcopenia ($r = 0.708$, $p < 0.001$). However, FIQ score was not correlated with anterior thigh muscle thickness, hand grip strength, 6MWT, and FTSST tests (Table 3).

Discussion

This study revealed an elevated prevalence of sarcopenia among patients with FMS. Although there is no difference in anterior thigh muscle thickness measured by USG, we evaluated a loss in physical performance and hand grip muscle strength in patients with FMS. We identified a correlation between the severity of fibromyalgia symptoms and the presence of sarcopenia.

There are a few studies investigating the frequency of sarcopenia in FMS[11,12]. An important point about our study was that we used the US for diagnosing sarcopenia. Dual X-ray absorptiometry (DXA), magnetic resonance imaging (MRI), computerized tomography (CT), ultrasonography (US), and bio-electrical impedance analysis (BIA) can be used for evaluating muscle mass. In addition to the radiation to which the patient is exposed, specific muscle mass cannot be evaluated by DXA. CT and MRI are the gold standard methods for quantifying muscle mass but they are expensive and time-consuming procedures. The US is portable, easier, and cheaper. Because of that, we used the US

Table 1. Demographic and clinical features of the participants

Patients' characteristics	Fibromyalgia group (n = 50)	Healthy controls (n = 50)	p
Age (year)	46.70 ± 8.78	43.82 ± 8.71	0.103
Height (cm)	156.55 ± 6.51	159.21 ± 6.94	0.051
Weight (kg)	69.6 (64.62-78.52)	67.1 (63.5-75.32)	0.285
BMI (kg/m2)	29.56 ± 4.55	27.77 ± 4.70	0.057
NRS	9 (6-10)		
Fibromyalgia Impact Questionnaire (FIQ)	74.8 (53.96-85.65)		
SARF-C	4.8 ± 2.31	1.40 ± 1.65	***< 0.001***
SARF-C, n (%)	37 (74%)	10 (20%)	***< 0.001***
6MWT (s)	11.64 ± 2.61	7.47 ± 1.43	***< 0.001***
FTSST (s)	14.40 ± 3.56	8.01 ± 1.27	***< 0.001***
Right hand grip strength (kg)	21.02 ± 7.33	24.60 ± 5.37	0.007
Right anterior thigh muscle thickness (mm)	16.3 ± 4.2	16.4 ± 3.5	0.875
Presence of sarcopenia, n (%)	20 (40%)	6 (12%)	0.001

BMI: body mass index; NRS: numeric rating scale; SARF-C: a simple questionnaire to rapidly diagnose sarcopenia; 6MWT: 6 m walk test; FTSST: five times sit-to-stand test. n: number. Numerical data are given as mean ± standard deviation or median (interquartile range) values. p values in bold and italics indicate statistically significant.

Table 2. Clinical features of fibromyalgia patients with sarcopenia and without sarcopenia

Variables	Patients with sarcopenia (n = 20)	Patients without sarcopenia (n = 30)	p
Age	46.85 ± 9.12	46.6 ± 8.7	0.923
NRS	8.20 ± 2.11	7.53 ± 2.37	0.315
Fibromyalgia Impact Questionnaire (FIQ)	76.57 (68.02-89.06)	73.9 (53.32-84.0)	0.373
SARF-C	5.85 ± 2.39	4.10 ± 2.0	***0.007***
6MWT (s)	15.87 ± 3.33	13.43 ± 3.43	***0.016***
FTSST (s)	12.78 ± 2.72	10.89 ± 2.28	***0.011***
Right anterior thigh muscle thickness (mm)	1.68 ± 0.43	1.55 ± 0.41	0.573
Right hand grip strength (kg)	14.1 ± 3.5	25.63 ± 5.2	***< 0.001***

NRS: numeric rating scale; SARF-C: a simple questionnaire to rapidly diagnose sarcopenia; 6MWT: 6 m walk test; FTSST: five times sit-to-stand test; n: number. Numerical data are given as mean ± standard deviation or median (interquartile range) values. p values in bold and italics indicate statistically significant.

for evaluating the muscle mass in our study according to ISarcoPRM criteria.

In a previous study[18], quadriceps femoris muscle mass, evaluated by ultrasonography, was found to be significantly lower in FMS patients. However, this study did not investigate the relationship between muscle mass, muscle strength, and physical performance. In a larger study[19], muscle mass was assessed using BIA, revealing no differences between FMS patients and healthy controls. Our study found similar anterior thigh muscle mass thickness between FMS patients and healthy participants. Despite no observed loss of muscle mass, our research identified reduced muscle strength in patients with FMS. Unlike these two studies, we utilized ultrasound for evaluation, employing a more detailed methodology.

Table 3. Correlation between sarcopenia criteria and clinical features in fibromyalgia patients with sarcopenia

Variables	SARF-C	6MWT (s)	FTSST (s)	Right anterior thigh muscle thickness (mm)	Right hand grip strength (kg)
Age*	r = 0.192 p = 0.418	r = 0.402 p = 0.079	r = 0.405 p = 0.077	r = –0.168 p = 0.479	r = –0.272 p = 0.245
NRS*	r = 0.204 p = 0.389	r = 0.056 p = 0.815	r = 0.401 p = 0.080	r = –0.221 p = 0.348	r = –0.222 p = 0.346
Fibromyalgia Impact Questionnaire (FIQ)	r = ***0.708*** p = ***0.000***	r = 0.132 p = 0.578	r = 0.059 p = 0.806	r = –0.063 p = 0.791	r = –0.100 p = 0.675

SARF-C: a simple questionnaire to rapidly diagnose sarcopenia; 6MWT: 6 m walk test; FTSST: five times sit-to-stand test; NRS: numeric rating scale; *Pearson correlation.
Values in bold and italics indicate statistically significant.

Some studies showed that muscle strength and physical performance reductions were found in FMS patients similar to our study[6,20,21]. These studies also showed a relationship between disease activity and quadriceps femoris muscle strength[21-23]. We found decreased hand grip strength in patients with FMS. However, we did not evaluate the quadriceps femoris muscle strength and we did not find a relationship between hand grip strength and disease activity in our study.

We did not classify patients according to the duration of fibromyalgia diagnosis or age range. Muscle strength may decrease more over time in patients with long-term disease[10]. At the same time, if patients were classified according to their age range, different results related to muscle strength may be obtained. In the previous study, patients with FMS were examined at 10-year age intervals and hand strength decreased significantly every 10 years, although muscle mass remained the same[19]. Devrimsel et al.[23] found higher hand disability scores in patients with FMS than in healthy populations. This shows that the assessment of hand strength is not only useful for screening sarcopenia but also may help to prevent disability. According to the results of our study, it is useful to be vigilant for sarcopenia in FMS patients with low hand grip muscle tests.

The previous study conducted in patients who developed sarcopenia after COVID-19 infection showed that high-intensity exercise increases hand grip strength, physical performance, and quality of life compared to low-intensity exercise[24]. Likewise, in the previous studies, we also found a significant loss in physical performance in FMS patients compared to healthy controls[6,20,21]. It is debatable whether fibromyalgia itself reduces physical performance or whether physical activity and, therefore, poor performance trigger fibromyalgia. In conclusion, the increased prevalence of sarcopenia and poor physical performance which we found in fibromyalgia patients may be due to lack of physical activity. In this case, an increased frequency of sarcopenia in fibromyalgia patients seems to be an expected result. This study once again emphasizes the importance of exercise and strategies to prevent sarcopenia and improve the quality of life in patients with fibromyalgia. Another study conducted in elderly adults found that patients with sarcopenia had higher mortality during in-hospital follow-up[25]. A meta-analysis involving women with ovarian cancer showed that sarcopenia and low muscle mass were associated with poor survival and high mortality[26]. This suggests that sarcopenia is not only associated with quality of life but also with mortality in later life. For this reason, it is important to be diagnosed and treated at a young age.

Some studies were found that patients with FMS had significantly decreased muscle strength, functional performance, and exercise capacity compared with healthy individuals[27-29]. Also in some studies, the values of the fat mass percentage were found higher in FMS patients[30]. In FMS, insulin-like growth factor I levels decrease, and proinflammatory cytokines IL-1beta, and TNF-a are increased[31]. These cytokines are also thought that they be associated with the development of sarcopenia[32]; on all these facts, there may be a connection between sarcopenia and FMS.

Chronic muscle pain has a great impact on the performance of daily activities. Being aware that the pain occurs with isokinetic movements has been reported among the possible causes of poor muscle performance in patients with FMS[28,29]. In our study, there was no relationship between sarcopenia and pain level in patients with FMS. This may suggest that there are more different factors than pain that play a role in muscle mass and strength in fibromyalgia.

FMS occurs in young women of reproductive age. In patients who develop sarcopenia at this age, not only functionality is affected but it alos can cause serious morbidity in patients at older ages. Sarcopenia in the elderly is an expected outcome, but affecting women of this age may also cause socioeconomic problems. So far, no complete protocol has been applied in previous studies on sarcopenia in patients with FMS. In a study, sarcopenia was assessed only by muscle strength, in the other only by the US or by functional status. In our study, we used both the SARC-F questionnaire, upper and lower extremity performance, and at the end US as an objective assessment parameter. This was a valuable study because there are a few studies about FMS and sarcopenia in the literature and sarcopenia is common in young women with FMS. However, there are some limitations in our study. Only female FMS patients were invited to our study and we did not comment on male FMS patients. Second, we did not know the other conditions that can affect sarcopenia such as physical activity levels, and nutritional status.

Conclusion

As a result of this study, we think that sarcopenia is common in patients with FMS. Hand strength is useful for suspecting sarcopenia. Assessing the presence of sarcopenia in FMS patients may improve the success of FMS treatment by improving the exercise program.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that the procedures followed complied with the ethical standards of the responsible Human Experimentation Committee and adhered to the World Medical Association and the Declaration of Helsinki. The procedures were approved by the Institutional Ethics Committee.

Confidentiality, informed consent, and ethical approval. The authors have followed their institution's confidentiality protocols, obtained informed consent from patients, and received approval from the Ethics Committee. The SAGER guidelines were followed according to the nature of the study.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

References

1. Wolfe F, Ross K, Anderson J, Russell IJ, Hebert L. The prevalence and characteristics of fibromyalgia in the general population. Arthritis Rheum. 1995;38:19-28.
2. 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.
3. Topbas M, Cakirbay H, Gulec H, Akgol E, Ak I, Can G. The prevalence of fibromyalgia in women aged 20-64 in Turkey. Scand J Rheumatol. 2005;34:140-4.
4. Wolfe F, Clauw DJ, Fitzcharles MA, Goldenberg DL, Häuser W, Katz RL, et al. 2016 Revisions to the 2010/2011 fibromyalgia diagnostic criteria. Semin Arthritis Rheum. 2016;46:319-29.
5. Clauw DJ. Fibromyalgia: update on mechanisms and management. JCR J Clin Rheumatol. 2007;13:102-9.
6. Cruz-Jentoft AJ, Sayer AA. Sarcopenia. Lancet. 2019;29:2636-46.
7. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;48:16-31.
8. Kara M, Kaymak B, Frontera W, Ata AM, Ricci V, Ekiz T, et al. Diagnosing sarcopenia: functional perspectives and a new algorithm from the ISarcoPRM. J Rehabil Med. 2021;53:jrm00209.
9. Kara M, Kaymak B, Ata AM, Özkal Ö, Kara Ö, Baki A, et al. STAR-sonographic thigh adjustment ratio: a golden formula for the diagnosis of sarcopenia. Am J Phys Med Rehabil. 2020;99:902-8.
10. Kapuczinski A, Soyfoo MS, De Breucker S, Margaux J. Assessment of sarcopenia in patients with fibromyalgia. Rheumatol Int. 2022;42:279-84.
11. Koca I, Savas E, Ozturk ZA, Boyaci A, Tutoglu A, Alkan S, et al. The evaluation in terms of sarcopenia of patients with fibromyalgia syndrome. Wien Klin Wochenschr. 2016;28:816-21.
12. Sarmer S, Ergin S, Yavuzer G. The validity and reliability of the Turkish version of the fibromyalgia impact questionnaire. Rheumatol Int. 2000;20:9-12.
13. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: a systematic literature review. J Pain Symptom Manage. 2011;41:1073-93.
14. Malmstrom TK, Morley JE. SARC-F: a simple questionnaire to rapidly diagnose sarcopenia. J Am Med Dir Assoc. 2013;14:531-2.
15. Innes E. Handgrip strength testing: a review of the literature. Aust Occup Ther J. 1999;46:120-40.
16. Lord SR, Murray SM, Chapman K, Munro B, Tiedemann A. Sit-to-stand performance depends on sensation, speed, balance, and psychological status in addition to strength in older people. J Gerontol A Biol Sci Med Sci. 2002;57:539-43.
17. Tan DM, McGinley JL, Danoudis ME, Iansek R, Morris ME. Freezing of gait and activity limitations in people with Parkinson's disease. Arch Phys Med Rehabil. 2011;92:1159-65.
18. Umay E, Gundogdu I, Ozturk EA. What happens to muscles in fibromyalgia syndrome. Ir J Med Sci. 2020;189:749-56.
19. Latorre-Román PÁ, Segura-Jiménez V, Aparicio VA, Santos E Campos MA, García-Pinillos F, et al. Ageing influence in the evolution of strength and muscle mass in women with fibromyalgia: the al-Ándalus project. Rheumatol Int. 2015;35:1243-50.
20. Sener U, Ucok K, Ulasli AM, Genc A, Karabacak H, Coban NF, et al. Evaluation of health-related physical fitness parameters and association analysis with depression, anxiety, and quality of life in patients with fibromyalgia. Int J Rheum Dis. 2016;19:763-72.
21. Norregaard J, Bulow PM, Lykkegaard JJ, Mehlsen J, Danneskiold-Samsoe B. Muscle strength, working capacity and effort in patients with fibromyalgia. Scand J Rehabil Med. 1997;29:97-102.
22. Aparicio VA, Ortega FB, Heredia JM, Carbonell-Baeza A, Sjöström M, Delgado-Fernandez M. Handgrip strength test as a complementary tool in the assessment of fibromyalgia severity in women. Arch Phys Med Rehabil. 2011;92:83-8.

23. Devrimsel G, Turkyilmaz AK, Beyazal MS, Karkucak M. Assessment of hand function and disability in fibromyalgia. Z Rheumatol. 2019;78: 889-93.
24. Ibrahim AA, Dewir IM, Abu El Kasem ST, Ragab MM, Abdel-Fattah MS, Hussein HM. Influences of high vs. low-intensity exercises on muscle strength, function, and quality of life in post-COVID-19 patients with sarcopenia: a randomized controlled trial. Eur Rev Med Pharmacol Sci. 2023;27:9530-9.
25. Tufan A, Tolu T, Senturk Durmus N, Alkac C, Can B. FRAIL Scale: an independent predictor of in-hospital mortality among older adults. Eur Rev Med Pharmacol Sci. 2023;27:10396-402.
26. Ge HP, Song DF, Wu P, Xu HF. Impact of sarcopenia and low muscle attenuation on outcomes of ovarian cancer: a systematic review and meta-analysis. Eur Rev Med Pharmacol Sci. 2023;27:4544-562.
27. Maquet D, Croisier JL, Renard C, Crielaard JM. Muscle performance in patients with fibromyalgia. Joint Bone Spine. 2002;69:293-9.
28. Góes SM, Leite N, Shay BL, Homann D, Stefanello JM, Rodacki AL. Functional capacity, muscle strength and falls in women with fibromyalgia. Clin Biomech (Bristol). 2012;27:578-83.
29. Larsson A, Palstam A, Bjersing J, Löfgren M, Ernberg M, Kosek E, et al. Controlled, cross-sectional, multi-center study of physical capacity and associated factors in women with fibromyalgia. BMC Musculoskelet Disord. 2018;19:121.
30. Lobo MM, Paiva ED, Andretta A, Schieferdecker ME. Body composition by dual-energy X-ray absorptiometry in women with fibromyalgia. Rev Bras Reumatol. 2014;54:273-8.
31. Salemi S, Rethage J, Wollina U, Michel BA, Gay RE, Gay S, et al. Detection of interleukin 1beta (IL-1beta), IL-6, and tumour necrosis factor-alpha in skin of patients with fibromyalgia. J Rheumatol. 2003;30:146-50.
32. Beaudart C, McCloskey E, Bruyère O, Cesari M, Rolland Y, Rizzoli R, et al. Sarcopenia in daily practice: assessment and management. BMC Geriatr. 2016;16:170.