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The evaluation in terms of sarcopenia of patients with fibromyalgia syndrome

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Summary
Background Fibromyalgia syndrome (FMS) is an extra-articular rheumatic illness, characterized by widespread body pain and decreased muscle function. Generalized loss of muscle mass and strength is named as sarcopenia. The objective of this study was to evaluate patients with FMS regarding sarcopenia.

Methods This was a cross sectional, case-controlled, single-blinded, and single-centered study. The FMS patients were assessed by Fibromyalgia Impact Questionnaire (FIQ), visual analog scale (VAS), Beck Depression Index (BDI), and Pittsburg Sleep Quality Scale (PSQI). All the participants were evaluated for sarcopenia by bioimpedance analysis (BIA), anthropometric measurements, handgrip strength, and the parameters of walking speed.

Results In this study, 82 patients with FMS and 38 healthy control female subjects were included. VAS, BDI, and PSQI scores were statistically higher in the FMS group than the control group ($p<0.001$). Handgrip strength (HS) and walking speed (WS) scores in the group with FMS were statistically lower than the control group ($p=0.023$, $p<0.001$ respectively). VAS score of FMS patients was significantly correlated with BIA, body mass index, waist circumference, HS, and WS scores ($r=0.284$, $p=0.012$; $r=0.228$, $p=0.045$; $r=0.249$, $p=0.028$; $r=-0.361$, $p=0.001$; and $r=-0.230$, $p=0.043$ respectively). Also FIQ in patients was significantly correlated with BIA, waist circumference, HS, WS, and body mass index ($r=0.267$, $p=0.018$; $r=0.291$, $p=0.010$; $r=-0.319$, $p=0.004$; $r=-0.360$, $p=0.001$; and $r=0.304$, $p=0.007$ respectively).

Conclusion Evaluation of female patients with primary FMS by the sarcopenia parameters could contribute a more objective evaluation during the patients' follow-up.

Keywords Fibromyalgia · Tender point · Sarcopenia

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Introduction

Fibromyalgia syndrome (FMS) is an extra-articular chronic rheumatic disease, characterized by widespread body pain, tenderness in certain anatomical areas, decreased pain threshold, sleep disturbances, fatigue, and psychological distress [1]. It is mostly prevalent in middle-aged women; however, it can also be seen in children and elderly [1, 2]. Although the etiology of FMS has not been clarified yet, it is thought that neuroendocrine dysfunction, as well as central pain mechanisms and central sensitization take part in the occurrence of it. Furthermore, factors such as genetic, trauma, inflamma-

tion, mental stress, infection may trigger or modulate the neuroendocrine abnormalities [3].

In FMS, the typical pain elevation is present 24 h after exercise. The existence of characteristic tender points, the focal reductions of high-energy phosphate levels, the focally distortion of muscle oxygenation in sensitive areas, the reduction in regional pain after the injections in trigger points, pain reduction during an epidural block, the increased activity of needle EMG in the areas of sensitive points are all the signs indicating that pain is related to the peripheral features [4–8]. The decrease in strength and endurance, and the difficulty in the relaxation between contractions have also been reported in patients with FMS [6].

Generalized loss of muscle mass and strength is named as sarcopenia. Usually physical inactivity, decreased mobility, slow walking, and poor physical endurance are accompanied with sarcopenia which are also common features of the fragility syndrome. Sarcopenia is primarily seen in elderly, and it may also develop secondarily, as the inability of usage, immobility, malnutrition, and cachexy [9]. The decrease in anabolic hormones [testosterone, estrogen, growth hormone, insulin-like growth factor-1 (IGF-1)], increased activity of apoptotic myofibrils, increase in proinflammatory cytokines [tumor necrosis factor-alpha (TNF-α), interleukin (IL)-6], increased oxidative stress, the changes of mitochondrial function of muscle cells, the reduction in the number of α-motor neurons, and the changes in neural input are the main factors involved in the pathophysiology of age-related sarcopenia (primary sarcopenia) [10, 11].

According to the literature, sarcopenia is associated with mobility disorders, increased risk of falling, basic daily living activities and the dependence using instruments for daily living, autonomy and balance loss, proprioception loss, osteoporosis, and osteoarthritis possess higher pain scores [12–14].

Fibromyalgia and sarcopenia have common etiological factors or clinical characteristics such as reduction in IGF-I levels, an increase in proinflammatory cytokines, reduction in muscle endurance, which might give the idea that there may be a relationship between fibromyalgia and sarcopenia [11, 15]. Even though there are not any studies regarding FMS patients, who were assessed using the parameters of sarcopenia in the literature, in this current study we aim to evaluate the FMS patients by using the sarcopenia evaluation parameters such as bioimpedans analysis, anthropometric methods, hand grip strength, and walking speed and comparing them with healthy subjects.

Material and method

The study was designed as cross sectional. Patients with FMS and the healthy control group were evaluated with sarcopenia evaluation parameters, considered as a single-blind study.

Participants

Female patients admitted to the rheumatology outpatient clinic and diagnosed FMS according to the American College of Rheumatology (ACR) classification criteria [1] were included as patient group in this study and they aged between 18 and 60. Age and BMI of the groups were matched. Study groups were formed from individuals who applied to the rheumatology outpatient clinic between January 2014 and March 2014.

All participants were informed about the study, and written consent was obtained. Medical history of all participants was questioned in detail. The patients with a history of any neurological diseases, myopathies, diabetes mellitus, goiter, kidney and liver disease, inflammatory rheumatic diseases, osteoporosis, osteomalacia, complex regional pain syndrome, depression, or any other story of psychiatric disorder and patients who had neuropathic or nociceptive pain or took any medical therapy in the last month were excluded from the study.

Evaluation of participants

The age, gender, height (cm), weight (kg), body mass index (BMI, kg/m^2), and educational status of all participants were recorded. The examination of posture, walking and range of motion of all joints, motor, sensory, and deep tendon reflex were performed. The patients with FMS were questioned for the presence of number of painful points, fatigue, paresthesia, sleep disorder, dysmenorrhea in premenopausal women, irritable bowel syndrome, headaches, morning stiffness, swelling, sensation, increased pain with stress, restless leg syndrome, and Raynaud's phenomenon.

Parameters used in the study

Fibromyalgia patients were evaluated with a FIQ. All participants were evaluated with VAS, BDI, PSQI, and sarcopenia. Sarcopenia was evaluated based on the criteria in the *Report of the European Working Group on Sarcopenia in Older People* [16]. BIA, anthropometric measurements, HS, and WS parameters were evaluated by a different doctor who was unaware of the patients' groups.

Fibromyalgia impact questionnaire

This is a scale used to evaluate the condition of the patient with FMS and the results of the disease. A higher score indicates that FMS's negative effects are more severe. In our country, the validity and reliability of that scale was performed by Sarmer et al. [17].

Visual analog scale

It was used to assess the subjective pain intensity. Scale was scored from 0 to 10 (VAS, 0 = no pain, 10 is the most severe pain). The patient is asked to specify the number related to pain [18].

Beck depression inventory

This is a scale measures physical, emotional, cognitive, motivational symptom seen in depression. The Turkish validity and reliability of this scale was performed by Hisli [19].

Pittsburgh sleep quality index

This is a scale that allows assessing the quality of sleep of individuals for the previous month. It consists of seven items to assess subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, daytime dysfunction, and usage of sleeping pill. It was adapted to Turkish patients [20].

Assessment of sarcopenia

Height was measured without shoes using an anthropometric set (Harpenden; Holtain Ltd., Crymych, UK). Body weight was measured by using a calibrated scale with subjects dressed in normal indoor clothing without shoes. BMI was calculated as the body weight divided by the square of the height (kg/m^2) [21].

Waist circumference (WC), the smallest WC between the lowest rib and the processus of anterior superior iliac spine were measured with a tape measure above umblicus parallel to the floor and recorded. Calf circumferences (CC), the widest points of both calves which are assessed using a tape measure were calculated and the average values were recorded. The average value of the measurements of both upper arm circumferences (UAC) were recorded after measuring from the midpoints between the shoulder and elbow [22]. All participants carried out a 6 m walk at their usual pace. The same procedure was repeated three times after patients had rest for 2 min, and the average walking speed was calculated as meters/second (m/s) respectively. A cut-off point of ≤0.8 m/s was considered as a low physical performance [22, 23].

Handgrip strength (in kg) was measured in the hand of the participants using Jamar hand dynamometer (Grip Strength Dynamometer, EH101-37; Camry, Mainland, China). All the measurements were preformed when the patient were in a sitting position, shoulder in adduction and neutral rotation, elbow in 90º flexion, forearm in neutral position, wrist in 0–30° dorsiflexion, and 0–15° ulnar flexion. The patients were asked to maintain maximum grip strength. Measurements were repeated three times and their mean was calculated. During measurement, the Jamar dynamometer was held from the top and the bottom in order to prevent the measurement to be affected by the weight of the device. Low muscle strength was defined as HS less than 22.5 kg [24, 25].

Body composition parameters (body fat percentage, total body fat, and lean body mass) were determined with a BIA system (Model: Omron HBF-352; Omron Healthcare Co. Ltd., 24 Yamanoshita-cho Yamanouchi Ukyo-ku Kyoto-shi, Kyoto 615-0084, Japan). Height was measured using a stadiometer and weight was measured using a manual personal scale.

The basic premise of the BIA procedure is that the volume of fat-free tissue in the body is proportional to the electrical conductivity of the body. Some precautions were taken before the measurements. The data was analyzed using the manufacturer's software, and body fat percentage, total body fat, and lean body mass were determined for each patient. Prediction equations have been validated for multiethnic adults and reference. BIA is widely used as an inexpensive and practical method in the evaluation of muscle mass [26, 27]. BIA measurement techniques have been studied for more than 10 years and the results of BIA under standard conditions have been found to correlate well with MRI prediction which is the gold standard [28, 29]. BIA and anthropometric measurements (BMI, arm, and calf circumference) along with muscle mass have been shown to be correlated [26, 30].

We used a skeletal muscle index (SMI) of 6.75 kg/m^2 in women as cut-off points low skeletal muscle mass based on the reference data in the *European Working Group on Sarcopenia* [16]. The staging of sarcopenia was performed by the participants using "based on the reference data of the European Working Group on Sarcopenia"; the "presarcopenia" stage is characterized by low muscle mass without impact on muscle strength or physical performance. The 'sarcopenia' stage is characterized by low muscle mass, plus low muscle strength or low physical performance. "Severe sarcopenia" is the stage identified when all three criteria of the definition are met (low muscle mass, low muscle strength, and low physical performance) [16].

Statistical analysis: The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 18.0 software (SPSS Inc., Chicago, IL, USA). The distribution of the group was analyzed with the Kolmogorov–Smirnov test. In the study, the Chi-square test was used to compare the discrete variables between groups in the comparison of continuous variables between the groups, Student *t*-test was used for normally distributed data and the Mann–Whitney *U* test was used for a normally distributed ones. The correlations between the parameters were analyzed using Pearson tests. Multiple linear regression analysis was performed to find the independent factors associated with age in the FMS group. All parametric results were expressed as mean ± standard deviation for each group. The significance level was determined as $p < 0.05$. Controlling for age partial correlation was performed to eliminate effect of age as a confounding factor.

Table 1 Demographic and clinical characteristics of participants

	FMS ($n=82$) [Mean ± SD]	Control ($n=38$) [Mean ± SD]	*P*
Age (years)	40.7 ± 2.0	38.8 ± 2.8	0.150
Duration of disease (months)	80.5 ± 4.2	–	
Education ± SD (years)	7.2 ± 2.1	7.9 ± 1.7	0.350
BMI (kg/m^2)	26.2 ± 4.2	25.1 ± 2.1	0.350
VAS score	7.3 ± 1.6	1.2 ± 1.1	**0.001****
BDI score	13.5 ± 3.2	2.6 ± 1.2	**0.001****
PSQI score	9.4 ± 2.2	4.1 ± 1.6	**0.001****
FIQ score	59.9 ± 8.2	–	
Waist circumference (cm)	87.0 ± 6.2	83.4 ± 4.6	0.082
Upper arm circumferences (cm)	29.7 ± 4.6	27.8 ± 2.4	0.075
Calf circumference (cm)	37.6 ± 5.4	35.5 ± 2.2	0.093
Handgrip strength (kg)	23.1 ± 4.3	26.6 ± 5.5	**0.023***
Walking speed (m/s)	0.88 ± 0.2	1.12 ± 0.3	**0.001****
BIA score (kg/m^2)	7.70 ± 1.1	7.8 ± 1.6	0.782

BMI Body mass index, *VAS* Visual analogue scale, *BDI* Beck depression inventory, *BIA* Bioimpedance analysis, *FIQ* Fibromyalgia impact questionnaire, *SD* Standard deviation
*$p<0.05$; **$p<0.001$

Results

In the study, 150 female patients with FMS and 60 healthy female volunteers were screened and 82 patients with FMS and 38 healthy controls, who met the inclusion criteria, were included.

There was no statistically significant difference between FMS and control groups regarding age and the BMI scores. VAS, BDI, and PSQI scores of patients were significantly higher than the control group ($p<0.001$; Table 1).

HS and WS scores in the FMS group were significantly lower than the control group (Table 1). There were nine patients with sarcopenia, four patients with presarcopenia in the FMS group, and two patients with presarcopenia in the control group ($p=0.517$).

VAS score of FMS patients was significantly correlated with BIA, BMI, WC, HS, and WS scores ($r=0.284$, $p=0.012$; $r=0.228$, $p=0.045$; $r=0.249$, $p=0.028$; $r=-0.361$, $p=0.001$; and $r=-0.230$, $p=0.043$ respectively). Also FIQ of patients was significantly correlated with BIA, WC, HS, WS, and BMI ($r=0.267$, $p=0.018$; $r=0.291$, $p=0.010$; $r=-0.319$, $p=0.004$; $r=-0.360$, $p=0.001$; and $r=0.304$, $p=0.007$ respectively). There was significant positive correlation between BDI score WC and BMI (Table 2).

Partial correlation analysis between sarcopenia evaluations parameters and Fibromyalgia Clinical Assessment Scores were done controlling for age to eliminate the effect of age as a confounding factor. On the other hand, partial correlation analysis between VAS and BIA were done controlling for BMI to eliminate the effect of BMI ($r=0.243$, $p=0.033$). Correlation between BIA and VAS was remained significant after elimination effect of BMI.

Discussion

HS and WS scores were significantly decreased in patients with FMS compared to the healthy control group. There was a negative correlation between VAS and FIQ along with HS and WS values, whereas there was a positive correlation between VAS and FIQ along with WC, BMI, and BIA values.

The significant reduction in muscle strength and performance in FMS patients compared to healthy controls have been shown in many studies [25, 31, 32]. Recent studies also reported a significant correlation between reduction in quadriceps muscle strength with disease aggravation [25, 31, 32]. Being aware that the pain occurs with isokinetic movements, pain itself, and the degree of motivation have been reported among the possible causes of the poor muscle performance in patients with FMS [31, 32].

HS is often used as a simple and non-invasive method to assess upper extremity muscle strength [32, 33].

Table 2 Correlation analysis between sarcopenia evaluation parameters with fibromyalgia clinical assessment scores

Variables		WC	UAC	CC	HS	WS	BMI	BIA
Disease duration	*r*	−0.007	−0.013	−0.093	−0.044	0.035	−0.044	0.005
	p	0.952	0.908	0.417	0.701	0.759	0.693	0.963
VAS score	*r*	0.249	0.111	−0.059	−0.361	−0.230	0.228	0.284
	p	0.028*	0.333	0.606	0.001*	0.043*	0.045*	0.012*
FIQ score	*r*	0.291	0.176	0.070	−0.319	−0.360	0.304	0.267
	p	0.010*	0.123	0.542	0.004*	0.001*	0.007*	0.018*
PSQI score	*r*	0.281	0.161	0.115	−0.177	−0.307	0.221	0.049
	p	0.013*	0.159	0.317	0.121	0.006*	0.052	0.673
BDI score	*r*	0.238	0.121	0.136	−0.194	−0.165	0.232	0.012
	p	0.036*	0.291	0.235	0.088	0.150	0.041*	0.918

Controlling for age partial correlation was performed to eliminate the effect of age as a confounding factor
WC Waist circumference, *UAC* Upper arm circumferences, *CC* Calf circumferences, *HS* Handgrip strenght, *WS* Walking speed, *BMI* Body mass index, *VAS* Visual analogue scale, *BDI* Beck depression inventory, *BIA* Bioimpedance analysis, *FIQ* Fibromyalgia impact questionnaire
*$p<0.05$

Maguet et al. [32] found that HS was 27% lower than the control group in female patients with FMS. Similar results were found by Mengshoel et al. [34]. Additionally, positive correlation between muscle strength and pain threshold was shown in FMS [25, 32]. Our study's results are consistent with the literature regarding the presence of significant decrease in HS patients with FMS compared to the healthy control group and significant negative correlation between HS and VAS with FIQ scores were found in patients with FMS. In this study, decreased HS in FMS patients may be explained with the patient's motivation level, impaired muscle ultrastructure, and pain.

In the literature, there are studies reporting significant decrease in static muscle endurance and functional capacity in patients with FMS [30, 31, 33]. In our study, patients with FMS have not been evaluated in terms of their endurance, but the walking speed in patients with FMS compared to controls have been found to be significantly lower. Also, there was a significantly negative correlation between VAS and FIQ scores with WS.

In our study, no significant differences were detected between the FMS and the control groups regarding BIA and anthropometric measurements scores. However, VAS and FIQ scores are positively correlated with BMI, BIA, and WC in patients with FMS. Previous research has demonstrated that, greater BMI is associated with greater pain severity, greater number of tender points, reduced physical strength and flexibility, and higher symptom burden in fibromyalgia [35–37].

In a study Kim et al. [35] found that the groups with the greater BMI had greater fibromyalgia-related symptoms with worse FIQ total scores. These findings are similar to our results.

According to these results we may say that weight loss may improve physical functioning in patient with FMS.

It is important to note that VAS, FIQ along with BIA scores had significant positive correlation. There are not any studies regarding this correlation according to the literature. It is a known fact that there is a relationship between severity of pain and tender points of certain muscle mass in FMS. Additionally it is reported that FMS patient's pain scores elevated after anaerobic exercises [5, 32], which strengthen and build muscle. In this regard, it can be concluded that patients with higher muscle mass may have higher perception of pain sensing. Muscle strengthening aerobic exercises might be suggested instead of anaerobic exercises that build muscle mass.

On the other hand, partial correlation analysis between VAS and BIA were done controlling for BMI to eliminate the effect of BMI. There was a positive correlation between BIA and VAS even after this analysis ($r=0.243$, $p=0.033$). BIA is positively correlated to VAS, independently from BMI and age. Pain level is elevated with muscle mass increase in fibromyalgia. Further studies are needed to evaluate relationship between muscle mass and pain elevation.

In the literature, there are many studies indicating that the sleep quality in patients with FMS is impaired [2, 25, 38]. Similarly in our study, sleep quality scores were found to be significantly impaired in the FMS group compared to the control group. In addition, in our study poor sleep quality was correlated with the increase in WC scores and decrease in WS scores in FMS patients.

In the literature, there are many studies indicating that depression scores in patients with FMS are worse than healthy control group. However, the causal relationship between depression and pain has not been fully elucidated [25, 39]. In our study, depression scores in the FMS group were found to be significantly higher compared to the control group. However, a significant positive correlation was determined between BDI scores and WC, BMI in the FMS group.

The major limitations in our study are; the cross sectional nature of this study, only female patients who have primary FMS and aged 18–60 years have been included, the assessment was not done according to the number of tender points and pain thresholds, and the participants have not been categorized according to their exercise habits.

In conclusion, the standard and objective tests or parameters to be especially used in determining the severity of disease and measurement of treatment effectiveness are not available for patients with FMS. In this context, we believe that the evaluation of female patients with FMS, using the sarcopenia evaluation parameters can contribute to a more objective evaluation of treatment effectiveness and follow-up process. However, further studies are needed with a broader participation in this regard.

Conflict of interest

The authors declare that there are no actual or potential conflicts of interest related to this article.

References

1. Wolfe F, Ross K, Anderson J, Russell I, Hobert L. The prevalence and characteristics of fibromyalgia in the general population. Arthritis Rheum. 1995;38:19–28.
2. White KP, Speechley M, Harth M, Ostbye T. The London fibromyalgia epidemiology study: comparing the demographic and clinical characteristics in 100 random community cases of fibromyalgia versus controls. J Rheumatol. 1999;26:1577–85.
3. Clauw D. Fibromyalgia: update on mechanism and management. J Clin Rheumatol. 2007;13:102–9.
4. Bennett RM. The fibromyalgia syndrome. In: Kelley WN, Haris ED, Ruddy S, Sledge CB, Editors. Textbook of rheumatology. Philadelphia: WB Saunders Company; 1997. pp. 511–9.
5. Bennett RM, Clark SR, Goldberg L, Nelson D, Bonafede RF, Porter J, et al. Aerobic fitness in patients with fibrositis: a controlled study of respiratory gas exchange and xenon clearence from exercising muscle. Arthritis Rheum. 1989;32:454–60.
6. Elert J, Dalhqvist SR, Alamy B, Eisemann B. Muscle endurance, muscle tension and personality traits in patients with mucle or joint pain: a pilot study. J Rheumatol. 1993;20:1550–6.

7. Bennett RM, Clark SC, Walczyk J. A randomized, double-blind, placebo- controlled study of growth hormone in the treatment of fibromyalgia. Am J Med. 1998;104:227–31.
8. Bengtsson A, Henriksson KG, Larsson J. Muscle biopsy in primary fibromyalgia: light microscopical and histochemical findings. Scand J Rheumatol. 1986;15:1–6.
9. Burton LA, Sumukadas D. Optimal management of sarcopenia. Clin Interv Aging. 2010;5:217–28.
10. Cesari M, Leeuwenburgh C, Lauretani F, Onder G, Bandinelli S, Maraldi C. Fragility syndrome and skeletal muscle: results from the Invecchiare in Chianti study. Am J Clin Nutr. 2006;83:1142–8.
11. Muscaritoli M, Anker SD, Argilés J, Aversa Z, Bauer JM, Biolo G, et al. Consensus definition of sarcopenia, cachexia and pre-cachexia: joint document elaborated by Special Interest Groups (SIG) "cachexia-anorexia in chronic wasting diseases" and "nutrition in geriatrics". Clin Nutr. 2010;29:154–9.
12. Hairi NN, Cumming RG, Naganathan V, Handelsman DJ, Couteur DG L, Creasey H, et al. Loss of muscle strength, mass (sarcopenia), and quality (specific force) and its relationship with functional limitation and physical disability: the concord health and ageing in men project. J Am Geriatr Soc. 2010;58:2055–62.
13. Frisoli A Jr, Chaves PH, Ingham SJ, Fried LP. Severe osteopenia and osteoporosis, sarcopenia, and frailty status in community- dwelling older women: results from the women's health and aging study (WHAS) II. Bone. 2010;48(4):952–7.
14. Lee S, Kim TN, Kim SH. Sarcopenic obesity is more closely associated with knee osteoarthritis than is nonsarcopenic obesity: a cross-sectional study. Arthritis Rheum. 2012;64:3947–54.
15. Salemi S, Rethage J, Wollina U, Michel BA, Gay RE, Gay S, Sprott H, et al. Detection of IL-1b, IL-6 and TNF-a in skin of fibromyalgia patients. J Rheumatol. 2003;30:146–50.
16. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, et al. European working group on sarcopenia in older people. Sarcopenia: European consensus on definition and diagnosis: report of the European working group on sarcopenia in older people. Age Ageing. 2010;39:412–23.
17. 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.
18. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. Pain. 1983;17:45–56.
19. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. Beck depression inventory. An inventory for measuring depression. Arch Gen Psychiatry. 1961;4:561–71.
20. Buysse DJ, Reynolds CF, Monk TH, Hoch CC, Yeager AL, Kupfer DJ. Quantification of subjective sleep quality in healthy elderly men and women using the Pittsburgh Sleep Quality Index (PSQI). Sleep. 1991;14:331–8.
21. WHO, editor. Organization WH: preventing and managing the global epidemic report of a WHO consultation on obesity. Geneva: World Health Organ Tech Rep Ser. 2000;1–253.
22. Rolland Y, Lauwers-Cances V, Cournot M, Nourhashémi F, Reynish W, Rivière D, et al. Sarcopenia, calf circumference, and physical function of elderly women: a cross-sectional study. J Am Geriatr Soc. 2003;51:1120–4.
23. Laurentani F, Russo C, Bandinelli S, et al. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol. 2003;95:1851–60.
24. Cardoso Fde S, Curtolo M, Natour J, Lombardi Júnior I. Assessment of quality of life, muscle strength and functional capacity in women with fibromyalgia. Rev Bras Reumatol. 2011;51:338–43.
25. Sener U, Ucok K, Ulasli AM, Genc A, Karabacak H, Coban NF, Simsek H, Cevik H. 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. 2013. doi:10.1111/1756-185X.12237.
26. Cooper C, Fielding R, Visser M, van Loon LJ, Rolland Y, Orwoll E, Reid K, Boonen S, Dere W, Epstein S, Mitlak B, Tsouderos Y, Sayer AA, Rizzoli R, Reginster JY, Kanis JA. Tools in the assessment of sarcopenia. Calcif Tissue Int. 2013;93:201–10.
27. Liu LK, Lee WJ, Liu CL, et al. Age-related skeletal muscle mass loss and physical performance in Taiwan: implications to diagnostic strategy of sarcopenia in Asia. Geriatr Gerontol Int. 2013;13:964–71.
28. NIH. Bioelectrical impedance analysis in body composition measurement: national institutes of health technology assessment conference statement. Am J Clin Nutr. 1996;64:524–32.
29. Janssen I, Heymsfield SB, Baumgartner RN, Ross R. Estimation of skeletal muscle mass by bioelectrical impedance analysis. J Appl Physiol. 2000;89:465–71.
30. Jacobsen S, Danneskiold Samsoe B. Dynamic muscular endurance in primary fibromyalgia compared with chronic myofascial pain syndrome. Arch Phys Med Rehabil. 1993;73:170–3.
31. 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.
32. Maquet D, Croisier JL, Renard C, Crielaard JM. Muscle performance in patients with fibromyalgia. Joint Bone Spine. 2002;69:293–9.
33. Şahin G, Ulubaş B, Çalikoğlu M, Erdoğan C. Handgrip strength, pulmonary function tests, and pulmonary muscle strength in fibromiyalgia syndrome is there any relationship? South Med J. 2004;97:25–9.
34. Mengshoel AM, Forre O, Komnaes HB. Muscle strengh and aerobic capacity in primary fibromiyalgia. Clin Exp Rheumatol. 1998;8:475–9.
35. Kim C-H, Luedtke CA, Vincent A, Thompson JM, Oh TH. Association of body mass index with symptom severity and quality of life in patients with fibromyalgia. Arthritis Care Res. 2012;64:222–8.
36. Okifuji A, Donaldson GW, Barck L, Fine PG. Relationship between fibromyalgia and obesity in pain, function, mood, and sleep. J Pain. 2010;11:1329–37.
37. Yunus MB, Arslan S, Aldag JC. Relationship between body mass index and fibromyalgia features. Scand J Rheumatol. 2002;31:27–31.
38. Harding SM. Sleep in fibromyalgia patients: subjective and objective findings. Am J Med Sci. 1998;315:367–76.
39. Morris RK, Ahmed M, Wearden AJ, Mullis R, Strickland P, Appleby L, et al. The role of depression in pain, psychophysiological syndromes and medically unexplained symptoms associated with chronic fatigue syndrome. J Affect Disord. 1999;55:143–8.