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Does sarcopenia influence rotator cuff tear patterns? Radiological insights from patients with rotator cuff syndrome

Sibel Süzen Özbayrak[1], Elem Yorulmaz[1], Esra Gürdal[2]

[1]Department of Physical Medicine and Rehabilitation, Health Science University, Haydarpaşa Numune Training and Research Hospital, İstanbul, Türkiye
[2]Department of Radiology, Health Science University, Haydarpaşa Numune Training and Research Hospital, İstanbul, Türkiye

ABSTRACT

Objectives: This study aims to determine whether sarcopenia is associated with the presence, severity, or type of rotator cuff tears in patients with rotator cuff syndrome. It also assesses how the degree of shoulder pain and functional disability relate to the existence of sarcopenia in patients with rotator cuff syndrome, as well as examines the impact of the patients' clinical characteristics and physical activity levels on sarcopenia.

Patients and methods: In this cross-sectional study conducted between October 2024 and October 2025, 130 patients with shoulder pain lasting at least three months were assessed, of whom 124 (25 males, 99 females; mean age: 60.4±10.3 years; range: 40 to 85 years) met the study criteria and were included in the analysis. Of these, 69 were sarcopenic, 15 presarcopenic, and 40 non-sarcopenic. Sarcopenia was evaluated using the ISarcoPRM diagnostic algorithm, which includes gait speed, handgrip strength, chair stand test, and ultrasonographic measurement of anterior thigh muscle thickness. Shoulder magnetic resonance imaging scans were assessed for the presence, type, and severity of rotator cuff tears, focusing particularly on supraspinatus tears, tendinosis, muscle atrophy (tangent sign), and impingement.

Results: Comparative analysis of the three groups revealed no statistically significant differences in supraspinatus tear, supraspinatus tendinosis, tendinosis of other rotator cuff muscles, impingement, or tangent signs. The most prominent result of this study was the significantly higher prevalence of diabetes mellitus and hypertension among sarcopenic patients (p<0.001). Another important finding was that the tangent sign, a radiological indicator of rotator cuff atrophy, did not change with the presence of sarcopenia; however, it was more frequently positive in patients aged 60 years or older (p=0.013).

Conclusion: While sarcopenia was not associated with differences in rotator cuff pathology or radiological atrophy as indicated by the tangent sign, it was significantly linked to a higher prevalence of diabetes mellitus and hypertension. Age, rather than sarcopenia, appeared to influence the presence of radiological markers of rotator cuff atrophy.

Keywords: Rotator cuff syndrome, sarcopenia, shoulder pain.

Rotator cuff syndrome encompasses a spectrum of injuries and degenerative conditions affecting the rotator cuff, including subacromial impingement syndrome, bursitis, tendinosis, and partial or full-thickness rotator cuff tears.[1] The frequency of rotator cuff tears increases markedly with advancing age.[2] Aging negatively influences the mechanical properties of tendons through mechanisms such as reduced blood supply, local hypoxia, increased free radical production, impaired metabolism and nutrition, and collagen degeneration, making elderly individuals more susceptible to tendon and ligament injuries.[3] In this population, the clinical consequences of rotator cuff dysfunction can lead to substantial morbidity and disability, interfering with self-care abilities and functional independence.[2]

Age-related muscle loss, which may be further accelerated by chronic diseases, leads to sarcopenia, a condition increasingly recognized as a key determinant of quality of life in older adults. Current estimates indicate that approximately 50 million people worldwide are affected, with a prevalence of 10 to 27% among individuals over 60 years of age.[4] With the rapid global aging trend, the number of

Corresponding author: Sibel Süzen Özbayrak, MD. Sağlık Bilimleri Üniversitesi, Haydarpaşa Numune Eğitim ve Araştırma Hastanesi, Fiziksel Tıp ve Rehabilitasyon Kliniği, 34668 Üsküdar, İstanbul, Türkiye.
E-mail: eleminal@gmail.com

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people living with sarcopenia is projected to reach 500 million by 2050.[5] Sarcopenia is characterized by a progressive decline in muscle mass, strength, and function, and is associated with a broad spectrum of adverse health outcomes. Individuals with sarcopenia have a higher risk of reduced overall and progression-free survival, postoperative complications, prolonged hospitalization, as well as falls, fractures, metabolic disorders, cognitive decline, and increased mortality. Multiple factors, including physical inactivity, malnutrition, smoking, extreme sleep duration, and diabetes, have been identified as contributors to its development.[6]

Although a genetic causal association has been identified between sarcopenia and rotator cuff tears, with sarcopenia-related traits such as reduced muscle mass and impaired physical performance contributing to increased risk, recent literature has drawn growing attention to the link between sarcopenia and various musculoskeletal disorders.[7-9]

The relationship between sarcopenia and rotator cuff pathology has been investigated in several studies, but the results remain inconclusive. Some studies reported no significant difference in the frequency of sarcopenia between patients with and without rotator cuff tears, suggesting that sarcopenia may not be a direct risk factor for tendon rupture.[10,11] In contrast, it has been reported that sarcopenia was more pronounced in patients with rotator cuff tears compared to age- and sex-matched controls, and the severity of sarcopenia correlated with tear size.[12] These conflicting findings highlight the need for further research to clarify the association between sarcopenia and rotator cuff pathology, as well as its clinical implications for shoulder pain and dysfunction.

The aim of this study was to investigate the relationship between sarcopenia and common magnetic resonance imaging (MRI) findings, particularly rotator cuff tears, in patients presenting with shoulder pain. In addition, we sought to evaluate the impact of sarcopenia on shoulder pain severity and shoulder-related disability. Finally, we examined the association between physical activity level and the presence of sarcopenia in this patient population.

PATIENTS AND METHODS

Study population

This cross-sectional study was conducted at the Physical Medicine and Rehabilitation outpatient clinic of Health Science University, Haydarpaşa Numune Training and Research Hospital assessing 130 patients with shoulder pain lasting at least three months. Six patients were excluded from the final analysis. Of the remaining 124 patients, 69 (9 males, 60 females; mean age: 64.4±9.7 years) were classified as sarcopenic, 15 (7 males, 8 females; mean age: 57.9±8.0 years) as presarcopenic, and 40 (9 males, 31 females; mean age: 53.2±9.3 years) as non-sarcopenic.

Patients aged between 40 and 85 years who had shoulder pain lasting at least three months, were able to ambulate independently, and underwent shoulder MRI as part of their diagnostic evaluation were eligible for inclusion. Patients were excluded if they had a history of previous shoulder surgery; shoulder pathologies limiting joint mobility, such as adhesive capsulitis or osteoarthritis; conditions affecting the bones, cartilage, or ligaments of the shoulder; prior lower extremity or spinal surgery; wheelchair dependence or bedridden status; oncologic disease; neurological disorders; or cognitive impairment. According to the ISarcoPRM diagnostic algorithm, six patients were classified as having dynapenia, characterized by normal anterior thigh muscle thickness but impaired physical performance. These patients were referred for further evaluation, as their reduced physical performance was considered attributable to factors other than sarcopenia, and they were therefore excluded from the analysis. Written informed consent was obtained from each patient. The study protocol was approved by the Health Science University, Haydarpaşa Numune Training and Research Hospital Ethics Committee (Date: 17.09.2024, No: HNEAH-BAEK 2024/123). The study was conducted in accordance with the principles of the Declaration of Helsinki. The trial was registered at ClinicalTrials.gov (registration number: NCT07183774).

Outcome measures

Demographic data of the patients were recorded. A detailed history regarding shoulder pain was obtained. Pain severity was assessed using the Visual Analog Scale (VAS), and shoulder functional impairment was evaluated using the Shoulder Disability Questionnaire (SDQ).[13] The short form of the International Physical Activity Questionnaire Short Form (IPAQ-SF) was utilized to assess the patients' physical activity levels, which were subsequently classified as low, moderate, or high.[14]

Following the clinical assessment of shoulder pain, sarcopenia evaluation was performed by a different physician who is blinded to the patients' imaging and clinical findings. Sarcopenia was assessed using the ISarcoPRM diagnostic algorithm.[15] In this method, gait speed, handgrip strength, and the chair stand test (CST) were first performed.

For gait speed, a six-meter walking track was used, and patients were instructed to walk at their normal pace. The time was recorded with a stopwatch, and each patient performed the test three times, with the average recorded in meters per second (m/sec).

In the CST, the patients were asked to rise from a chair five times as quickly as possible without using their arms, keeping both hands crossed over the chest. The time taken was recorded with a stopwatch.

Handgrip strength was measured using a Jamar dynamometer (Sammons Preston, Inc., Bolingbrook, IL, USA), with the shoulder in adduction, elbow at 90° flexion, and the wrist and hand in a neutral position. The patient repeated the test three times, and the highest value was recorded.

Patients were then evaluated based on whether their gait speed is below 1.0 m/s, grip strength is two standard deviations below the norm,[15] or CST is ≥12 seconds.

Subsequently, anterior thigh muscle thickness was measured. A 5-10 MHz linear array probe (Mindray DC-T6, China) was used under real-time ultrasound guidance. The sonographic thigh adjustment ratio (STAR) value was calculated by dividing the anterior thigh muscle thickness by the body mass index (BMI), and the cutoff values were 1.0 for females and 1.4 for males.

Presarcopenia was defined as reduced regional or total muscle mass in the presence of normal muscle strength and physical performance. Sarcopenia, on the other hand, was diagnosed when reduced regional or total muscle mass was accompanied by decreased muscle strength and/or impaired physical performance, as shown in Figure 1. Based on this comprehensive assessment, patients were classified as non-sarcopenic, presarcopenic, or sarcopenic.

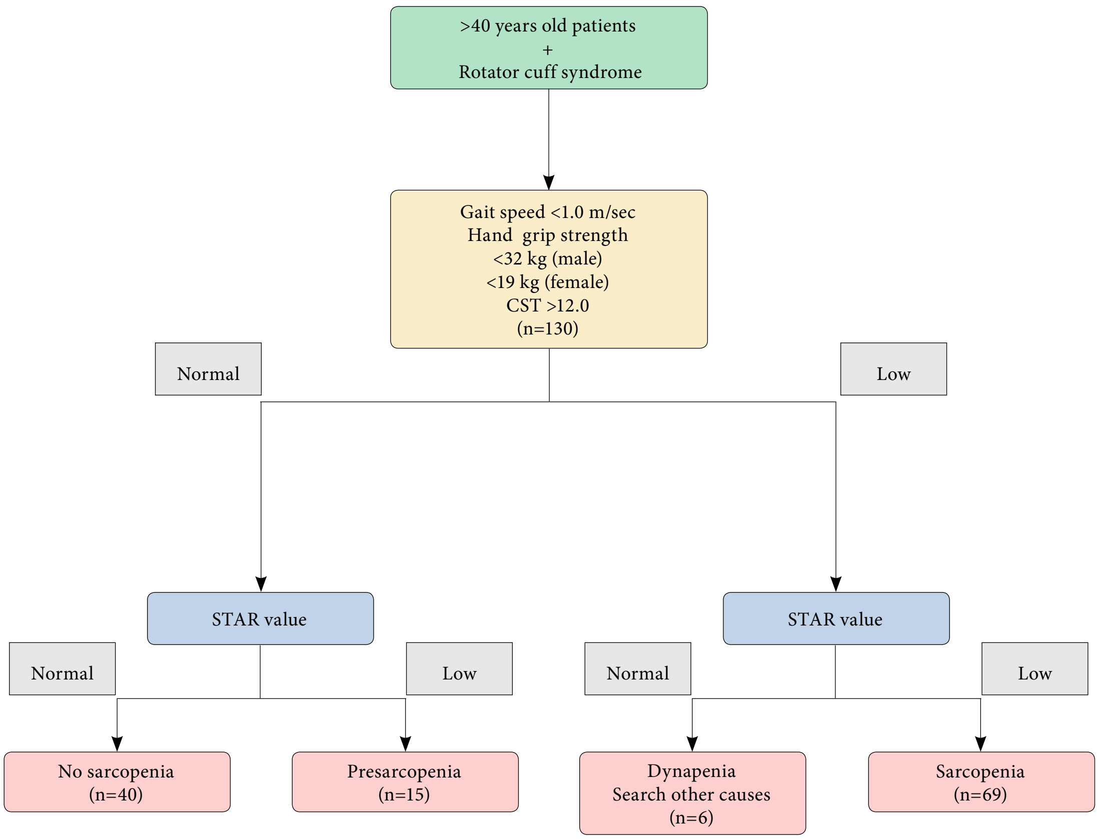

Figure 1. The diagnostic algorithm for sarcopenia.
STAR: Sonographic thigh adjustment ratio.

Shoulder MRI examinations were performed using a 1.5-Tesla scanner (GE Healthcare, Milwaukee, WI, USA) with a dedicated shoulder coil. The imaging protocol included coronal oblique T1-weighted spin-echo, coronal oblique proton density (PD) fat-suppressed, coronal oblique T2-weighted fat-suppressed, axial PD fat-suppressed, and sagittal oblique T2-weighted fat-suppressed sequences. Slice thickness was 3-4 mm, and field of view and matrix parameters were adjusted according to patient size. Shoulder MRIs of patients in each of these three categories were analyzed to assess the presence, type, and severity of rotator cuff tears. Supraspinatus tendon integrity was assessed according to tendon continuity and classified as no tear, partial-thickness tear, or full-thickness tear. A partial-thickness tear was defined as hyperintense signal involving either the articular or bursal surface and intrasubstance tears without complete tendon discontinuity, whereas a full-thickness tear was defined as complete fiber disruption extending from the articular to the bursal surface. For statistical analyses, patients were additionally grouped according to the presence of a supraspinatus tear. In addition, the presence and grade of tendinosis in rotator cuff tendons, impingement signs, and any other pathological findings were documented. Supraspinatus tendinosis was graded according to tendon signal intensity and morphological alterations: Grade 1 as mild focal increased intratendinous signal without tendon thickening; Grade 2 as moderate increased signal intensity with mild tendon thickening but preserved tendon contour; and Grade 3 as marked increased signal intensity associated with evident tendon thickening and structural irregularity without full-thickness fiber discontinuity. Tendinosis of the infraspinatus, subscapularis, and biceps tendons was recorded as present or absent. The presence of muscle atrophy assessed using the tangent sign was recorded. Sagittal T2-weighted fat-saturated MRI images are used to assess the presence of a positive tangent sign. The evaluation is performed on the most lateral image in which the scapular spine and coracoid process contact the body of the scapula. A tangent line is drawn from the superior border of the scapular spine to the superior margin of the coracoid process. In a normal supraspinatus muscle, the muscle belly extends above this line, indicating a negative tangent sign (Figure 2).[16] The evaluation of MRI findings was performed by a radiologist who was blinded to the patients' clinical information and sarcopenia status.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 21.0 software (IBM Corp., Armonk, NY, USA). A post hoc power analysis was performed based on data from 86 patients using a chi-square test to evaluate the association between sarcopenia status and the presence of rotator cuff tear. Assuming a significance level of 0.05 and a target power of 80%, the observed effect size (Cohen's w=0.2759) indicated that a total sample size of 104 patients was required.

The Fisher's exact test (for small sample sizes) and the Chi-square test were used to assess differences in proportions or associations between categorical variables. The distributions of quantitative variables were described using measures of central tendency and variability (mean ± SD). Descriptive statistics for categorical variables were presented as frequencies and percentages (n, %). After assessing data normality with the Shapiro-Wilk test and homogeneity of variances with Levene's test, group means were compared using the Student's t-test for two groups and one-way ANOVA for more than two groups. In cases where these assumptions were not satisfied, the Kruskal-Wallis H test (for more than two groups)

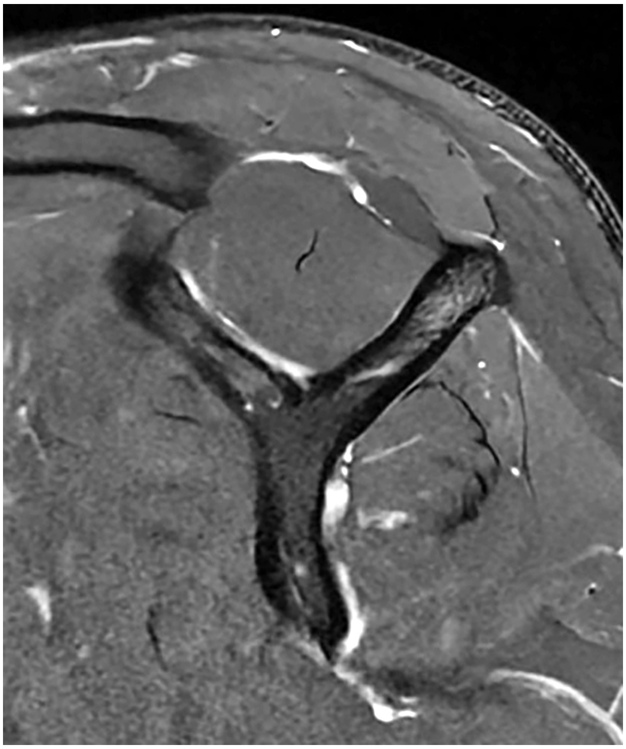

Figure 2. Example of negative tangent sign on T2-weighted fat-saturated sagittal cut on magnetic resonance imaging.

TABLE 1
Distribution of demographic and clinical variables according to sarcopenia status

	Sarcopenia (+) (n=69)					Presarcopenia (n=15)					Sarcopenia (–) (n=40)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
Age (year)			64.4±9.7					57.9±8.0					53.2±9.3			**<0.001**
Sex																0.014
Female	60	87.0				8	53.3				31	77.5				
Male	9	13.0				7	46.7				9	22.5				
Weight (kg)			78.0±15.0	74	70-86			78.4±15.1	73	70-84			73.7±13.0	74.5	63.5-83.25	0.441
Height (m)			159.6±8.1	160	155-165			167.2±9.8	168	160.5-172.5			163.2±10.0	160	155-169.2	**0.007**
BMI (kg/m²)			30.8±6.3	29.6	26.3-35.4			28.1±5.6	26.1	24.5-29.9			27.6±4.0	27.1	24.9-29.5	**0.01**
Pain duration (mo)			9.4±10.4	6	4-12			16.0±18.8	7	4.5-21			6.9±6.3	5	3-8	0.147
Education																0.181
No education/low literacy	7	70.0				1	10.0				2	20.0				
Primary education	40	64.5				7	11.3				15	24.2				
Secondary education	13	38.2				4	11.8				17	50.0				
Higher education	9	50.0				3	16.7				6	33.3				
Smoking (package/year)																0.841
Yes	12	17.4				3	20.0				6	15.0				
No	57	82.6				12	80.0				34	85.0				
Alcohol drinking																0.181
Yes	1	1.4				1	6.7				3	7.5				
No	68	98.6				14	93.3				37	92.5				
Dominant hand																0.197
Right	69	100.0				15	100.0				38	95.0				
Left	0	0.0				0	0.0				2	5.0				
Involved shoulder																0.71
Right	43	62.3				11	73.3				25	62.5				
Left	26	37.7				4	26.7				15	37.5				
Diabetes mellitus																**0.001**
Yes	24	34.8				3	20.0				2	5.0				
No	45	65.2				12	80.0				38	95.0				
Hypertension																**<0.001**
Yes	38	55.1				3	20.0				8	20.0				
No	31	44.9				12	80.0				32	80.0				
Thyroid disorder																0.884
Yes	9	13.0				2	13.3				7	17.5				
No	60	87.0				13	86.7				33	82.5				

SD: Standard deviation; BMI: Body mass index; Stats: Pearson Chi-squared test, Fisher exact test, Kruskal-Wallis test - ANOVA F-test.

TABLE 2
Distribution of outcome parameters according to sarcopenia status

	Sarcopenia (+) (n=69)					Presarcopenia (n=15)					Sarcopenia (–) (n=40)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
VAS (Resting)			4.1±2.8	4	2-6			4.1±2.5	4	2-6			3.6±2.8	3.5	2-5.2	0.614
VAS (Activity)			6.5±2.5	7	5-8			6.4±2.8	7	4-8.5			7.0±1.7	7	6-8	0.779
VAS (Night)			5.6±2.9	5	4-8			5.8±3.5	7	3-8.5			6.2±3.0	6.5	4-9	0.599
SDQ			55.0±18.7	56.2	43.7-68.7			58.3±27.0	68.7	50-75			66.2±15.4	68.7	56.2-75	**0.007**
Hand grip													23.5±8.4	21,6	19.2-29.2	**<0.001**
Right			18.8±5.2	19	15-21			30.2±8.2	30	25-35			23.6±8.3	21	18.4-30	
Left			18.6±4.9	19	15-20			28.4±7.7	25	22-35						
CST			17.6±5.9	15.8	13.3-20								13.1±3.2	12.5	11.4-15.6	**<0.001**
								11.7±3.8	11	10-11.7						
Gait speed			0.9±0.6	0.9	0.7-1			1.1±0.1	1.1	1-1.2			0.9±1.2	1.1	0.9-1.2	**<0.001**
Anterior thigh muscle thickness			23.7±6.2	22.3	19-27			26.8±6.2	26.1	21.4-31.4			37.6±9.0	38.4	29.8-42.5	**<0.001**
STAR value			0.77±0.1	0.7	0.6-0.9			0.9±0.2	0.9	0.8-1.1			1.3±0.3	1.2	1.1-1.5	**<0.001**
Supraspinatus tear																0.796
Partial thickness	22	32.4				5	33.3				11	28.2				
Full-thickness	16	23.5				3	20.0				6	15.4				
Supraspinatus tendinosis																0.967
Total	30	44.1				7	46.7				22	56.4				
Grade 1	8	11.6				3	20.0				6	15.0				
Grade 2	12	17.4				2	13.3				6	15.0				
Grade 3	8	11.6				2	13.3				6	15.0				
Infraspinatus tendinosis	13	18.8				2	13.3				6	15.0				0.951
Subscapularis tendinosis	8	11.6				2	13.3				4	10.0				0.923
Biceps tendinosis	9	13.0				1	6.7				5	12.5				0.934
Impingement sign	8	11.6				2	13.3				3	7.5				0.756
Tangent sign																0.277
Positive	15	22.4				2	13.3				4	10.0				
Negative	52	77.6				13	86.7				36	90.0				
IPAQ-SF score																0.078
Low	40	64				4	6				19	30				
Moderate	29	48				11	18				21	34				

SD: Standard deviation; VAS: Visual Analog Scale; SDQ: Shoulder Disability Questionnaire; CST: Chair stand test; STAR: Sonographic thigh adjustment ratio; IPAQ-SF: International Physical Activity Questionnaire Short Form; Stats: Pearson Chi-squared test, Fisher exact test, Kruskal-Wallis test, ANOVA F-test.

and the Mann-Whitney U test (for two groups) were used. Bonferroni post hoc correction was applied for multiple comparisons between groups.

The regression analysis was designed to compare the presence of sarcopenia (Sarcopenia =1) with the combined group of presarcopenia and non-sarcopenia (0). Univariate analyses were initially performed, and variables found to be significant were entered into a backward elimination procedure to identify the final set of significant predictors. Binary logistic regression was used for multivariable analysis. Statistical significance was set at $p<0.05$ for all analyses.

RESULTS

A significant gender difference was detected between the groups, as the proportion of men was higher in the presarcopenia group compared with the other groups ($p=0.014$). There was a statistically significant difference in age between the groups ($p<0.001$), with sarcopenic patients exhibiting a higher mean age, as expected. A statistically significant difference in BMI was observed among the three groups, with sarcopenic patients exhibiting higher values ($p=0.01$). No significant differences were observed among the groups regarding smoking and alcohol use, dominant hand, affected shoulder,

TABLE 3
Distribution of demographic and clinical variables according to the presence of supraspinatus tear

	Supraspinatus tear (+) (n=63)					Supraspinatus tear (–) (n=61)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
Age (year)			62.7±10.2					57.5±10.5			**0.006**
Sex											0.684
Female	52	82.5				46	78.0				
Male	11	17.5				13	22.0				
Weight (kg)			76.3±14.6	74	66.5-84.5			76.1±13.5	75	69.5-83	0.841
Height (m)			160.2±8.8	160	155-167			163.1±9.52	162	155.5-168	0.117
BMI (kg/m²)			29.9±5.9	29.4	25.6-32.8			28.7±5.0	27.3	24.9-33	0.289
Pain duration (mo)			10.1±11.7	6	3.2-12			8.9±10.2	5	3.5-9.5	0.464
Education											0.366
No education/low literacy	6	60.0				4	40.0				
Primary education	35	58.3				25	41.7				
Secondary education	14	41.2				20	58.8				
Higher education	8	44.4				10	55.6				
Smoking											1.00
Yes	11	17.5				10	16.9				
No	52	82.5				49	83.1				
Alcohol drinking											0.196
Yes	1	1.6				4	6.8				
No	62	98.4				55	93.2				
Dominant hand											1.00
Right	62	98.4				58	98.3				
Left	1	1.6				1	1.7				
Involved shoulder											1.00
Right	40	63.5				38	64.4				
Left	23	36.5				21	35.6				
Diabetes mellitus											**0.009**
Yes	21	33.3				7	11.9				
No	42	66.7				52	88.1				
Hypertension											0.08
Yes	30	47.6				18	30.5				
No	33	52.4				41	69.5				
Thyroid disorder											0.538
Yes	11	17.5				7	11.9				
No	52	82.5				52	88.1				

SD: Standard deviation; BMI: Body mass index; Stats: Mann-Whitney U test - (s) Student's t-test, Mann-Whitney U test - (s) Student's t-test.

TABLE 4
Distribution of outcome parameters according to the presence of supraspinatus tear

	Supraspinatus tear (+) (n=63)					Supraspinatus tear (–) (n=61)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
VAS (Resting)			4.1±2.8	4	2-6			3.9±2.8	4	2-6	0.712
VAS (Activity)			6.6±2.5	7	5-8			6.8±2.2	7	5.5-8	0.94
VAS (Night)			5.9±3.01	5	4-8			5.7±3.1	5	4-8.5	0.959
SDQ			57.5±21.4	56.2	46.8-75			60.4±16.9	62.5	50-71.8	0.678
Hand grip											
Right			20.7±7.5	19.4	15.2-22.9			22.8±8.0	21	18.1-25	0.139
Left			21.1±6.4	20	17.4-23.7			21.5±8.1	19.3	15.3-25	0.751
CST			15.72±5.97	14	12.1-17.5			15.24±5.2	21	18.1-25	0.85
Gait speed			1.06±0.68	1	0.8-1.1			1.1±0.69	1	0.9-1.2	0.222
Anterior thigh muscle thickness			27.16±9.55	25.7	20.6-31.6			29.82±9.6	29.4	21.8-34.8	0.059
STAR value			0.92±0.32	0.8	0.6-1			1.06±0.39	0.9	0.8-1.2	**0.024**
Sarcopenia (+)	38	60.3				30	50.8				
Presarcopenia	8	12.7				7	11.9				0.468
Sarcopenia (–)	17	27				22	37				
Tangent sign											0.095
Positive	15	23.8				6	10.5				
Negative	48	76.2				51	89.5				
IPAQ-SF score											0.717
Low	33	54.1				28	45.9				
Moderate	30	49.2				31	50.8				

SD: Standard deviation; VAS: Visual Analog Scale; SDQ: Shoulder Disability Questionnaire; CST: Chair stand test; STAR: Sonographic Thigh Adjustment Ratio; IPAQ SF: International Physical Activity Questionnaire Short Form; Stats: Mann-Whitney U test - (s) Student's t-test, Mann-Whitney U test - (s) Student's t-test.

or duration of shoulder symptoms. Among the most commonly reported chronic diseases, the prevalence of diabetes mellitus and hypertension was significantly higher in sarcopenic patients (p<0.001), as shown in Table 1.

There were no significant differences among the groups in resting, activity, or night VAS scores; however, a statistically significant difference was observed in shoulder disability scores. Analysis of the SDQ revealed that disability scores were higher in non-sarcopenic patients. The mean values of handgrip strength, CST, gait speed, and anterior thigh muscle thickness for the groups are presented in Table 2. Analysis of shoulder MRI findings across the three groups revealed no statistically significant differences in supraspinatus tear, supraspinatus tendinosis, tendinosis of other rotator cuff muscles, impingement, or tangent signs (Table 2).

When patients were divided into two groups based on age (<60 *vs.* ≥60 years), both groups showed a similar distribution in terms of demographic characteristics. Dominant hand, affected shoulder, and duration of pain were comparable between the groups. While the prevalence of diabetes and thyroid disorders was similar, hypertension was significantly more common in patients over 60 years of age (p<0.001). Pain severity and shoulder disability scores were also similarly distributed between the groups.

Those over 60 exhibited lower handgrip strength (p=0.002), poorer CST (p=0.008) and gait speed (p<0.001, and reduced anterior thigh muscle thickness (p<0.001). The prevalence of sarcopenia was found to be higher in individuals aged over 60 (p<0.001). Radiological parameters did not differ between the two groups, with the exception of tangent sign which is a finding of rotator cuff atrophy (p=0.013).

When we separated and compared the patients based on the presence of supraspinatus tears, we found that the group with tears had a significantly higher age (p=0.006) and a higher prevalence of diabetes (p=0.009), as shown in Table 3. No significant differences were detected among the patients in terms of pain severity, disability, handgrip strength, CST, gait speed, STAR values, and, most importantly, sarcopenia status, as shown in Table 4.

Multivariate logistic regression analysis identified several significant predictors of sarcopenia. The CST score was positively associated with the likelihood of sarcopenia (β=0.215, odds ratio (OR) (CI: 95%)=1.239 (1.013-1.516), p=0.037), indicating that higher scores are linked to an increased risk, although the effect size was moderate. Average grip strength was inversely associated with sarcopenia risk (β=−0.298, OR (CI: 95%)=0.742 (0.619-0.89), p=0.001), demonstrating that higher muscle strength reduces the likelihood of sarcopenia. Among all predictors, STAR exhibited the strongest negative effect (β=−11.149, OR (CI: 95%)=0 (0-0.002), p<0.001), showing that higher STAR values markedly decrease the risk of sarcopenia. Additionally, sex was a significant predictor, with female participants having a substantially lower risk compared to males (β=−5.598, OR (CI: 95%)=0.004 (0-0.132), p=0.002), suggesting a protective effect of female sex. The logistic regression model was statistically significant (likelihood ratio χ^2=104.23, p<0.001), with a high level of explanatory power (Nagelkerke R^2=0.7886). The Hosmer-Lemeshow test indicated good model fit (p=0.2349).

DISCUSSION

Comparative analysis of shoulder MRI findings across the sarcopenia, presarcopenia, and non-sarcopenia groups revealed no statistically significant differences in the prevalence of supraspinatus tears, supraspinatus tendinosis, tendinosis in other rotator cuff muscles, impingement findings, or tangent signs. The most notable result of this study was the significantly higher prevalence of certain chronic diseases, particularly diabetes mellitus and hypertension, among sarcopenic patients. Additionally, while the tangent sign did not vary according to sarcopenia status, it was significantly more likely to be positive in patients over 60 years of age.

In recent years, several studies have explored the association between rotator cuff tear and sarcopenia; however, the available evidence remains inconsistent. In a retrospective study, sarcopenia was diagnosed by reviewing 10 years of dual-energy X-ray absorptiometry and body composition assessments from hospital records. Shoulder MRIs of the patients were evaluated, and no association was found between sarcopenia and rotator cuff tears.[11] Although radiological parameters were examined in detail in this study, its retrospective design and the limited clinical information regarding patients' shoulder pain represent limitations. In a prospective study of 106 patients, participants were divided into two groups based on the presence or absence of a full-thickness rotator cuff tear, and no significant differences in sarcopenia were observed between the groups.[10] Unlike our study, that investigation included only individuals older than 65 years and did not assess additional radiological parameters, such as partial-thickness tears and other imaging findings. When we included patients with partial tears in the tear group and performed the comparison, we did not detect a difference in the presence of sarcopenia. However, a significant difference was observed in the STAR values. We believe that this difference may be attributed to the slightly lower anterior thigh muscle thickness and slightly higher BMI in the tear group.

Consistent with the results of our study, a study including community-dwelling adults aged over 65 reported no increase in the prevalence of sarcopenia among patients with rotator cuff tears. However, patients with sarcopenia have a higher risk of shoulder pain, and consistent tendinopathic changes develop in the supraspinatus tendon in these individuals.[17] In contrast to this study, we did not observe an increased frequency of tendinosis in the supraspinatus tendon or in other rotator cuff tendons in sarcopenic patients.

In another prospective study, the study group consisted of 48 patients with full-thickness rotator cuff tears, while the control group included an equal number of individuals without shoulder pain; however, the absence of rotator cuff tears in the control group was not confirmed through imaging.[12] The authors reported that the sarcopenic index was lower in patients with rotator cuff tears and that individuals with massive tears had a lower sarcopenic index compared with those with medium-sized tears. Considering that previous studies have shown that up to 54% of asymptomatic adults over 60 years of age present with partial- or full-thickness rotator cuff tears on MRI, the selection of the control group constitutes a major limitation of that study.[18] Another limitation is that sarcopenia was assessed using only two parameters, which is insufficient for a comprehensive evaluation.

In our study, we used the ISarcoPRM diagnostic algorithm, incorporating not only anterior thigh muscle thickness but also handgrip strength, gait speed, and the CST, providing a more robust assessment of sarcopenia. Given that average grip strength, the CST, and STAR values emerged as significant predictors of sarcopenia independent of other variables in the regression analysis, it can be concluded that the ISarcoPRM diagnostic algorithm, encompassing all its components, represents a highly robust tool for the diagnosis of sarcopenia. Additionally, unlike the aforementioned study, we included patients with partial-thickness tears. Furthermore, although our results primarily focused on supraspinatus tears, other rotator cuff tendon injuries were also evaluated. Notably, among patients who presented with supraspinatus tears, three also exhibited concomitant infraspinatus tears; however, due to the limited sample size, separate statistical analyses could not be performed.

Although most of the sarcopenic patients were female, a striking finding of our study is that regression analysis indicated female sex as a protective factor against sarcopenia. The sex-specific risk for sarcopenia differs among studies, and there is currently no consensus regarding which sex is more vulnerable. In one study, sex was identified as a predictive factor, with male sex highlighted as a risk factor for sarcopenia. This finding has been attributed to genetic factors, as the disease-causing gene is located on the sex chromosome, and men possess only one copy, meaning that a single gene mutation is sufficient to manifest the disease.[19] In another study, men were found to have a higher likelihood of developing sarcopenia regardless of obesity status. It's generally known that testosterone supports muscle growth and strength and postmenopausal women are more prone to sarcopenia. Men generally engage in more physical activity and protein intake, helping preserve muscle mass and strength. Taken together, these factors would imply that being male should be protective against sarcopenia. Although men have a higher percentage of type 2 muscle fibers, which are more susceptible to age-related muscle atrophy, it remains unclear whether the identification of male sex as a risk factor for sarcopenia in these studies is coincidental, due to genetic factors, or related to muscle fiber distribution. This finding, however, needs to be confirmed through studies with larger sample sizes.[20]

The resting, activity-related, and nighttime VAS scores of patients with rotator cuff syndrome did not differ according to sarcopenia status. However, shoulder disability scores were higher in the non-sarcopenic group compared to those with sarcopenia. In contrast to our findings, previous studies have reported that reduced skeletal muscle mass is associated with decreased shoulder mobility and poorer peri- and postoperative shoulder function, particularly in elderly female patients.[21] Similarly, Han et al.[17] demonstrated that sarcopenic individuals with rotator cuff syndrome exhibit higher pain levels, along with increased SDQ pain domain and total scores.

In our study, no significant differences in measured physical activity levels were observed between sarcopenia groups. However, individuals without sarcopenia may be functionally more active in daily life, leading to greater awareness of pain and functional limitations, which contribute to higher disability scores. This aligns with literature and our observations, suggesting that the IPAQ-SF may not reliably capture actual activity levels in older adults due to recall difficulties and its limited assessment of light-intensity movements such as household chores or prolonged standing. The questionnaire primarily focuses on moderate- and vigorous-intensity activities, underestimating the lower-intensity movements that constitute a substantial portion of daily function.[22] Thus, non-sarcopenic individuals may use their shoulders more frequently in daily tasks, whereas sarcopenic patients, despite poorer functional status, may report less perceived pain due to overall lower activity and muscle weakness.

Consistent with previous literature, our study demonstrated that the prevalence of diabetes increased markedly with the presence of sarcopenia, rising from 5.0% in non-sarcopenic individuals to 34.8% in those with sarcopenia. Sarcopenia is also known to be more common among individuals with diabetes, with reported rates ranging from 7% to 29.3%.[23] In our study, we further observed that the prevalence of diabetes was significantly higher in patients with supraspinatus tears. Similarly, in a study consistent with our findings, diabetes was more frequent among sarcopenic patients presenting with shoulder pain and rotator cuff syndrome, potentially reflecting the higher incidence of rotator cuff pathology in individuals with diabetes.[24] Physiologically, insulin promotes muscle anabolism; however, insulin resistance in diabetes disrupts this process by reducing protein synthesis and increasing protein degradation, ultimately leading to loss of muscle mass and strength.[25] Moreover, another study demonstrated that achieving glycemic control with antidiabetic treatment over a six-month period resulted in improved muscle strength and a reduction in sarcopenia.[26]

A further noteworthy finding of our study was the marked increase in the prevalence of hypertension in the sarcopenic group compared with the presarcopenic and non-sarcopenic groups, increasing from 20.0% to 55.1%. A meta-analysis demonstrated a strong association between sarcopenia and hypertension in older adults, with the presence of sarcopenic obesity further intensifying this risk. Several mechanisms have been proposed to explain the link between sarcopenia and hypertension, including reduced physical activity, insulin resistance, insufficient protein intake, and chronic low-grade inflammation.[27]

In our study, sarcopenia and hypertension were considerably more prevalent in individuals over 60 years. The frequency of rotator cuff tears did not differ between age groups, but the tangent sign was more often positive in older adults. While sarcopenia increases with age, it may not directly cause rotator cuff tears; instead, age-related degenerative changes, such as muscle atrophy indicated by a positive tangent sign, are more pronounced.[28,29] Previous studies show that the supraspinatus occupation ratio is reduced in shoulders with rotator cuff pathology, whereas normal shoulders show minimal age-related atrophy.[30] These findings suggest that observed rotator cuff atrophy may primarily reflect higher sarcopenia and hypertension prevalence in older patients.

Our study indicates that advanced age and diabetes are significantly associated with the presence of supraspinatus tears, while sarcopenia status does not differ between patients with and without tears. These findings highlight the multifactorial nature of rotator cuff pathology, in which metabolic factors, age-related degenerative changes, and comorbid conditions play key roles. Other factors, including smoking, male sex, hypertension, and anatomical variations such as a higher critical shoulder angle, may also contribute to tendon vulnerability.[10,30-33] Collectively, our results suggest that while multiple factors influence rotator cuff integrity, age and diabetes appear to have a more prominent impact on the development of supraspinatus tears.

Our study is notable for using the ISArcoPRM diagnostic algorithm to evaluate sarcopenia in patients with shoulder pain, enabling the identification of both sarcopenia and presarcopenia. Unlike previous research that primarily focused on supraspinatus pathology, we assessed all rotator cuff tendons and incorporated additional MRI findings such as impingement and the tangent sign. The study's methodological rigor was strengthened by its blinded design, in which the radiologist was unaware of sarcopenia measurements and clinical evaluations, and the clinician was blinded to MRI findings.

This study has several limitations. Despite meeting the sample size determined by power analysis, the study population was relatively small. In addition, MRI evaluations were performed by a single radiologist; therefore, neither inter-rater nor intra-observer reliability could be assessed, which may affect the consistency of the radiological findings. The cross-sectional design precludes causal inference and highlights the need for prospective longitudinal studies. Furthermore, physical activity levels were assessed using a self-report scale rather than an objective measurement tool, which may have limited accuracy. Finally, the absence of a follow-up period prevented evaluation of the potential longitudinal development of sarcopenia in this patient population.

In conclusion, sarcopenia does not appear to directly affect the incidence of rotator cuff tears; however, it is associated with a higher prevalence of comorbidities such as diabetes and hypertension. The ISarcoPRM diagnostic algorithm is a reliable tool for identifying sarcopenia, and female sex may offer a protective effect. Both sarcopenia and rotator cuff atrophy are more frequent in individuals over 60 years of age, while supraspinatus tears are linked to older age and higher rates of diabetes. These findings underscore the importance of evaluating sarcopenia and related comorbidities in the comprehensive management of rotator cuff disorders, particularly among older adults.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Author Contributions: Idea/concept, analysis and/or interpretation, writing the article: S.S.O, E.Y.; Design, materials, data collection and/or processing, literature review: S.S.O, E.Y., E.G.; Control/supervision, references and fundings: E.Y., E.G.; Critical review: S.S.O, E.G.

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