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Original Article

The relation between sarcopenia, associated factors, and disease activity in patients with rheumatoid arthritis

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Abstract

Aim
The aim of this study was to detect the incidence of sarcopenia in patients with rheumatoid arthritis (RA) and study associated factors.

Patients and methods
Dual-energy X-ray absorptiometry was used to assess the body composition of 80 patients with RA and 80 healthy controls. Sarcopenia was defined as a relative skeletal muscle index of less than 5.5 kg/m^2 in male and less than 7.26 kg/m^2 in female patients. BMI, waist circumference, and disease activity score 28 erythrocyte sedimentation rate were used to assess disease activity. Functional disability was measured using Health Assessment Questionnaire, and 4-m gait speed test was used to determine patient's physical performance.

Results
The relative skeletal muscle index was significantly lower in the RA group (6.1 ± 1.2 vs. 7.2 ± 0.9 kg/m^2, $P < 0.0001$). Thirty-one (38.8%) patients in the RA group had sarcopenia. Sarcopenia in RA group was not related to age, disease duration, steroid therapy, and disease activity assessed by disease activity score 28 erythrocyte sedimentation rate. Most of the patients with sarcopenia were preobese, and 67% had abnormal waist circumference (102.1 ± 14.9 vs. 98.9 ± 12.0 cm, $P = 0.003$). There was no significant relation between sarcopenia and the Health Assessment Questionnaire score ($P = 0.057$), and both subgroups were comparable regarding the extent of physical disability ($P = 0.448$) and performed similarly on the 4-m gait speed test ($P = 0.800$). The only independent predictor was male sex in our patients with RA.

Conclusion
Sarcopenia is a common finding in patients with RA but does not have an association with disease activity, functional disability, or physical performance. Future studies are required for better comprehension of sarcopenia to clear up its relationship with different comorbidities.

Keywords: Associated factors, rheumatoid arthritis, sarcopenia

Introduction

Sarcopenia is related to aging; however, it perhaps influences younger adults as a part of inflammation accompany prolonged illness like rheumatoid joint inflammation [1]. The recently established diagnosis of sarcopenia should be on the basis of decreased muscle mass and strength and/or lower physical performance [2]. The leading causes implicated in lean muscle reduction in patients with rheumatoid arthritis (RA) were chronicity of inflammation owing to prolonged disease course and limited movement and physical activity owing to stiffness and pain [3]. Thus, detection of sarcopenia in patients diagnosed with RA is crucial.

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Patients with RA may be accompanied by increased risk of overweight and even obesity owing to larger fat mass content, and they are at an increased risk to progress to severe disability owing to alteration in their body composition (BC) [4]. Previously BMI was used to evaluate BC [3]. Recently, using whole-body dual-energy X-ray absorptiometry, BC can be assessed [5].

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The aim of this study was to evaluate the frequency of sarcopenia among patients with RA and to study its associations with disease activity and associated factors.

Patients and Methods

The study was conducted in Rheumatology & Rehabilitation Department, El Galaa Teaching Hospital, between January and August 2017. It included 80 patients with RA (their age ≥18 years) according to the ACR/Eular 2010 classification criteria [6] and 80 age-matched and sex-matched non-RA cases as the control group. All cases were informed and gave their consent about the objectives of the study before inclusion in the study. The consent procedures were approved by the Ethics Committee of the El Galaa Teaching Hospital.

Patients with life-threatening medical conditions were excluded from the study. Patients were subjected to the following:

(1) Full medical history, including disease duration and medication use
(2) Laboratory investigations including erythrocyte sedimentation rate (ESR), rheumatoid factor (RF), C-reactive protein (CRP), and anti-cyclic citrullinated protein antibody (anti-CCP)
(3) Joint disease activity score, using ESR (DAS28 ESR) and CRP (DAS28 CRP), was evaluated
(4) Body mass index (BMI) (Kg/m^2) was calculated. Waist circumference (WC) was measured in centimeters (cm). increased cardio metabolic risk was considered (risk which became significant when the WC value over 88cm for women and over 102 cm for men according to WHO and American Diabetes Association) [7]
(5) The Health Assessment Questionnaire (HAQ) was used to assess disability [8]
(6) All participants underwent whole-body dual-energy X-ray absorptiometry scanning (Lunar prodigy advance). Tissue quantitation is part of the total body analysis. Fat, lean, and bone masses for the entire body (except head) and per region (arms and legs) were analyzed by using the manufacturer's validated software CORE_V13.5_E (General Electric, Madison Wistosin, US). Appendicular skeletal muscle mass was the calculation of the skeletal mass in upper and lower limbs. The simple formula can obtain relative skeletal muscle index (RSMI): appendicular skeletal mass in kilograms divided by the square of the height. According to Baumgartner *et al.* [9], uisng the anthropometric equation, sarcopenia was defined as RSMI less than 7.26 kg/m^2 in male and less than 5.5 kg/m^2 in female
(7) Physical performance was assessed using 4-m gait speed (4MGS). It was the time that recorded for each patient needed to pass two tape marks on the floor, which were placed 4 m apart. The average value of velocity was reported as outcome. The 4MGS lower than 0.8 m/s was used to define an inferior muscle performance [10].

Statistical methods

Data were analyzed using Stata, version 14.2 (StataCorp LLC, College Station, Texas, USA) and MedCalc, version 15.8 (MedCalc Software bvba, Ostend, Belgium). Normality of binary data distribution was examined using the Shapiro–Wilk test. Customarily distributed binary variables were presented as mean ± SD, and intergroup differences were compared using the unpaired *t*-test. Matched numerical data were analyzed using the paired *t*-test. Categorical data were presented as number and percentage, and between-group differences were examined using Fisher's exact test (for nominal data) or the χ^2-test for trend (for ordinal data). Matched categorical data were analyzed using the McNemar test. Correlations were tested using the Pearson product-moment correlation. Receiver-operating characteristic curve analysis was used to identify the accuracy and best cutoff value of RSMI for discrimination between patients with or without RA. Multivariable binary logistic regression analysis was used to determine predictors of sarcopenia in patients with RA. *P* value less than 0.05 was considered statistically significant.

Results

Table 1 shows the RA group characteristics. The mean ± SD age was 51.8 ± 9.7 years (range: 30–70 years) with a male/female ratio of 12/68. The duration of disease ranged from 3 to 25 years, with a mean ± SD of 11.4 ± 4.8 years.

According to the DAS28-ESR score, five (6.3%) patients were in remission, eight (10.0%) in low disease activity, 49 (61.3%) in moderate disease activity and 18 (22.5%) in high disease activity. According to the DAS28-CRP score, in contrast, four (5.0%) patients were in remission, 20 (25.0%) in low disease activity, 50 (62.5%) in moderate disease activity and six (7.5%) in high disease activity. Regarding the HAQ disability score, 31 (38.8%) patients had mild difficulty to moderate disability, 47 (58.8%) patients had moderate to severe disability, and only two (2.5%) patients had severe to very severe disability. Using an RSMI cutoff criterion of less than 5.5 kg/m^2 for females and less than 7.26 kg/m^2 for males, 31 (38.75%) patients were labeled as having sarcopenia (Fig. 1).

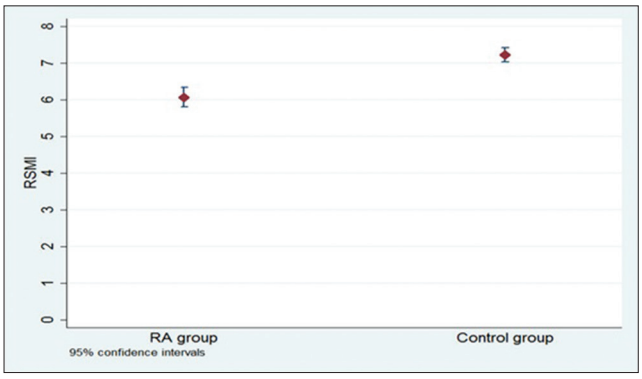

Figure 1: Mean relative skeletal mass index (RSMI) in patients with rheumatoid arthritis (RA) and non-RA controls. Error bars represent the 95% confidence interval.

Table 1: Characteristics of the rheumatoid arthritis group

Variables	Mean±SD (range)/*n* (%)
Age (years)	51.8±9.7 (30-70)
Sex	
Male	12 (15.0)
Female	68 (85.0)
BMI (kg/m^2)	29.3±2.8 (23.0-35.0)
BMI class (kg/m^2)	
18.5-24.9 (normal)	6 (7.5)
25-29.9 (preobese)	39 (48.8)
30-34.9 (obese class I)	32 (40.0)
35-39.9 (obese class II)	3 (3.8)
Waist circumference (cm)	102.1±14.9 (84.0-150.0)
Waist circumference class	
Below risk (female <80 cm, male <94 cm)	3 (3.8)
High risk (female >80 and <88 cm, male >94 and <102 cm)	14 (17.5)
Very high risk (female >88 cm, male >102 cm)	63 (78.8)
Disease duration (years)	11.4±4.8 (3.0-25.0)
Medications	
Methotrexate	63 (78.8)
Salazopyrin	5 (6.3)
Antimalarials	50 (62.5)
Leflunomide	13 (16.3)
Steroids	6 (7.5)
DAS28-ESR	4.7±1.5 (2.0-9.0)
Disease activity as per DAS28-ESR	
Remission	5 (6.3)
Low disease activity	8 (10.0)
Moderate disease activity	49 (61.3)
High disease activity	18 (22.5)
DAS28-CRP	4.1±1.2 (2.0-8.0)
Disease activity as per DAS28-CRP	
Remission	4 (5.0)
Low disease activity	20 (25.0)
Moderate disease activity	50 (62.5)
High disease activity	6 (7.5)
HAQ	1.4±0.6 (0.0-3.0)
Disability as per HAQ	
Mild difficulty to moderate disability	31 (38.8)
Moderate to severe disability	47 (58.8)
Severe to very severe disability	2 (2.5)
4-m gait speed (m/s)	1.27±0.38 (0.2-2.0)
Laboratory findings	
ESR (mm/h)	42.3±11.2 (12.0-76.0)
CRP (mg/l)	6.9±1.7 (4.0-10.0)
RF	72 (90.0)
Anti-CCP	68 (85.0)
RSMI (kg/m^2)	6.08±1.22 (3.00-9.00)
Sarcopenia	
Nonsarcopenic (female ≥5.5 kg/m^2, male ≥7.26 kg/m^2)	49 (61.25)
Sarcopenic (female <5.5 kg/m^2, male <7.26 kg/m^2)	31 (38.75)

CCP, cyclic citrullinated peptides; CRP, C-reactive protein; DAS, disease activity score; ESR, erythrocyte sedimentation rate; HAQ, Health Assessment Questionnaire; RF, rheumatoid factor; RSMI, relative skeletal mass index.

Table 2 shows a comparison of RA cases and non-RA controls. The mean BMI was significantly lower (29.3 ± 2.8 vs. 30.0 ± 2.6 kg/m^2, P = 0.001) and the WC significantly higher (102.1 ± 14.9 vs. 98.9 ± 12.0, P = 0.003) in the RA group, but these differences were too small to be of clinical value. The mean HAQ score was significantly higher in the RA group (1.4 ± 0.6 vs. 0.5 ± 0.4, P < 0.0001) with significantly more patients in the moderate to severe disability and severe to very severe disability classes (P < 0.0001). The patients in the RA group performed significantly slower on 4-m gait speed test (1.3 ± 0.4 vs. 2.4 ± 0.8 m/s, P < 0.0001) (Fig. 2). The ESR (P < 0.0001) and CRP (P < 0.0001) were significantly higher in the RA group, and significantly more patients in the RA group tested positive for the RF (P < 0.0001) and anti-CCP (P < 0.0001). The RSMI was significantly lower in the RA group (6.1 ± 1.2 vs. 7.2 ± 0.9 kg/m^2, P < 0.0001). Thirty-one (38.8%) patients in the RA group were classified as having sarcopenia compared with only eight (10%) patients in the control group (P < 0.0001).

Table 3 shows a comparison of patients with RA with or without sarcopenia. The difference between the two subgroups was not statistically significant regarding any of the demographic (age and sex), anthropometric (BMI and WC), or laboratory variables (ESR, CRP, RF, and anti-CCP) (all P > 0.05). The disease duration was, likewise comparable in both subgroups (11.5 ± 5.1 vs. 11.3 ± 4.4 years in nonsarcopenic and sarcopenic patients, respectively, P = 0.821). In particular, there was no statistically significant relation between sarcopenia and the DAS28-ESR (P = 0.633) or DAS28-CRP score (P = 0.524). The patients with sarcopenia and without sarcopenia were comparable regarding the grade of disease activity as rated on both versions of the DAS28 scoring system (P = 0.548 and 0.400 for the DAS28-ESR and DAS28-CRP, respectively). Likewise, there was no statistically significant relation between sarcopenia and the HAQ score (P = 0.057). Both subgroups were comparable regarding the extent of physical disability as graded with the HAQ scoring system (P = 0.448) and performed similarly on the 4-m gait speed test (P = 0.800).

Table 4 shows the results of correlation analysis between the RSMI and other numerical variables in patients with RA. There was a weak positive correlation between the RSMI and both the DAS28-ESR (r = 0.243, P = 0.030) and DAS28-CRP scores (r = 0.284, P = 0.011) (Fig. 3). The results of multivariable binary logistic regression analysis for determinants of sarcopenia in patients

Table 2: Comparison of rheumatoid arthritis cases and non-rheumatoid arthritis controls

Variables	RA group (*n*=80)	Control group (*n*=80)	*P*
BMI (kg/m^2)	29.3±2.8	30.0±2.6	0.001[a]
BMI class (kg/m^2)			0.007[b]
18.5–24.9 (normal)	6 (7.5)	4 (5.0)	
25–29.9 (preobese)	39 (48.8)	29 (36.3)	
30–34.9 (obese class I)	32 (40)	43 (53.8)	
35–39.9 (obese class II)	3 (3.8)	4 (5.0)	
Waist circumference (cm)	102.1±14.9	98.9±12.0	0.003[a]
Waist circumference class			0.122[b]
Below risk (female <80 cm, male <94 cm)	3 (3.8)	2 (2.5)	
High risk (female >80 and <88 cm, male >94 and <102 cm)	14 (17.5)	19 (23.8)	
Very high risk (female >88 cm, male >102 cm)	63 (78.8)	59 (73.8)	
HAQ	1.4±0.6	0.5±0.4	<0.0001[a]
Disability as per HAQ			<0.0001[b]
Mild difficulty to moderate disability	31 (38.8)	77 (96.3)	
Moderate to severe disability	47 (58.8)	2 (2.5)	
Severe to very severe disability	2 (2.5)	1 (1.3)	
4-m gait speed (m/s)	1.3±0.4	2.4±0.8	<0.0001[a]
ESR (mm/h)	42.3±11.2	16.4±2.3	<0.0001[a]
CRP (mg/l)	6.9±1.7	4.5±0.8	<0.0001[a]
Positive RF	72 (90)	8 (10)	<0.0001[b]
Positive anti-CCP	65 (85)	0 (0)	<0.0001[b]
RSMI (kg/m^2)	6.1±1.2	7.2±0.9	<0.0001[a]
Sarcopenia			<0.0001[b]
Nonsarcopenic	49 (61.2)	72 (90)	
Sarcopenic	31 (38.8)	8 (10)	

Data are represented as mean±SD or *n* (%). CCP, cyclic citrullinated peptides; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; HAQ, Health Assessment Questionnaire; RA, rheumatoid arthritis; RF, rheumatoid factor; RSMI, relative skeletal mass index. [a]Paired *t*-test. [b]McNemar test.

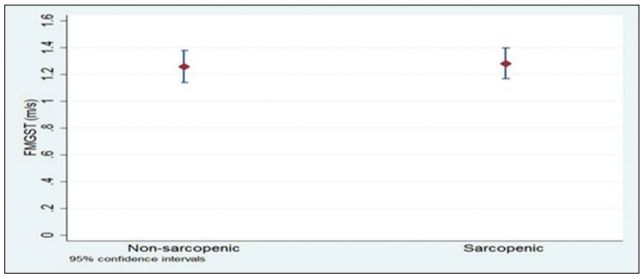

Figure 2: The result of 4-m gait speed test (FMGST) in sarcopenic and nonsarcopenic rheumatoid arthritis groups. Error bars represent the 95% confidence interval.

with RA are shown in Table 5. After adjustment for the confounding effect of other variables, male sex was the only independent predictor of sarcopenia in this patient

Table 3: The relation between sarcopenia and other demographic, clinical and laboratory variables in patients with rheumatoid arthritis

Variables	Nonsarcopenic (*n*=49)	Sarcopenic (*n*=31)	*P*
Age (years)	52.4±9.9	50.9±9.3	0.495[a]
Sex			0.051[b]
Male	4 (8.2)	8 (25.8)	
Female	45 (91.8)	23 (74.2)	
BMI (kg/m^2)	29.3±3.0	29.2±2.6	0.927[a]
BMI class (kg/m^2)			0.841[c]
18.5-24.9 (normal)	4 (8.2)	2 (6.5)	
25-29.9 (preobese)	24 (49.0)	15 (48.4)	
30-34.9 (obese class I)	19 (38.8)	13 (41.9)	
35-39.9 (obese class II)	2 (4.1)	1 (3.2)	
Waist circumference (cm)	104.1±16.2	99.1±12.2	0.123[a]
Waist circumference class			0.059[c]
Below risk (female <80 cm, male <94 cm)	1 (2.0)	2 (6.5)	
High risk (female >80 and <88 cm, male >94 and <102 cm)	6 (12.2)	8 (25.8)	
Very high risk (female >88 cm, male >102 cm)	42 (85.7)	21 (67.7)	
Disease duration (years)	11.5±5.1	11.3±4.4	0.821a
Medications			
Methotrexate	39 (79.6)	24 (77.4)	1.0[b]
Salazopyrin	4 (8.2)	1 (3.2)	0.644[b]
Antimalarials	28 (57.1)	22 (71.0)	0.244[b]
Leflunomide	7 (14.3)	6 (19.4)	0.552[b]
Steroids	3 (6.1)	3 (9.7)	0.672[b]
DAS28-ESR	4.7±1.6	4.5±1.3	0.633[a]
Disease activity as per DAS28-ESR			0.548[c]
Remission	3 (6.1)	2 (6.5)	
Low disease activity	6 (12.2)	2 (6.5)	
Moderate disease activity	30 (61.2)	19 (61.3)	
High disease activity	10 (20.4)	8 (25.8)	
DAS28-CRP	4.1±1.3	4.0±1.0	0.524[a]
Disease activity as per DAS28-CRP			0.400[c]
Remission	2 (20.4)	2 (6.5)	
Low disease activity	11 (22.4)	9 (29.0)	
Moderate disease activity	32 (65.3)	18 (58.1)	
High disease activity	4 (8.2)	2 (6.5)	
HAQ	1.5±0.6	1.2±0.6	0.057[a]
Disability as per HAQ			0.448[c]
Mild difficulty to moderate disability	18 (36.7)	13 (41.9)	
Moderate to severe disability	29 (59.2)	18 (58.1)	
Severe to very severe disability	2 (4.1)	0 (0.0)	
4-m gait speed (m/s)	1.3±0.4	1.3±0.3	0.800[a]
Laboratory findings			
ESR (mm/h)	42.2±11.8	42.5±10.3	0.882[a]

Contd...

Table 3: Contd...

Variables	Nonsarcopenic (*n*=49)	Sarcopenic (*n*=31)	*P*
CRP (mg/l)	7.0±1.5	6.7±1.9	0.341[a]
RF	42 (85.7)	30 (96.8)	0.142[b]
Anti-CCP	39 (79.6)	29 (93.5)	0.115[b]

Data are expressed as mean±SD or *n* (%).CCP, cyclic citrullinated peptides; CRP, C-reactive protein; DAS, disease activity score; ESR, erythrocyte sedimentation rate; HAQ, Health Assessment Questionnaire; RF, rheumatoid factor; RSMI, relative skeletal mass index. [a]Unpaired *t*-test. [b]Fisher's exact test. [c]χ^2-test for trend.

Table 4: Correlation between relative skeletal mass index and other numerical variables in patients with rheumatoid arthritis patients

Variables	RSMI	
	Correlation coefficient (*r*)	*P*-value[a]
Age	0.157	0.165
BMI	0.002	0.989
Waist circumference	0.142	0.209
Disease duration	0.211	0.060
DAS28-ESR	0.243	0.030
DAS28-CRP	0.284	0.011
HAQ	−0.004	0.972
4-m gait speed	0.190	0.091
ESR	0.006	0.960
CRP	0.079	0.485

There was weak positive correlation between the RSMI and both the DAS28-ESR(*r*=.243, *P* value .030) and DAS28-CRP scores (*r*=.284, *P*-value=.011). CRP, C-reactive protein; DAS, disease activity score; ESR, erythrocyte sedimentation rate; HAQ, Health Assessment Questionnaire; RSMI, relative skeletal mass index. [a]Pearson's product-moment correlation.

Table 5: Multivariable binary logistic regression analysis for determinants of sarcopenia in patients with rheumatoid arthritis

Variables	Regression coefficient	SE	*P*	Odds ratio	95% CI
Male sex	2.66	0.99	0.007	14.29	2.04-100.00
Age (years)	−0.04	0.03	0.179	0.96	0.90-1.02
BMI (kg/m^2)	0.15	0.13	0.226	1.17	0.91-1.50
Waist circumference (cm)	−0.04	0.02	0.151	0.96	0.92-1.01
Disease duration (years)	−0.01	0.07	0.890	0.99	0.87-1.13
DAS28-ESR	−0.43	0.22	0.056	0.65	0.42-1.01
Methotrexate therapy	−0.56	0.68	0.410	0.57	0.15-2.16
Steroid therapy	0.15	1.04	0.888	1.16	0.15-8.89
Salazopyrin therapy	−0.76	1.39	0.582	0.47	0.03-7.07
Leflunomide therapy	0.12	0.69	0.861	1.13	0.29-4.33
Constant	2.98	-	-	-	-

CI, confidence interval; DAS28-ESR, disease activity score 28 erythrocyte sedimentation rate.

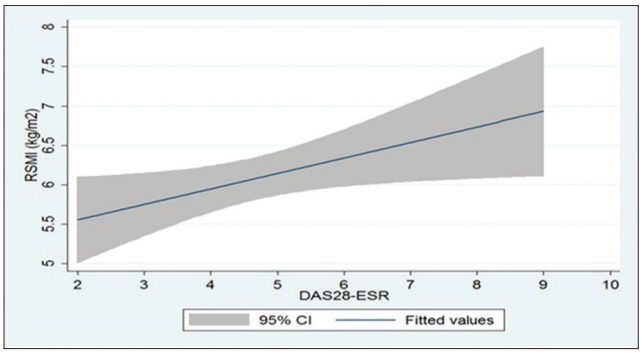

Figure 3: Fitted scatter diagram showing the correlation between the disease activity score 28 erythrocyte sedimentation rate (DAS28-ESR) and relative skeletal mass index (RSMI) in patients with rheumatoid arthritis (RA). The fitted line represents regression line. The shaded area represents the 95% confidence intervals (CIs). There is weak positive correlation between RSMI and DAS28-ESR ($r = 0.243$, $P = 0.030$).

group (odds ratio = 14.29, 95% confidence interval = 2.04–100.00, $P = 0.007$).

Discussion

This study demonstrated that sarcopenia is a frequent finding in our patients with RA. Approximately 39% in the RA group were classified as having sarcopenia compared with only eight (10%) patients in the control ($P < 0.0001$). In several studies, sarcopenia was reported to be prevalent in RA as different rates, with one as high as 30% [11]. Ngeuleu *et al.* [3] reported high sarcopenia rate, as more than one patient with RA on three were sarcopenic. Dogan *et al.* [12] established the prevalence of sarcopenia of 43.3%, whereas a rate of 25.9% was detected by Giles *et al.* [13]. Tournadre *et al.* [5] observed a muscle mass below the cutoff value for sarcopenia in one-third of their patients with RA in comparison with controls distinct with regular fat mass.

Variables influencing muscle loss should be explained including limited mobility status, disease flare, and the utilization of steroids [14–17]. Inflammation causes various and complex effects on muscles, for example, a decrease of an insulin/growth factor and increasing breakdown of proteins. Altered BC leads to cardiometabolic disease [18]. Reduction in body cell mass in patients with RA was related to provocative cytokines, recommending a cytokine-driven condition of hypermetabolism as the reason [19].

We could not demonstrate the relationship between muscle mass and the disease features, including age, duration of the disease, and disease activity. The results of multivariable binary logistic regression analysis for determinants of sarcopenia in our patients with RA after adjustment for the confounding effect of other variables showed that the male sex was the only independent predictor of sarcopenia in this patient group (odds ratio = 14.29, 95% confidence interval = 2.04–100.00, $P = 0.007$). Previous work has shown that variations in BC during aging can be sex specific. For example, a more significant decline in muscle mass was detected in men with aging compared with women [20].

It was well established that women may develop pronounced muscle loss related to prolonged muscle disuse [21]. Recent study exerts attention that RA might give a higher disease effect on muscle outcomes in men [22].

Dao *et al.* [23] reported a significantly greater extent of altered BC phenotypes in women with early RA, with higher fat mass in the trunk and lowered lean mass than controls. Disease activity and disability scores were related to undesirable BC. Ngeuleu *et al.* [3] found that sarcopenia has a positive correlation to normal and overweight regarding BMI in their patients with RA. This study showed no significant difference between the sarcopenia and BMI in both sarcopenic and nonsarcopenic RA subgroups ($P > 0.05$). Munro *et al.* [24] observed a negative correlation between CRP level and muscle mass in women with RA. It is expected that apart from CRP, proinflammatory cytokines as tumor necrosis factor-α and interleukin 1β, which are connected with RA pathogenesis, play an essential role in sarcopenia progression [25,26]. It is realized that sarcopenia might be related to another condition than age. Westhovens *et al.* [27] assessed BC in 89 patients with RA (43 men and 46 women) and 157 controls and found that lean body mass was lower in the RA group. In this study, RSMI of our patients with RA was observed to be lower than the controls. Hence, lower muscle mass might be related to disease itself rather than age profile. It was notable that the chief cause of diminished lean mass might be the duration of RA disease, reduction in physical activity, chronicity of pain, and expenditure of energy during rest [1].

The study by Giles *et al.* [14] assessed altered BC phenotypes and RA features in patients with RA, and they have noticed that abnormal BC was associated with a positive RF, joint deformity, and increased CRP level. Santos *et al.* [28] recognized altered BC in women with systemic lupus erythematosus and RA than noninflammatory controls in spite of having a comparable BMI. It was observed that sarcopenia was more frequent in the RA women, who have a high serum level of CRP than in controls. It was more associated with the normal and overweight subset than the obese subset according to BMI [12].

This study showed that there was no statistically significant relation between sarcopenia and disease activity in patients with RA evaluated by the DAS28-ESR ($P = 0.633$) and DAS28-CRP score ($P = 0.524$); this may be owing to the low disease activity profile of our patients with RA. Ngeuleu *et al.* [3] observed a relationship between ESR, DAS28 ESR, and sarcopenia in men, but not in women. Dao *et al.* [23] and El Maghraoui *et al.* [29] have shown that BC changes were associated with high DAS28 score. Similar to our results, Melikoglu [30] reported no correlation between skeletal muscle mass, ESR, CRP levels, and disease activity. It is presently well known that sarcopenia is related to daily life disability and is an independent risk factor for falls in older people, and premature death [31]. Although chronic morbidity is a potential risk factor for functional impairment, functional impairment and disability were found to be linked with low muscle mass independent of chronic morbidity [32]. Melikoglu [30] demonstrated a significant inverse correlation between RSMI and HAQ scores of their patients with RA. Juan *et al.* [32] found that the risk of functional disability increases with high disease activity and limitation of joint mobility. Our findings corroborated previous studies [30–32], which showed that the mean HAQ score was significantly higher in our RA group (1.4 ± 0.6 vs. 0.5 ± 0.4, $P < 0.0001$) with significantly more patients in the moderate to severe disability and severe to very severe disability classes ($P < 0.0001$).

It was recognized that lean mass loss because of sarcopenia in patients with RA leads to increase in insulin resistance and inevitably cardiometabolic comorbidity [23]. WC has been considered the best indicator of diabetes and hypertension, the two leading causes of death and disability. Several studies such as Chin *et al.* [33] and Sanada *et al.* [34] have demonstrated the association of sarcopenia with high cardiovascular risk through multiple ways: increment of fat mass and diminishment of muscle (because of functional impairment and physical disability). Ngeuleu *et al.* [3] reported higher cardiometabolic illness in their patients with RA having sarcopenia. The present investigation demonstrated no increase in cardiometabolic risk regarding WC as an indicator in our patients with RA having sarcopenic compared with patients with RA who do not have sarcopenia.

Melikoglu [30] reported that low muscle mass and limited physical activity besides the inflammatory nature of RA disease might lead to 0 doing daily activities. In this study, physical performance was assessed using walking speed, the most widely used tool in clinical practice. Our RA group performed significantly slower on the 4MGS test (1.3 ± 0.4 vs. 2.4 ± 0.8 m/s, $P < 0.0001$).

Conclusion

Despite sarcopenia being a common finding in patients with RA occurring in ~39% of patients, no relation could be found between the disease activity, degree of disability, or duration of the disease and the occurrence of sarcopenia. No relationships between sarcopenia and any of the anthropometric measures, medications received, or laboratory findings were observed. However, multivariable analysis showed that male sex was an independent predictor for sarcopenia in this patient group. It is recommended that future research in this area with larger sample size is required for better comprehension of sarcopenia to clear up its relationship with differently associated disease comorbidities.

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Conflicts of interest

There are no conflicts of interest.

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