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Sarcopenia in systemic sclerosis: the impact of nutritional, clinical, and laboratory features

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Abstract

We evaluated the presence of sarcopenia in a population of systemic sclerosis (SSc) patients, with respect to nutritional, clinical, and laboratory features. A total of 62 patients who met the ACR/EULAR 2013 classification criteria were enrolled. Sarcopenia was defined according to the Relative Skeletal Mass Index (RSMI) and hand grip strength (HGS). Body composition was assessed with the calculation of the Body Mass Index (BMI), lean body mass (LBM) and fat mass (FM). Malnutrition was evaluated according to the ESPEN criteria. Clinical evaluation included nailfold capillaroscopy and skin evaluation by modified Rodnan Skin Score (mRSS), pulmonary function tests (PFT) with diffusing capacity for carbon monoxide adjusted for hemoglobin (DLCO), high-resolution computed tomography (HR-CT) of the lungs, echocardiography and high-resolution manometry (HRM) for esophageal involvement. Laboratory evaluation included erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), hemoglobin, creatinine, creatine kinase (CK), transaminases, lipid profile, glycemia, albumin, and vitamin-D. Antinuclear antibodies (ANA) and extractable nuclear antigens (ENA) were also assessed. Considering RSMI, the prevalence of sarcopenia is 42%. In this case, age, malnutrition, disease duration, mRSS, capillaroscopy score, esophageal involvement, ESR, and ANA titer are higher in the sarcopenic group, while DLCO and LBM are lower. Considering HGS, the prevalence of sarcopenia is 55%. Age, disease duration, malnutrition, FM, mRSS, capillaroscopy score, esophageal involvement, ESR, and ENA positivity are higher in the sarcopenic group, while DLCO is lower. By using both RSMI and HGS to assess sarcopenia in SSc, the results of this study demonstrated that this condition correlates with different nutritional, clinical, and biochemical parameters associated with the worsening of the disease.

Keywords Systemic sclerosis · Sarcopenia · Malnutrition · Relative Skeletal Mass Index (RSMI) · Hand Grip Strength (HGS)

Introduction

Sarcopenia is defined by the European Working Group on Sarcopenia in Older People (EWGSOP) as a "progressive loss of muscle mass and strength with a risk of adverse outcomes such as disability, poor quality of life and death"

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[1]. This condition can be age associated (primary form) or secondary to chronic disorders, including malignancy or musculoskeletal diseases [2–4]. Patients with rheumatic disorders, such as rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, systemic lupus erythematosus, and fibromyalgia syndrome are notably predisposed to develop sarcopenia, because of the muscle loss caused by the typical pro-inflammatory state, pain, and inactivity, and by the use of corticosteroids [5, 6].

Systemic sclerosis (Scleroderma, SSc) is a chronic autoimmune rheumatic disease characterized by widespread vasculopathy, progressive fibrosis of the skin and other internal organs, such as lung, kindeys, gastrointestinal tract, cardiovascular system [7]. According to the extent of the skin involvement, we can recognize two major disease subsets namely limited cutaneous SSc (LcSSc), characterized by skin thickening restricted to the distal extremities of the limbs with or without face and neck involvement, and diffuse cutaneous SSc (DcSSc) featured by extensive skin affection [8]. DcSSc is characterized by earlier severe internal organ dysfunctions with consequent decreased life expectancy [9, 10].

Different from the other chronic rheumatic inflammatory disorders, sarcopenia has not been well evaluated in the past in SSc. Only recently, some studies have focused their attention on the presence of sarcopenia in SSc. Caimmi et al. [11] reported a prevalence of 20.7% of sarcopenia in a large cohort of SSc patients showing an association between sarcopenia with the disease duration and the severity of lung and skin involvement. Another trial, published in the same year, showed very similar prevalence (22.5%) of sarcopenia in SSc [12].

The primary and/or secondary muscle involvement, the chronic inflammation and steroid consumption can be considered the principal risk factors for the development of sarcopenia in SSc [13, 14].

The aim of the current study is to extend the knowledge of sarcopenia in SSc patients using two commonly used instruments for the assessment of sarcopenia, as hand grip strength (HGS) and Relative Skeletal Mass Index (RSMI) [15, 16]. Moreover, different disease relevant nutritional, clinical, and biochemical parameters were investigated with respect to sarcopenia in the SSc population.

Materials and methods

Patients

Sixty-two Caucasian patients, aged over 18, who fulfilled the 2013 American College of Rheumatology (ACR)/European League against Rheumatology (EULAR) classification criteria for SSc [17, 18] were consecutively selected by the Scleroderma Unit of the University Hospital of Siena in the period ranging from April 2018 to July 2018 and included in the present study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the ethical committee of University Hospital of Siena and in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The local ethical committee (C.E.A.V.S.E.) of the University Hospital of Siena approved the procedure (protocol number CEL280212), and informed written consent was obtained from all individual participants included in the study. The main exclusion criteria included a history of inflammatory rheumatic chronic disorders (rheumatoid arthritis, systemic lupus erythematosus, inflammatory myositis, and vasculitis), other inflammatory chronic disorders (chronic obstructive pulmonary disease, tuberculosis, and inflammatory bowel disease) or other possible causes of sarcopenia, such as malignancies, severe comorbidities (uncompensated diabetes, chronic renal and heart failure, endocrine diseases), pregnancy, and obesity. Ongoing therapy with prednisone above 10 mg/day (or other steroid equivalent) and a diagnosis of SSc overlapping with other autoimmune diseases were other exclusion criteria. All patients underwent a detailed interview followed by a general clinical assessment, from which we obtained demographical and clinical data, as shown in Table 1. As part of routine diagnostic and follow-up investigations, the patients underwent skin involvement evaluation by modified Rodnan Skin Score (mRSS) [19], pulmonary function tests (PFT) including diffusing capacity for carbon monoxide adjusted for hemoglobin (DLCO), high-resolution computed tomography (HR-CT) of the lungs and echocardiography. PAH was defined by mean pulmonary artery pressure ≥ 25 mmHg evaluated by right heart catheter [20], while interstitial lung disease was diagnosed on HR-CT. Esophageal involvement was evaluated by high-resolution manometry (HRM) [21]. Microvascular involvement of the hands was instrumentally evaluated by nailfold video-capillaroscopy with the distinction among the early, active, and late patterns [22]. All patients were fully informed of the characteristics of the study and gave written informed consent before the inclusion in the study.

Nutritional evaluation

The weight and the height of each patient were recorded and used for the calculation of the Body Mass Index (BMI): so patients were classified as underweight, normal weight, overweight, and obese according to World Health Organization (WHO) criteria [23]. The body composition was evaluated by dual energy X-ray absorptiometry (DEXA): in particular, the Lean Body Mass (LBM) and Fat Mass (FM) Indexes were measured in

Table 1 Demographic, nutritional, clinical, and laboratory characteristics of the patients enrolled in the study

	Total population	LcSSc ($n=50$)	DcSSc ($n=12$)	p
Age (years)	62.0 (32.0–78.0)	59.5 (32.0–68.5)	67.5 (55.5–78.0)	0.9
Sex, no. male/female	8/54	4/50	4/12	0.12
Disease duration (years)	8.0 (6.0–14.0)	8.5 (6.0–12.5)	10.5 (7.5–14.0)	0.3
mRSS	15.0 (3.0–29.0)	10.0 (3.0–17.0)	24.5 (16.5–29.0)	0.0002***
DLCO % predicted	81.0 (67.0–93.0)	83.0 (73.0–93.0)	70.0 (67.0–74.0)	0.027*
PAH	20 (32)	16 (31)	4 (33)	0.3
ILD on chest HR-CT	30 (48)	18 (36)	12 (100)	0.000016***
Esophageal involvement in HRM	26 (42)	20 (40)	6 (50)	0.3
Normal capillaroscopic pattern	2 (3)	2 (4)	0 (0)	0.12
Early capillaroscopic pattern	26 (42)	22 (44)	4 (33)	0.34
Active capillaroscopic pattern	18 (29)	16 (32)	2 (16)	0.052
Late capillaroscopic pattern	16 (26)	10 (20)	6 (50)	0.002**
ESR (mm/h)	27.5 (5.5–49.0)	25.5 (5.5–47.5)	28.5 (6.5–49.0)	0.12
CRP (mg/dL)	1.5 (0.5–2.5)	1.0 (0.5–2.0)	1.5 (0.5–2.5)	0.68
Hemoglobin (g/dL)	12.5 (11.0–15.5)	13.5 (12.5–15.5)	13.0 (11.0–15.0)	0.1
Creatinine (mg/dL)	0.9 (0.5–1.3)	0.8 (0.5–1.1)	1.0 (0.6–1.3)	0.3
CK (U/L)	79.5 (66.5–92.5)	78.5 (66.5–90.5)	80.0 (70.5–92.5)	0.3
Total cholesterol (mg/dL)	177.5 (150.5–210.0)	175.5 (150.5–200.0)	180.0 (159.5–210.0)	0.48
LDL cholesterol (mg/dL)	109.0 (80.0–135.0)	108.0 (80.0–125.5)	112.0 (90.5–135.0)	0.45
HDL cholesterol (mg/dL)	59.5 (43.0–76.5)	60.5 (45.5–76.5)	58.0 (43.0–72.0)	0.2
Triglycerides (mg/dL)	111.5 (53.5–160.5)	109.5 (53.5–149.5)	121.0 (59.5–160.5)	0.2
Glycemia (mg/dL)	110.0 (92.5–119.5)	109.5 (92.5–118.0)	112.5 (98.5–119.5)	0.48
Albumin (g/dL)	3.5 (3.0–4.0)	3.5 (3.0–4.0)	3.5 (3.0–4.0)	0.12
Vitamin-D (ng/mL)	22.0 (16.0–26.0)	21.0 (16.0–24.0)	23.0 (18.0–26.0)	0.3
ANA positivity	60 (97)	48 (96)	12 (100)	0.48
Anti-Scl-70 positivity	12 (19)	0 (0)	12 (100)	0.00015***
Anti-Cenp-B positivity	26 (42)	26 (52)	0 (0)	0.00001***
BMI (kg/m^2)	24.5 (21.5–28.0)	25.0 (23.5–28.0)	24.0 (21.5–26.5)	0.88
LBM (g)	38045.0 (33850.0–42450.0)	37850.0 (33850.0–40985.0)	39050.0 (35650.0–42450.0)	0.37
FM (g)	27350.0 (22750.0–34950.0)	27,110.0 (22,750.0–33,985.0)	28,450.5 (23,987.5–34,950.5)	0.34
RSMI (kg/m^2)	5.5 (4.0–7.0)	6.0 (5.0–7.0)	5.5 (4.0–6.5)	0.6
HGS (kg force)	17.5 (10.5–24.0)	18.5 (12.0–24.0)	16.5 (10.5–22.0)	0.3
Malnutrition	12 (19)	10 (20)	2 (17)	0.48

Pharmacological treatment: patients with esophageal involvement were in treatment with proton pump inhibitors and prokinetic agents; patients with ILD and/or pulmonary arterial hypertension (PAH) were in treatment with ET-1 receptor antagonists (ERAs). Patients in treatment with prednisone (or other steroid equivalent) did not exceed the dose of 10 mg/day

Data are presented as median (minimum–maximum), or ratio (male/female) or n (%), Kolmogorov–Smirnov test *$p<0.05$, **$p<0.01$, ***$p<0.001$

each patient. Malnutrition was defined according to the ESPEN criteria [24]: BMI < 18.5 kg/m^2 or unintentional weight loss > 10% in an indefinite time in combination with a BMI < 20–22 kg/m^2 or with a Fat-Free Mass Index (FMMI) < 15 kg/m^2 in women or < 17 kg/m^2 in men. Weight loss was defined on the basis of serial body weight measurements at regular intervals in the year before the study.

Sarcopenia evaluation

Sarcopenia was defined according to EWGSOP criteria including both low muscle quantity and low muscle strength [15, 16]. In our study, we used the RSMI and HGS as sarcopenia parameters. RSMI derived from the appendicular skeletal muscle mass (ASM) (kg) divided by the square of the height (m). ASM is obtained by the sum of the skeletal

muscle mass in the arms and legs assuming that all non-fat and non-bone tissues are skeletal muscle. According to these criteria, sarcopenia was defined in the presence of a RSMI < 5.5 kg/m^2 in women and < 7.26 kg/m^2 in men [15]. HGS was measured through a dynamometer, as described by Roberts et al. [25]. The patients were asked to squeeze the dynamometer as hard as possible using the non-dominant hand in a sitting position and with the arm at 90° angle.

Laboratory evaluations

The following laboratory data were evaluated: erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), hemoglobin, creatinine, creatine kinase (CK), lipid profile, glycemia, albumin, and vitamin-D. Patients sera were tested for the presence of anti-nuclear antibodies (ANA) measured by indirect immunofluorescence (IFI) using Hep-2 cell culture with a starting dilution 1:160 and autoantibodies to extractable nuclear antigen (ENA) assessed by EliA Symphony screening (Thermo Fisher Scientific, Waltham, Massachusetts, USA); further ELiA tests were performed for single ENA specificities, particularly for anti-Scl-70 antibodies and anti-Cenp-B antibodies.

Quality of life assessment

The quality of life was assessed by the Short Form-36 (SF-36) survey [26]. In detail, the questionnaire which consists of 36 questions is self-administered, and measures the quality of life and well-being in 8 multi-item scales.

Statistical analysis

For statistical analysis, patients were divided into two groups according to the presence of sarcopenia measured twice for the two indexes HGS and RSMI. We compared, for each index, the feature of sarcopenic and non-sarcopenic patients in relation to the index itself by using the Kolmogorov–Smirnov test. Moreover, for correlation analysis, we used Spearman correlation test. Results with a significance level of $p < 0.05$ were considered statistically significant.

Results

We included 62 SSc of whom 50 (81%) were affected by LcSSc and 12 (19%) were by the DcSSc. As reported in Table 1, there were no significant differences in age, disease duration, esophageal involvement, ESR, CRP, hemoglobin, creatinine, CK, total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides, albumin, vitamin-D, and ANA titer between the two groups. The body composition parameters and malnutrition status also did not change between LcSSc and DcSSc patients. The mRSS was higher in the DcSSc group than in LcSSc group. Concerning ENA antibodies, the anti-Scl-70 were predominant in DcSSc patients, while the anti-Cenp-B resulted to be prevalent in LcSSc ones. The lung fibrosis and the impairment of the DLCO test resulted more frequently in the DcSSc group. Finally, the late capillaroscopic pattern was predominant in the DcSSc group, as expected.

According to RSMI, it is possible to classify a patient as sarcopenic when the value of this index is < 7.26 for men and < 5.50 for women. Considering this index, the prevalence of sarcopenia in our population was 42% (26 patients affected). Table 2 shows the differences between sarcopenic and non-sarcopenic population about the items under observation.

Age influenced sarcopenia, while BMI and vitamin D were similar in both population as well as fat mass. As expected, malnutrition and LBM impacted on sarcopenia condition. Disease duration was able to influence sarcopenia as well as the inflammation status, as showed by ESR which resulted higher in sarcopenic population with respect to non-sarcopenic one. The average of ANA titer was also higher in patients with sarcopenia.

mRSS values are higher in the sarcopenic population. Other parameters that are able to influence sarcopenia are the lung functionality (established by a reduction of DLCO) and esophageal involvement. Finally, the quality of life measured by the SF-36 survey resulted statistically lower in the sarcopenic group. A correlation analysis confirmed the data: disease duration, mRSS, esophageal involvement, ESR, and ANA negatively correlated with RSMI, while DLCO positively correlated with RSMI as shown in Table 3.

Another confirmation about the influence of SSc on sarcopenia comes from the data related to the capillaroscopic pattern. As we know, the microvascular condition evaluated by nailfold capillaroscopy correlates with the evolution of the disease in terms of organ involvement and prognosis. In fact, in the following Table 4, the value of RSMI got worse when the capillaroscopy pattern got worse more in sarcopenic patients than in non-sarcopenic ones.

According to HGS, it is possible to classify a patient as sarcopenic when the value of this index is < 30 for men and < 20 for women.

Considering this index, the prevalence of sarcopenia in our population was 54.8% (34 patients affected).

As above, Table 5 shows the differences between sarcopenic and non-sarcopenic populations about the items under observation.

About parameters not directly depending from the disease, only age, malnutrition, and FM seemed to be able to influence HGS.

Table 2 "Sarcopenia" and "No Sarcopenia" groups according to RSMI index

	Sarcopenia	No sarcopenia	*p*
RSMI	5.0 (4.0–6.0)	6.5 (5.5–7.5)	0.0001***
Age	65.0 (45.0–78.0)	52.0 (32.0–67.0)	0.0019**
BMI	24.0 (14.0–29.0)	25.0 (15.0–28.0)	0.31
Malnutrition	23.0 (15.0–28.0)	15.5 (7.5–21.5)	0.002**
Vitamin-D	21.6 (19.6–22.6)	21.3 (18.3–22.3)	0.51
LBM	35,999.5 (31,750.5–39,359.0)	39,687.0 (35,678.0–43,098.0)	0.0012**
FM	26,888.0 (22,543.0–29,325.0)	27,025.5 (22,987.0–30,856.5)	0.55
SF-36	36.0 (28.0–42.0)	51.0 (39.0–59.0)	0.002**
Disease duration	12.5 (5.0–15.0)	6.0 (3.0–9.0)	0.0001***
mRSS	18.0 (12.0–24.0)	13.0 (10.0–15.0)	0.044*
Esophageal involvement	57.0 (39.0–65.0)	25.0 (19.0–43.0)	0.02*
CPR	1.5 (0.5–3.5)	1.0 (0.5–2.5)	0.09
ESR	37.0 (25.0–45.0)	22.0 (18.0–28.0)	0.0047**
ANA	1300.0 (640.0–2500.0)	640.0 (160.0–1125.0)	0.02*
ENA	8.0 (7.0–10.0)	9.0 (6.0–10.0)	0.77
DLCO	72.5 (62.5–83.5)	85.5 (65.5–95.5)	0.044*
Diffuse	15%	22%	0.75
Limited	85%	78%	0.84

Difference of nutritional, clinical, and biological markers between the two groups (Kolmogorov–Smirnov test $*p<0.05$, $**p<0.01$, $***p<0.001$). Data are presented as median (minimum–maximum) or as percentage (%)

Table 3 RSMI correlation with SSc disease markers

Correlation of RSMI with disease markers	***r***	***p***
Disease duration	−0.6	0.00001***
mRSS	−0.36	0.003**
Esophageal involvement	−0.35	0.0043**
ESR	−0.47	0.0001***
ANA	−0.35	0.0043**
DLCO	0.53	0.0001***

Spearman $*p<0.05$, $**p<0.01$, $***p<0.001$

Analyzing parameters which represent the direct expression of the disease, we can see that disease duration impacted on sarcopenia index, and there was a strong difference about mRSS comparing sarcopenic and non-sarcopenic patients. In fact, mRSS was on an average four times higher in sarcopenic cohort than in non-sarcopenic one. ESR influenced the index because the value was higher in sarcopenic population. The presence of ENA seemed to impact the index as well. The lung functionality resulted better in non-sarcopenic cohort, while the esophageal involvement was higher in the sarcopenic one. The quality of life decreased

Table 4 RSMI in capillaroscopy sub-groups (early, active, and late) in "Scarcopenia" and "No Sarcopenia" groups

Capillaroscopy pattern and RSMI	Sarcopenia	*p*	*p*	*p*
Early	5.5 (3.5–6.5)	Early vs. active	Early vs. late	Active vs. late
Active	4.5 (3.5–5.5)	0.0146*	0.0009***	0.0075**
Late	3.0 (2.0–5.0)			
Capillaroscopy pattern and RSMI	No Sarcopenia	*p*	*p*	*p*
Early	7.0 (5.0–8.0)	Early vs. active	Early vs. late	Active vs. late
Active	6.5 (4.5–8.5)	0.11	0.0025**	0.047*
Late	5.5 (3.5–7.5)			

Data are presented as median (minimum–maximum), Kolmogorov–Smirnov test $*p<0.05$, $**p<0.01$, $***p<0.001$

Table 5 "Sarcopenia" and "No Sarcopenia" groups according to HGS index

	Sarcopenia	No Sarcopenia	*p*
HGS	12.0 (8.0–16.0)	24.0 (10.0–32.0)	0.0001***
Age	65.0 (45.0–78.0)	55.0 (32.0–65.0)	0.0015**
BMI	24.0 (20.0–26.0)	24.5 (21.5–27.5)	0.46
Malnutrition	23.0 (21.0–24.0)	11.0 (9.0–13–0)	0.002**
Vitamin-D	22.0 (19.0–27.0)	21.5 (18.5–26.5)	0.23
LBM	38,650.5 (32,350.5–43,785.5)	37,509,71 ± 3023,61	0.31
FM	29,507.5 (21,450.5–37,650.5)	24,990.0 (20,875.0–32,650.0)	0.0059**
SF-36	31.0 (26.0–38.0)	51.0 (38.0–62.0)	0.0015**
Disease duration	13.0 (6.0–18.0)	7.0 (4.0–10.0)	0.045*
mRSS	23.0 (17.0–29.0)	11.5 (9.5–15.5)	0.0001***
Esophageal involvement	40.5 (29.5–52.5)	29.5 (21.5–39.5)	0.04*
CPR	1.5 (1.0–2.5)	1.0 (0.5–2.5)	0.62
ESR	33.0 (18.0–44.0)	21.0 (12.0–38.0)	0.01**
ANA	710.0 (160.0–1236.0)	738.0 (160.0–1275.0)	0.81
ENA	12.0 (6.0–21.0)	9.0 (4.0–12.0)	0.0001***
DLCO	75.0 (65.0–85.0)	89.0 (72.0–97.0)	0.0002***
Limited	64%	100%	0.34
Diffuse	36%	0%	0.0024**

Difference of nutritional, clinical, and biological markers between the two groups (Kolmogorov–Smirnov test $*p<0.05$, $**p<0.01$, $***p<0.001$). Data are presented as median (minimum–maximum) or as percentage (%)

Table 6 HGS correlation with SSc disease markers

Correlation of HGS with disease markers	*r*	*p*
Disease duration	−0.2	0.04*
mRSS	−0.53	0.0001***
Esophageal involvement	−0.2	0.04*
ESR	−0.38	0.0022**
ENA	−0.38	0.0007***
DLCO	0.5	0.0001***

Spearman $*p<0.05$, $**p<0.01$, $***p<0.001$

in the sarcopenic group. It is important to underline that all patients with DcSSc resulted sarcopenic according to the HGS index.

A correlation analysis confirmed the data in Table 6: disease duration, mRSS, esophageal involvement, ESR, and ENA negatively correlated with HGS, while DLCO positively correlated with the index.

About the relationship between HGS and the capillaroscopic pattern, it is possible to observe in Table 7 that the value of the sarcopenia index got worse when there was a worse capillaroscopic pattern.

Table 7 HGS in capillaroscopy sub-groups (early, active and late) in "Sarcopenia" and "No Sarcopenia" groups

Capillaroscopy pattern and HGS	Sarcopenia	*p*	*p*	*p*
Early	14.0 (11.0–18.0)	Early vs. active	Early vs. late	Active vs. late
Active	15.0 (12.0–18.0)	0.61	0.013*	0.029*
Late	9.0 (7.0–11.0)			
Capillaroscopy pattern and HGS	No Sarcopenia	*p*	*p*	*p*
Early	24.5 (20.5–29.5)	Early vs. active	Early vs. late	Active vs. late
Active	24.0 (21.0–28.0)	0.55	0.013*	0.02*
Late	21.0 (15.0–26.0)			

Data are presented as median (minimum–maximum), Kolmogorov–Smirnov test $*p<0.05$, $**p<0.01$, $***p<0.001$

Discussion

In the present study, we evaluated the presence of sarcopenia in a cohort of SSc patients by using two indexes: RSMI and HSG. According to RSMI, the percentage of sarcopenia was 42%, according to HGS 54.8%. Considering the mean age of 69 ± 9.5 years in the sarcopenia group for the RSMI index and of 67.5 ± 8.3 years for HGS one, the overall percentages of sarcopenia for both indexes are higher than ones reported in the literature for patients with that age (25.5% for 70 years old patients) [27–29]. Our data indicate a higher prevalence of sarcopenia in SSc patients than expected for this age group, despite age impacted on the presence of sarcopenia for both RSMI and HGS indexes. In fact, according to the literature, the prevalence of sarcopenia in SSc is 22.5% which is in line with other rheumatic diseases, such as rheumatoid arthritis (20.8%), psoriatic arthritis (20%), and ankylosing spondylitis (22.7%) [5]. The higher prevalence of sarcopenic patients in our population study could also depend on the fact that we used different sarcopenia indexes than the one suggested by the European Working Group on Sarcopenia in Older People (EWGSOP) [30, 31]. However, we believe that both indexes (RSMI and HGS) appear to be able to describe a sarcopenia condition in SSc patients, as evidenced in another study present in the literature [32]. There is a direct impact on sarcopenia attributable to age, and both indexes show this feature once again in compliance with data present in the literature [33]. It is also logical to think that nutritional parameters can impact on sarcopenia conditions in SSc [34]: in fact, our data show that malnutrition and a lower LBM can impact on sarcopenia according to RSMI index, while malnutrition and a higher FM can impact on sarcopenia according to HGS index. These data are perfectly in line with the literature, since it has been demonstrated that a sarcopenic condition in elderly is influenced by malnutrition and characterized by a decrease in lean body mass and increase in fat mass [35, 36].

The purpose of this paper is related to the analysis of SSc-specific disease markers in relation to sarcopenia. In fact, despite the association of sarcopenia with disease markers has been extensively investigated in other rheumatic diseases such as osteoarthritis [37, 38], rheumatoid arthritis [39, 40], fibromyalgia syndrome [41], systemic lupus erythematosus [42], and ankylosing spondylitis [43], very little is known about the association of SSc-specific markers with sarcopenia. Our study demonstrated that RSMI correlates with disease duration, mRSS, esophageal involvement, ESR, ANA, DLCO, and capillaroscopic pattern, while HGS correlates with disease duration, mRSS, esophageal involvement, ESR, ENA, DLCO, and capillaroscopic pattern. The fact that mRSS is present in both the indexes empowers the association of sarcopenia with disease markers, since mRSS correlates with internal organ involvement, severity of ILD, and is a predictor of mortality in SSc [44]. This observational study highlights that sarcopenia is part of SSc, and the disease itself is responsible for sarcopenia onset and evolution. Moreover, we believe that, despite nutritional parameters can impact on sarcopenia, the treatment of the disease could improve the general condition of the patients, independently from nutritional and from other laboratory and clinical parameters not related to SSc.

We are aware that this study presents several limitations. One is the lack of widely accepted criteria in terms of cutoff values for sarcopenia in young adults and in chronic diseases such as SSc, since all the cutoff values are intended for elderly patients [45]. Another one is related to the fact that most of the studies of sarcopenia reported a higher prevalence in women than in men [46] and the population in this study is mainly composed by women due to the sex bias of SSc. Therefore, the high percentage of sarcopenia measured by the two indexes, RSMI and HGS, could also reflect the prevalence of female sex in the examined population. Moreover, the heterogeneity of the examined population did not allow the use of multivariate analyses by normalizing for multiple confounders (e.g., age, employment status, educational status, treatment received or currently receiving, comorbidities) that could explain the obtained results. Finally, the absence of a control group represents another limitation of the study.

Compliance with ethical standards

Conflict of interest None declared.

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