ORIGINAL ARTICLE

Relationship between handgrip strength, peripheral muscle strength, and respiratory muscle endurance in women with fibromyalgia: a cross-sectional study

Relação entre força de preensão manual, força muscular periférica e resistência muscular respiratória em mulheres com fibromialgia: um estudo transversal

Natasha Teixeira da Cunha Melian[1], Joaquim Henrique Lorenzetti Branco[1], Guilherme Torres Vilarino[1], Alexandro Andrade[1], Darlan Laurício Matte[1]

ABSTRACT

Fibromyalgia (FM) is a disease characterized by generalized and chronic musculoskeletal pain. It is common, the presence of other symptoms such as fatigue, depression, sleep disorders, leading patients to adopt a sedentary lifestyle. **Objective:** Verify the muscular and respiratory strength of women with FM. **Method:** It is a cross-sectional study that evaluated 41 women with clinical diagnosis of FM. We analyzed handgrip strength (HS), the strength of the lower limbs, and respiratory muscle endurance using the spirometric maneuver. **Results:** Patients with FM had a significant reduction in HS, both in the dominant and non-dominant upper limb. Furthermore, peripheral muscle strength in the lower limbs was reduced because on average, participants exceeded the normative five-repetition sit-to-stand test times stipulated for the age groups. Approximately two-thirds of the sample had maximal voluntary ventilation values below the lower limit of normality. We detected inverse and moderate correlation between peripheral muscle strength and HS of non-dominant upper limb (r= −0.472; p= 0.002) and inverse and weak correlation with the HS of dominant upper limb (r= −0.374; p= 0.016); weak correlations between respiratory muscle endurance and HS of dominant upper limb (r= 0.299; p= 0.058), HS of non-dominant upper limb (r= −0.317; p= 0.043), and peripheral muscle strength (r= −0.372, p= 0.017); and strong correlation between HS of dominant upper limb and non-dominant upper limb (r= 0.899; p<0.001). **Conclusion:** Women with FM present with reduced muscle strength in the upper and lower limbs, as well as lower respiratory muscle resistance.

Keywords: Fibromyalgia, Muscle Strength, Muscle Strength Dynamometer, Hand Strength, Respiratory Muscles

RESUMO

A Fibromialgia (FM) é uma doença caracterizada por dor musculoesquelética generalizada e crônica. É comum a presença de outros sintomas como fadiga, depressão, distúrbios do sono, levando os pacientes a adotarem um estilo de vida sedentário. **Objetivo:** Verificar a força muscular e respiratória de mulheres com FM. **Método:** Estudo transversal que avaliou 41 mulheres com diagnóstico clínico de FM. Analisamos a força de preensão manual (FPM), a força de membros inferiores e a resistência dos músculos respiratórios por meio da manobra espirométrica. **Resultados:** Pacientes com FM tiveram redução significativa da FPM, tanto no membro superior dominante quanto não dominante. Além disso, a força muscular periférica dos membros inferiores foi reduzida porque, em média, os participantes excederam os tempos normativos do teste de levantar e sentar estipulados para as faixas etárias. Aproximadamente dois terços da amostra apresentavam valores máximos de ventilação voluntária abaixo do limite inferior da normalidade. Detectamos correlação inversa e moderada entre força muscular periférica e FPM do membro superior não dominante (r= −0,472; p= 0,002) e correlação inversa e fraca com a FPM do membro superior dominante (r= −0,374; p= 0,016); correlações fracas entre resistência muscular respiratória e FPM do membro superior dominante (r= 0,299; p= 0,058), FPM do membro superior não dominante (r= -0,317; p= 0,043) e força muscular periférica (r= -0,372, p= 0,017); e forte correlação entre FPM de membro superior dominante e membro superior não dominante (r= 0,899; p<0,001). **Conclusão:** Mulheres com FM apresentam redução da força muscular de membros superiores e inferiores, bem como da resistência dos músculos respiratórios inferiores.

Palavras-chaves: Fibromialgia, Força Muscular, Dinamômetro de Força Muscular, Força da Mão, Músculos Respiratórios

[1] Universidade do Estado de Santa Catarina - UDESC

Address for correspondence
Darlan Laurício Matte
E-mail: darlan.matte@udesc.br

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INTRODUCTION

Fibromyalgia (FM) is characterized as a rheumatic disease that manifests in the musculoskeletal system as chronic and diffuse pain.[1,2,3] In addition to pain, the presence of other symptoms, such as fatigue, sleep disorders, depression, and cognitive problems is common.[1,4-8] Based on published criteria, in 1990, in the first American College of Rheumatology (ACR) guideline, a diagnosis of FM is indicated if the following criteria are met: presence of symptoms for >3 months and palpation pain in at least 11 of 18 specific body sites known as tender points.[9]

In view of the difficulties in diagnosing FM in clinical practice, the ACR published new guidelines for the criteria for diagnosis: presence of symptoms for a minimum period of 3 months; diffuse pain index ≥7/19; and severity scale ≥5, or diffuse pain index between 3 and 6 and severity scale ≥9.[3]

FM is one of the most frequent rheumatic diseases, occurring in approximately 3% to 5% of women aged between 30 and 55 years worldwide.[10] Although the etiology and pathogenesis of FM are still unknown, evidence shows that certain individuals may have a genetic predisposition to develop FM when exposed to some environmental factors. The literature suggests that patients with FM have low-grade chronic inflammation[11] and suggests the involvement of the hypothalamic–pituitary–adrenal axis and the autonomic nervous system in response to stress in individuals susceptible to FM or its symptoms.[4,12,13]

Studies have shown that women with FM have reduced muscle strength of the upper limbs, assessed using handgrip dynamometry.[14,15] In addition, the musculature of lower limbs, which presents considerable strength reduction, is impaired.[16] Therefore, the performance of daily activities, which may contribute to the reduction of functional capacity and quality of life, may be directly impacted.[17] In addition, patients with FM may show impairment of respiratory muscles.[18]

Scientific researches have shown that muscle strength is an important component of physical fitness related to health and plays a relevant role in the physical performance of several activities of daily living, correlating with increased quality of life.[19,20] Despite evidence, studies analyzing the upper and lower limb muscle strength and respiratory muscle endurance in patients with FM are scarce.

OBJECTIVE

In view of the above, the present study aimed to verify the relationship among handgrip strength, peripheral muscle strength (PMS), and respiratory muscle endurance in women with FM.

METHODS

This is an analytical, observational and cross-sectional study that followed Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations.[21]

Participants and Procedures

The study included 41 women with FM from the Extension Program "Sports psychology and exercise applied to health," developed by the Laboratory of Sports and Exercise Psychology - LAPE, of the Center for Health Sciences and Sports/CEFID of the University of the State of Santa Catarina/UDESC.

The objectives of this study are part of the research project titled "Effects of different intensities of strength training, walking and stretching exercises in patients with fibromyalgia syndrome: controlled and randomized clinical trials." The research project is approved by the Research Ethics Committee with Human Beings of UDESC (706.588 and CAAE 24584213.0.0000.0118).

The sample was selected in a non-probabilistic and random way. Patients with FM who were willing to participate in the study were required to meet the following inclusion criteria: clinical diagnosis of FM, age >18 years, suitable for evaluation of respiratory function, and having no incapacitating condition to perform physical tests. All participants completed and signed the "Free and Informed Consent Form." All evaluations were conducted in UDESC by a trained researcher.

Outcome measures

Handgrip strength (HS) was characterized based on measurements using a hydraulic dynamometer (Saehan Corporation, 973, Yangdeok-Dong, Masan 630-728, Korea). The PMS of the lower limbs was determined from the performance on the five-repetition sit-to-stand test (SST). Spirometric maneuvers were also performed using a full-body plethysmograph to obtain pulmonary volumes and capacities, as well as respiratory muscle endurance measurement.

Handgrip strength

HS was measured using the Saehan hydraulic dynamometer (Saehan Corporation, 973, Yangdeok-Dong, Masan 630-728, Korea), with the adjustment of the handle in the second position, to characterize upper limb strength. The participants were placed based on the recommendation of American Society of Hand Therapist:[22] individuals sitting comfortably in a chair without arms, feet resting on the floor, hips and knees positioned at approximately 90° flexion.

The shoulder of the upper limb tested remained in adduction and neutral rotation, the elbow in 90° flexion, the forearm in neutral position, and the wrist between 0° and 30° extension and between 0° and 15° adduction. Accessories were removed from both upper limbs. The hand that was untested remained resting on the ipsilateral thigh.

Participants were advised not to look at the dynamometer display during gripping maneuvers to prevent receiving feedback. No verbal encouragement was provided during the test, the instructions for performing the test were standardized, and a constant tone of voice was maintained to avoid influencing the intensity of muscle contraction. Before the start of the test, the dominant upper limb in each patient was identified.

The tests were performed initially with the right hand, followed by the left hand, non-alternately. Three consecutive tests were performed with the right hand and then with the left hand. The participants were instructed to perform a maximum contraction for 3s in each test, with a 30s resting period between each trial, and 2min rest between each hand. The result is the simple arithmetic mean of the values obtained from the three tests in each hand was used. Before and after each test, blood pressure, heart rate, and peripheral oxygen saturation were obtained to monitor the hemodynamic data of the participants. Furthermore, dyspnea and upper limb fatigue were measured based on the Modified Borg Scale.[23]

Five-repetition sit-to-stand test

The five-repetition sit-to-stand test was used to assess the muscular strength of the lower limbs. The test was performed in an armless chair, 48cm from the seat to the ground and positioned against the wall for stabilization. The participants were instructed to sit on the chair such that their feet were shoulder width apart and could touch the ground completely and their arms were crossed over the chest.

They were instructed to stand up and sit five consecutive times, in the shortest time possible, after demonstration by the examiner, and after performing a repetition to verify the correct way to perform the test. Verbal command was provided to start and end the test, and no incentive was provided during the test.

The examiner recorded the time to get up and sit five times in seconds. Two tests were performed, with a 20min interval between each test, using the shortest execution time as the result. Before and after each test, blood pressure, heart rate, and peripheral oxygen saturation were obtained to monitor the hemodynamic data of the participants.[24] In addition, dyspnea and lower limb fatigue were measured based on the Modified Borg Scale.[23]

Maximal voluntary ventilation

Pulmonary function tests were obtained by MasterScreen Body plethysmograph (Jaeger, Wuerzburg, Germany) and respiratory muscle endurance was measured from the maximal voluntary ventilation (MVV) maneuver. The plethysmography was performed in the pulmonary function laboratory in the premises of the Clinical School of Physiotherapy - UDESC/CEFID.

The patients were positioned in a comfortable sitting position inside the cabin. The procedures were explained, including the maneuvers performed, closure of the cabin, correct fitting of the mouthpiece, and use of the nasal clip.[25] Equipment calibration was performed daily before the start of the tests with a 3-l calibration syringe (+0.4%) from the Care Fusion brand (Jaeger, Wuerzburg, Germany).

A bronchodilator was not used because the purpose of the present study was not to evaluate bronchodilator response and because individuals with forced expiratory volume/ forced vital capacity (FEV1/FVC) ratio <0.7 were absent in the sample. The values obtained were expressed as a percentage of predicted values based on the predictive equation of Pereira et al.[26]

Statistical analysis

Statistical analysis of the data was performed using the SPSS® program (Statistical Package for the Social Sciences) for Windows, version 20.0. The Shapiro-Wilk test was used to test data normality. Descriptive statistics were applied for all variables, including the measure of central tendency (mean) and dispersion (standard deviation) for the quantitative variables.

Pearson linear correlation coefficient was used to determine the association among PMS, HS, and respiratory muscle endurance. Correlation values were assumed to be weak when r= 0.10–0.39; moderate when r= 0.40–0.69 and strong when r= 0.70–1.[27] The significance level was set at p<0.05 for all analyses. To perform the sample calculation, a test power of 0.95 and a significance level of 0.05 were considered. The calculation was performed using a 0.23 correlation as a reference.[28]

RESULTS

Forty-one women with FM participated in the study. The mean age of the sample was 52.9 years (±8.52 years) (Table 1).

Table 1 shows that most of the sample (51.2%) was composed of women aged 45–54 years, with a predominance of caucasians (68.3%). The mean BMI values were 29.2 kg/m² (±5.7 kg/m²) (Table 2).

Table 1. Sociodemographic characteristics of study participants

Varibles	n (%)
Participants	41 (100)
Gender	
Female	41 (100)
Age range (years)	
35-44	05 (12.1)
45-54	21 (51.2)
55-64	13 (31.7)
65-74	1 (2.4)
75 or more	1 (2.4)
Skin color (self reported)	
Caucasian	28 (68.3)
Brown	9 (22)
Black	3 (7.3)
Asian	1 (2.4)

n: absolute frequency; (%): relative frequency

With regard to the spirometric characteristics, all participants presented with the ratio of forced expiratory volume in the first second to forced vital capacity (FEV_1/FVC) higher than 0.70, eliminating obstructive disorders and, therefore, 9.75% of the sample presented mild restrictive ventilatory disorder, taking as baseline the values of the relationship of FEV_1/FVC and FVC (Tables 2 and 3).

With regard to the MVV maneuver, the mean was 74.6% of predicted (±18.33); hence, this value was below normality parameters (80% predicted).[29] Individually, approximately two-thirds of the sample, or 65.85%, presented values below the lower limit of normality for the MVV maneuver.

The study participants spent a mean of 14.1 s (±6.9 s) on SST, with the shortest and longest times being 4.8 s and 39.2s, respectively. They also presented HS mean for the dominant upper limb (DUL) of 17.5 kgf (±7.9 kgf) and 16.5 kgf (±7.1 kgf) for the non-dominant upper limb (NDUL). The lowest value for both was 0.0 kgf, and the highest values for DUL and NDUL were 31.6 kgf and 29.6 kgf, respectively (Table 2).

The PMS values obtained were outside the normal range in the age range of 80-89 years, based on the mean values suggested for SST by Bohannon.[30] Although no reference values were noted for the 35-59 years age group, it can be inferred that it also presents values outside the normal range, taking the established reference value for the 60-69 years age group as a parameter (Table 4).

Table 2. Anthropometric, spirometric and functional characteristics of the study participants

Variables		Values (n= 41)	
		mean±sd	Value min-max
Age (years)		52,90±8,52	35,0-80.0
Weight (kg)		73,8±18.7	47,5-134.3
Height (cm)		154,5±25.5	155,0-176.0
BMI (kg/m2)		29,2±5.7	20,7-44.8
FVC (% pred)		98,8±16.2	56,0-134.0
FEV_1 (% pred)		94,2±14.0	59,0-120.0
FEV_1/FVC (%)		95,0±8.0	75,0-113.0
MVV (% pred)		74,6±18.33	30,5-114.5
SST (seg)		14,1±6.9	4,8-39.2
HS (kgf)	DUL	17,5±7.9	0,0-31.6
	NDUL	16,5±7.1	0,0-29.6

n: absolut frequency; (%): relative frequency; sd: standard deviation; BMI: body mass index; FVC: forced vital capacity; FEV_1: forced expiratory volume in the first second; FEV_1/FVC: ratio of FEV_1/FVC; MVV: maximal voluntary ventilation; SST: 5 repetition sit-to-stand test; HS: handgrip strength; DUL: dominant upper limb; NDUL: non-dominant upper limb

Table 3. Spirometric classification of the study participants

	Ventilatory function		
		Disturb	
	Regular	Restrictive	Obstructive
n	37	04*	-
%	90.25	9.75	-

*n: absolute frequency; (%): relative frequency; *: mild degree*

Table 4. Results of five Repetitions Sit-to-Stand Test

Age range (years)	n	Values (n=41) mean±sd	Value min-max	Reference values
35-59	33	11.9±5.9	6.9-32.8	NA
60-69	7	11.4±3.9	4.8-17.6	11.4
70-79	-	-	-	12.6
80-89	1	39.2±0	39.2	14.8

n: absolute frequency; (%): relative frequency; sd: standard deviation; ND: not available

Table 5 shows an important reduction of HS in both the DUL and NDUL in all age groups evaluated based on the mean reference values suggested by Caporrino et al.[31] and Novaes et al.[32] in studies involving the Brazilian population.

The correlation between the variables of PMS (SST), HS (manual dynamometry), and respiratory muscle endurance (MVV) is shown in Figure 1. A weak and inverse correlation was found between PMS and HS of DUL (r= −0.374, p= 0.016). However, an inverse and moderate correlation (r= −0.472; p= 0.002) was observed between the HS of NDUL and PMS.

Furthermore, respiratory muscle endurance correlated weakly and inversely with PMS (r= −0.372, p= 0.017), weak with HS of DUL (r= 0.299, p= 0.058), and HS of NDUL (r= 0.317, p= 0.043). The correlation between the HS of DUL and NDUL was strong (r=0.899, p=0.001).

Table 5. Handgrip strength evaluation results

Age range (years)	n	Upper limb	Values (n=41) mean±sd	Value min-max	Reference value (mean±sd)
35-39	3	D	6.5±7.0	0.6-14.3	32.9±7.2
		ND	7.1±5.3	3.6-13.3	29.3±6.0
40-44	2	D	16.0±9.3	9.4-22.6	32.1±6.9
		ND	11.8±10.0	4.7-19.0	28.3±6.7
45-49	7	D	19.9±9.1	7.0-31.3	32.4±9.2
		ND	16.9±7.3	6.3-24.0	29.1±8.7
50-54	14	D	16.1±7.2	0.0-26.0	30.5±7.6
		ND	16.9±6.3	0.0-24.0	27.5±6.6
55-59	7	D	21.8±7.1	9.6-29.0	31.7±8.8
		ND	20.1±7.5	9.0-29.6	28.9±8.6
>60	8	D	18.6±6.4	13.0-31.6	23.8±3.0
		ND	17.3±6.6	9.3-27.3	23.0±2.5

n: absolute frequency; sd: standard deviation; D: dominant; ND: non-dominant

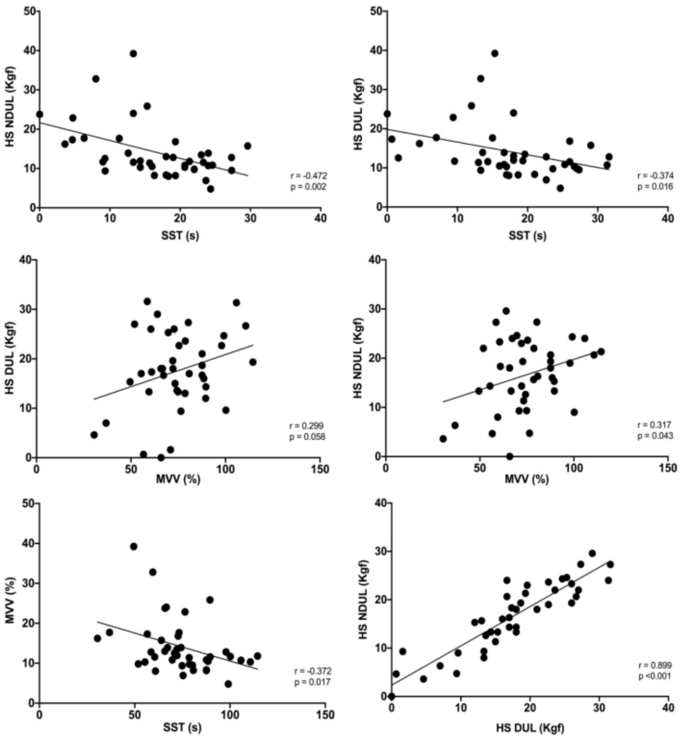

Figure 1. Correlations between HS NDUL, HS DUL, SST and MVV in fibromyalgia patients

DISCUSSION

The results of the study showed that women with FM present lower HS in both upper limbs; strength reduction in the lower limbs, represented by the high values obtained for the SST; and a decrease in respiratory muscle endurance. Among the studied variables, weak and inverse correlation was found between PMS and HS; moderate and negative correlation, between HS of NDUL and PMS; weak and negative relationship, between respiratory muscle endurance and PMS; weak correlation, between respiratory muscle endurance and HS of

DUL and NDUL; strong correlation, between HS of DUL and NDUL.

Regarding the HS variable, corroborating with the results of the present study, Aparicio et al.[33] compared the HS in 81 patients with FM and 44 healthy individuals, who comprised the control group. These authors observed a reduction in HS in women with FM, being higher in those patients with severe FMS, when compared with patients with moderate FM. In another study performed with 25 patients with FM and 23 healthy controls, Köklü et al.[34] also reported reduced HS values in patients with FM compared with the control group.

However, no significant differences were found in HS among the subgroups of patients affected by severe and moderate FM. However, Panton et al.[35] did not obtain the same results and similarity in HS values, which were evaluated using manual dynamometry. They reported that no differences were found in HS between women with FM and a healthy control group matched for age and body weight.

As for physiology, Staud,[36] through brain images, demonstrated the presence of a direct relationship between FM and abnormalities in pain processing. Cardoso et al.[15] suggested that the HS reduction may be a result of the presence of chronic pain in women with FM. In addition to the pain component, Nordenskiöld et al.[37] indicated that fatigue and other factors of central origin may contribute to decreased strength in patients with FM. Still, according to Aparicio et al.[33] the ability to perform activities of daily living may be adversely affected in patients with FM due to the presence of moderate or severe pain, thus leading to a reduction in muscle strength. Considering the passage of time, such facts could explain, at least in part, the reduced HS values found in our sample.

With regard to the variable muscle strength of the lower limbs, Góes et al.[16] in a study with 16 patients diagnosed with FM and 16 healthy women, observed a decrease in muscle strength in the lower limbs in patients with the syndrome, when compared with the control group. Such muscle force deficits occurred, more evidently, in knee and hip extensors, and adductors.

Henriksen et al.[38] in a study conducted between 1998 and 2005 in which 840 patients with FM were evaluated, observed significantly reduced muscle strength in the knee extensors and flexors in more than half of the sample. Similarly, Akyol et al.[2] reported decreases in muscle strength in the flexors and knee extensors in patients with FM. Moreover, Panton et al.[35] identified lower limb muscle strength reduction in women with FM.

Corroborating the results of the above-mentioned studies, the results obtained in this study for the SST, which involves the activation of several muscles of the lower limbs, particularly the knee extensors and flexors, demonstrate reduced PMS in patients with FM.[30] We also observed reduced of HS in both upper limbs. Similar results were obtained by Cardoso et al.[15] who also found lower limb strength and decreased HS. Sener et al.[28] reported that in a study involving 39 women with FM and 40 healthy controls, HS in both the right and left upper limbs significantly decreased, as well as a decrease in strength of the lower limbs, although they did not observe the dominance of the upper limbs of the participants.

In the present study, moderate and inverse correlation was observed between the PMS and the HS of NDUL. Based on Caporrino et al.[31] using the NDUL in determining the HS is possible because the discrepancy of values between DUL and NDUL is estimated at 12%. In the present study, such discrepancy of values was only 6%, evidencing a smaller discrepancy between mean HS values of DUL and NDUL compared with those of healthy patients. Therefore, we can infer the existence of the correlation regarding the reduction of PMS of upper and lower limbs in individuals with FM.

According to Jacobsen et al.[39] patients with FM present lower isokinetic and maximal isometric muscle strength, in relation to healthy individuals. Such deficits would be the result of lack of motivation, negative feedback from the pain on the recruitment of motor units, and/or neurogenic peripheral disorder. Other peripheral abnormalities have also been observed in the neuromuscular system of patients with FM, such as unusual findings in muscle biopsies, poor oxygen distribution, and reduced muscle content of high-energy phosphates. These changes contribute to the reduction of muscular capacity of force generation and may suggest the explanation for the results obtained in the present study.

In addition to the reduction of HS and PMS, data from the literature report that maximal inspiratory and expiratory pressures are reduced in patients with FM, although they have spirometric values within the normal range. This fact may reflect the reduction of respiratory muscle strength, as well as the reduction of thoracic expansibility. The inhibitory reflex caused by fear of pain has been suggested to be the cause of reduced thoracic expansibility, leading to reduced respiratory muscle strength.[40]

Moreover, according to Ozgocmen & Ardicoglu,[41] the respiratory force deficit in patients with FM can arise from the discomfort and pain in the thoracic region, which promote a decrease in pulmonary compliance and a consequent reduction in pulmonary pressures.

However, although the present study did not specifically evaluate respiratory muscle strength through the measurement of maximum respiratory pressures through the analysis of the results obtained, it can be inferred that patient with FM present, in concomitance with the reduction of muscle strength, decreased endurance of respiratory muscles. Forti et al.[18] in a study conducted in 23 women with FM and 23 healthy controls, also observed a reduction in the values of MVV, indicating a decrease in respiratory muscle endurance.

According to Moreno et al.[42] the MVV maneuver simulates a strenuous physical effort, being able to reflect the resistance of the respiratory muscles. Endurance capacity is closely related to the mechanical properties of the lungs and chest cavity, as well as respiratory muscle conditions (muscle fiber type, adequate blood supply and integrity of the contractile elements of the fiber).[43]

Gerdle et al.[44] reported that individuals with FM present a high conduction velocity in the membranes of muscle fibers, which is associated with the presence of large numbers of tender points. Such an increase in the velocity of conduction in the membranes of the muscular fibers can be attributed to abnormalities in the oxidative metabolism of type I fibers and hypotrophy in type II muscle fibers, and such alterations may also occur in the respiratory muscles. Moreover, studies have shown that physical inactivity may promote some changes in contractile proteins and mitochondrial metabolism, resulting in hypotrophy, weakness, and decrease in the number of sarcomeres.[45]

In addition, according to Latorre et al.[46] fatigue, which is one of the main limitations in FM, can contribute to reduced values of MVV and justify a decrease in the values of the MVV found in our study, without considering the mild restrictive ventilatory disorder found in 9.75% of the participants.

Although the present study has reported important results, some limitations need to be considered. Because it is not a multi-center study, the participants come from the same demographic region; a control group is not included, although there are normative values in the literature for almost all the analyzed data; and the sample size is small.

We consider that this study has some strengths: the use of hydraulic handgrip dynamometer, which has its suggested reference values for the Brazilian population and is recognized both in the literature and in clinical practice as a gold standard instrument for measuring HS, presenting good validity and reliability indexes; the use of pulmonary function assessment and respiratory muscle endurance by using Master Screen Body (Jaeger Wuerburg, Germany) full body plethysmograph, which demonstrates high performance and reliability indexes; and relevance to the population addressed.

CONCLUSION

The results obtained in this study demonstrate that women with FM present reduced HS, both in the DUL and NDUL, reduced muscle strength of the lower limbs, and reduced MVV values. Despite the observed reduction of muscle strength in all compartments evaluated, the PMS was verified to be inversely and moderately correlated with the HS of NDUL, and weakly and inversely correlated with the HS of DUL. Additionally, weak correlations were observed between respiratory muscle endurance and HS of DUL, HS of NDUL, and PMS.

We suggest that such findings should be considered in the formulation of treatment plans and strategies for this population, besides being useful as evaluation tools and limiting and evolution markers of interventions in patients with FM.

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