J Surg Med. 2024;8(4):73-77.
https://doi.org/10.28982/josam.7998

JOSAM

Journal of Surgery and Medicine

e-ISSN: 2602-2079

Research article
https://jsurgmed.com/

Sarcopenia prevalence between obese and morbid obese patients in an obesity center

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Ethics Committee Approval
The study was approved by the Ethics committee of Dr Lutfi Kırdar Kartal City Hospital (Date: October 26, 2022, Number: 20221514/236/8). All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2024 March 27

Abstract

Background/Aim: Sarcopenia and obesity are independent diseases that result in decreased muscle strength and function. Few studies have been conducted on the association of sarcopenia and obesity, especially in women. This study aims to measure the possibility of sarcopenic obesity in women with obesity.

Methods: Our study was organized using a prospective cross-sectional study in Turkey**.** A total of 135 volunteer were included in the study. Inclusion criteria required the patients to have a BMI >35 kg/m^2 or BMI >40 kg/m^2 and no current comorbid disease. The exclusion criteria included: age (<18 and >70 years were excluded), history of muscle disease, malignancy, psychiatric disorders such as bipolar disease and psychosis, malnutrition, and recent corticosteroid (CS) use (within the last three months). Probable sarcopenia is determined by low skeletal muscle strength, and confirmed sarcopenia is defined if there is both low skeletal muscle mass and low skeletal muscle quality. Muscle strength was measured with isometric dynamometry using the handgrip method. A six-minute walk test (6MWT), in which we measured walking speed, was performed to determine the physical performance of the patients. We adjusted appendicular skeletal muscle (ASM) using height squared (ASM/height^2) bioelectrical impedance analysis (BIA) to measure the muscle mass.

Results: Patients' mean age was 43 (11.4) (20-69) years. Of the total participants, 64.6% were in the age range of 40-59; 19.2% of patients were defined as possible sarcopenia; and 2.2% had confirmed sarcopenia. A total of 78.5% of patients did not meet any of the sarcopenia criteria. We determined that there was no difference in anthropometric measurements between sarcopenic and non-sarcopenic patients (P>0.05), except for waist and hip circumferences. However, we did observe a noteworthy distinction in waist and hip circumference measurements between the two groups, with sarcopenic patients exhibiting larger circumferences (P=0.05 and P=0.032, respectively). Our study revealed a significant disparity in the results of the six-minute walk test and handgrip strength values between sarcopenic and non-sarcopenic patients (P<0.001). Specifically, non-sarcopenic patients demonstrated higher values in both tests..

Conclusion: Obesity and sarcopenic obesity will continue to be a public health problem in the future among middle-aged women. It should be considered that the prevalence of decreased muscle strength was high in our study group, and physical performance decreased due to muscle strength. We concluded that as success in the six-minute walk test and handgrip values increased, the diagnosis of sarcopenia decreased, and each increase in platelet count increased the risk of sarcopenia in obese female patients.

Keywords: sarcopenia, sarcopenic obesity, middle aged women, EWGSOP

How to cite: Tuna M, Isık A, Hurmeydan O. Sarcopenia prevalence between obese and morbid obese patients in an obesity center. J Surg Med. 2024;8(4):73-77.

Introduction

When body fat increases and muscle mass and strength decrease with aging, sarcopenic obesity (SO) will occur. For a young healthy population, a muscle mass index, which is two standard deviations below the norm, was first named SO by Baumgartner [1]. SO leads to an increased risk of metabolic deterioration together with physical impairment rather than either sarcopenia or obesity alone [2].

Sarcopenia is associated with inflammatory, hormonal, and muscle cell alterations in response to aging and pathological factors, leading to muscle weakness, increased fat mass, and relatively decreased lean mass [3]. When the balance of muscle growth shifts toward muscle inhibitors, normal muscle quantity and function are disrupted. This is a mechanism in the pathogenesis of sarcopenia [4].

Low muscle mass is triggered together with many comorbid conditions [4,5]. In women with obesity, when fat tissue increases and muscle mass decreases with aging, it can cause resistance to insulin. If those women have hypertension, hyperlipidemia and type 2 diabetes mellitus (T2DM), metabolic syndrome will appear [6]. Defective lipolysis occurs in skeletal muscle due to insulin resistance in obese and T2DM individuals. Fatty acids from triglyceride storage are lipolyzed via adipose triglyceride lipase and hormone sensitive lipase [7,8]. In addition, obesity increases the risks of arthritis, some types of cancers, and sleep apnea [9]. Sarcopenia can develop in young adults due to factors including autoimmune disorders, inflammatory diseases, and endocrine dysfunctions [10].

Our aim is to examine the sarcopenic obesity prevalence between the group of Turkish obese and morbidly obese patients in this study.

Materials and methods

Patients

This cross-sectional study registered patients who were followed up with a diagnosis of obesity in the Obesity Center outpatient polyclinic of our hospital from April 2022 until January 2023. The study was approved by the Ethics Committee of Dr. Lutfı Kırdar Kartal City Hospital in Turkey (Decision number: 202215l4/236/8, Date: October 26, 2022). Patients were classified into two groups: women 20 to 39 years old and women 40 to 69 years old). The study was continued if the patients' values were BMI >35 kg/m2 or BMI >40 kg/m2 and they had no comorbid diseases.

The exclusion criteria included: age (<18 and >70 years were excluded), history of muscle disease, malignancy, psychiatric disorders such as bipolar disease and psychosis, malnutrition, and recent corticosteroid (CS) use (within the last three months). We obtained a written informed consent form from the patients. The management of the study adheres to the World Medical Association Declaration of Helsinki.

Skeletal muscle mass/quantity/quality assessment

Weight units are given in kilograms (kg), height is measured in meters (m), and BMI is measured using the formula kg/m2. Tanita MC-580 body composition analysis (TANITA, MC-580, Japan) was used in the anthropometric measurements. We adjusted the appendicular skeletal muscle (ASM) using height squared (ASM/height^2), because muscle mass is related to body size [11,12]. In our study, we used the cutoff values of 9.2 kg/m2 for males and 7.4 kg/m2 for females for ASM/h2, defined by Bahat et al. [13] for the Turkish population.

According to the revised definition of the European Working Group on Sarcopenia in Older People (EWGSOP), probable sarcopenia is determined in the presence of low skeletal muscle strength. Confirmed sarcopenia is concluded in the presence of both low skeletal muscle mass and low skeletal muscle quality. Finally, in the presence of low physical performance in addition to these two findings, sarcopenia is defined to be “severe”[11].

Skeletal muscle strength assessment

We used the handgrip strength (HGS) test for muscle strength assessment [14]. A strain-gauged dynamometer (TKK 5001, Takei Scientific Instruments, Tokyo, Japan) was used to measure HGS (kg). During measurements, the subject was in a standing position with the arms parallel to the body but without contact with the body. Patients repeated grip force at least three times with both their left and right hands and the maximum value was recorded. In the study, the cutoff reference values defined by Bahat et al. [13] for low HGS, <32 kg in male and <22 kg in female, were used. Low HGS values define low muscle strength.

Physical performance

The six-minute walk speed test (6MWST), a widely used assessment for measuring walking speed, was used to measure physical performance. Patients were asked to walk at a normal pace without interruption on a long corridor with flat, hard and smooth floors for six minutes. Walking speed was calculated using distance in meters and time in seconds for each participant (m/s). Low gait speed cutoff value was defined as <0.8 m/s [11].

Statistical analysis

Analyses were performed with the statistical package software, SPSS (version 23.0, IBM Corp. Armonk, NY). Frequency and percentage were given for categorical data; mean (standard deviation) or median, minimum and maximum descriptive values were given for continuous data. For comparisons between groups, the independent samples t-test or the Mann-Whitney U test was used for the two groups, and chi-square or Fisher's exact test was used to evaluate categorical variables. Logistic regression analysis was used to examine the risk factors affecting the development of sarcopenia. Variables with a *P*-value less than 0.10 in univariate analysis were included in the logistic regression analysis. The results were considered statistically significant when the *P*-value was 0.05 or less.

Results

The study was conducted with 135 female patients who met the criteria and whose mean age (SD) was 43 (11.4) (20-69) years. Of the patients, 64.6% were in the age range from 40 to 59. All the laboratory and clinical evaluations and demographic values are shown in Table 1 and Table 2.

One hundred six (78.5%) patients did not meet any of the sarcopenia criteria (no sarcopenia); 26 (19.2%) patients were determined to have possible sarcopenia, and 3 (2.2%) patients had confirmed sarcopenia. None of the patients were diagnosed with severe sarcopenia. We used the Bahat’s study cutoff values

Table 1: Demographic and clinical findings of the patients

Variables	Total (n=135)		Non-Sarcopenic (n=106)		Sarcopenic (n=29)		*P*-value
	Mean (SD)	Median (Min-Max)	Mean (SD)	Median (Min-Max)	Mean (SD)	Median (Min-Max)	
Age (years)	43.3 (11.4)	43 (18-69)	42.6 (11)	42 (22-69)	46.2 (12.9)	48 (18-66)	0.146
Height (cm)	159.6 (6.8)	159 (145-180)	159.6 (6.9)	158 (145-180)	159.7 (6.5)	160 (147-168)	0.537
Waist circumference (cm)	114.5 (13.4)	**112 (82-158)**	**113.4 (13.6)**	**110.5 (82-158)**	**118.3 (12.4)**	**114 (99-140)**	**0.050**
Hip circumference (cm)	126.1 (11.8)	**125 (101-155)**	**125.1 (11.8)**	**123 (101-155)**	**129.8 (11.1)**	**130 (110-150)**	**0.036**
Arm circumference (cm)	35.4 (4.7)	34.8 (27-55)	35.1 (4.5)	34 (27-50)	36.5 (5.2)	36 (31-55)	0.178
Weight (kg)	102.4 (18.4)	99 (70.6-157)	101 (18.2)	97.3 (70.6-157)	107.6 (18.8)	105.7 (75.5-153.1)	0.089
BMI (kg/m^2)	40.2 (6.5)	39.3 (30-58.9)	39.6 (6.3)	38.2 (30-58.9)	42.3 (7)	42.9 (30.3-55.8)	0.055
PBF (%)	42.1 (4.2)	41.6 (32.9-54.5)	41.7 (4.1)	41.3 (32.9-53.7)	43.4 (4.7)	42 (35.7-54.5)	0.060
SLM (kg)	53.6 (7.7)	52.5 (39-75.2)	53.1 (7.4)	52.3 (41.5-75.2)	55.4 (8.4)	54.6 (39-72.6)	0.153
ASMM (kg)	26.6 (4.6)	25.9 (17.4-39.1)	26.3 (4.4)	25.7 (17.4-38.5)	27.8 (5.2)	27.1 (18.8-39.1)	0.194
ASMM/H^2 (kg/cm^2)	10.4 (1.7)	10.1 (3.5-15)	10.3 (1.5)	10.1 (6.9-15)	10.8 (2.4)	10.7 (3.5-15)	0.307
6 min walking test (m)	422.1 (61.6)	416 (275-580)	**441.1 (53.5)**	**435.8 (300-580)**	**352.6 (32.2)**	**350 (275-425)**	**<0.001**
Handgrip (kg)	22.5 (5.2)	21.9 (11.8-38.9)	**23.6 (5.2)**	**23.2 (13.1-38.9)**	**18.6 (2.5)**	**19.3 (11.8-21.8)**	**<0.001**

BMI: body mass index, ASMM: appendicular skeletal muscle mass, ASMM/h^2: appendicular skeletal muscle mass/height^2, SLM: smooth lean mass. Values are given as mean and median (range). The Mann-Whitney U test was performed. *Chi-squared test was used.

Table 2: Laboratory findings of patients

Variables	Total (n=135)		Non-Sarcopenic (n=106)		Sarcopenic (n=29)		*P*-value
	Mean (SD)	Median (Min-Max)	Mean (SD)	Median (Min-Max)	Mean (SD)	Median (Min-Max)	
Glucose (mg/dl)	103.6 (21.9)	100 (68-243)	103.6 (22.6)	100 (68-243)	103.4 (19.6)	97 (68-166)	0.849
Insulin (IU)	18.6 (11.6)	15.7 (3.5-67.9)	18.5 (10.5)	15.9 (3.5-61.4)	19.1 (15.3)	15 (5.3-67.9)	0.493
TC (mg/dl)	207.9 (39.6)	207 (120-314)	206.5 (38.7)	206.5 (120-305)	213 (42.9)	211 (140-314)	0.439
HDL (mg/dl)	50.5 (10.5)	50 (27-88)	51 (10.8)	50 (27-88)	48.6 (9)	47 (30-75)	0.293
TG (mg/dl)	138.9 (81.2)	130 (39-831)	141.8 (88.3)	131.5 (39-831)	128.2 (47.2)	126 (43-232)	0.688
LDL (mg/dl)	132.2 (35.6)	128 (64-233)	129.1 (34.4)	123.5 (64-229)	143.6 (38.5)	145 (78-233)	0.053
TSH (mIU/L)	2.5 (1.6)	2.2 (0.3-10.5)	2.5 (1.7)	2.2 (0.3-10.5)	2.6 (1.5)	2.4 (0.8-7.9)	0.491
HOMA	4.8 (3.1)	4.1 (0.9-19.3)	4.6 (2.6)	3.9 (1-14.2)	5.6 (4.4)	4.8 (0.9-19.3)	0.492
Iron (mcg/dl)	65.5 (24.1)	61 (28-139)	66.7 (24.7)	62 (28-139)	61.2 (21.8)	58 (29-107)	0.309
Ferritin (mcg/L)	36 (31)	26.8 (3-146)	35 (31)	25.4 (3-146)	39.7 (31.2)	29.3 (3.6-111)	0.377
25OHD3 (ng/ml)	16.5 (7.6)	15.4 (4.1-49.1)	16.3 (7.2)	15.1 (4.1-37.7)	17.3 (9)	16.1 (4.5-49.1)	0.734
Hgb (g/dL)	13 (1.1)	13.1 (9.8-16.3)	13 (1.1)	13.1 (9.8-15.2)	12.9 (1.2)	13 (10.2-16.3)	0.453
HTC (%)	39.1 (4.6)	39.4 (9.2-49.5)	39.4 (3.9)	39.5 (15.3-46.6)	38.1 (6.4)	39.2 (9.2-49.5)	0.168
PLT (10^3/ul)	294.2 (90.5)	273 (102-774)	285.2 (80.2)	270 (102-524)	326.3 (116.3)	300 (191-774)	0.056
HBA1C (mmol/L)	6 (0.9)	5.8 (4.9-9.9)	5.9 (0.8)	5.8 (5-9.9)	6.2 (1)	6 (4.9-8.6)	0.157
Vitamin B12 (ng/mmol)	243.6 (116.4)	221.5 (85-944)	242.3 (116.7)	219 (85-944)	248.5 (117.1)	224 (133-764)	0.658

TC: Total cholesterol, HDL: High density cholesterol, TG: triglycerides, LDL: low density lipoprotein, TSH: thyroid stimulant hormone, HOMA: homeostasis model assessment, HTC: hematocrit, PLT: platelet, HBA1C: glycosylated hemoglobin

adapted from EWGSOP for the Turkish people [15]. In this diagnostic method, low grip strength with certain cutoff points (handgrip 22 kg for female) defines possible sarcopenia. Sarcopenia was confirmed if the low muscle quantity (SMMI cutoff value 7.2 kg/m^2) was combined with the first criteria [13].

It was identified that there were no significant differences in anthropometric measurements between patients with sarcopenia and those without sarcopenia (P>0.05 for each), except for waist and hip circumferences. However, we did observe a notable contrast in waist and hip circumference measurements between the two groups, with sarcopenic patients showing larger circumferences (P=0.05 and P=0.032, respectively). Furthermore, our study unveiled a significant difference in the results of the six-minute walk test and handgrip strength values between sarcopenic and non-sarcopenic patients (P<0.001). Specifically, non-sarcopenic patients exhibited higher values in both tests.

The distribution of comorbidities detected along with the diagnosis of sarcopenia is given in Table 3. According to the table, it was determined that there was no relationship in the groups in terms of comorbidity distributions and additional diseases (P=0.316).

Table 3: The distribution of comorbid diseases in patients who diagnosed sarcopenia or not

Variables	Total (n=135)	Non-Sarcopenic (n=106)	Sarcopenic (n=29)	*P*-value
	n (%)	n (%)	n (%)	
Comorbidity				0.316
No	84 (62.2)	69 (65.1)	15 (51.7)	
1 comorbidity	33 (24.4)	25 (23.6)	8 (27.6)	
≥2 comorbidity	18 (13.3)	12 (11.3)	6 (20.7)	
HT	19 (14.1)	**11 (10.4)**	**8 (27.6)**	**0.031**
DM	20 (14.8)	14 (13.2)	6 (20.7)	0.376
HL	1 (0.7)	0 (0)	1 (3.4)	0.215
Hashimoto	2 (1.5)	2 (1.9)	0 (0)	1.000
Thyroid	11 (8.1)	9 (8.5)	2 (6.9)	1.000
Insulin resistance	4 (3)	3 (2.8)	1 (3.4)	1.000
PCOS	1 (0.7)	1 (0.9)	0 (0)	1.000
Hyperprolactinemia	1 (0.7)	0 (0)	1 (3.4)	0.215
Pituitary deficiency	1 (0.7)	1 (0.9)	0 (0)	1.000
GER	2 (1.5)	2 (1.9)	0 (0)	1.000
Rheumatologic diseases	1 (0.7)	1 (0.9)	0 (0)	1.000
CAD	1 (0.7)	0 (0)	1 (3.4)	0.215
Fibromyalgia/Osteoporosis	2 (1.5)	1 (0.9)	1 (3.4)	0.385
Epilepsy	2 (1.5)	2 (1.9)	0 (0)	1.000
Psoriasis	1 (0.7)	1 (0.9)	0 (0)	1.000
Asthma	1 (0.7)	1 (0.9)	0 (0)	1.000
COPD	2 (1.5)	1 (0.9)	1 (3.4)	0.385

HT: hypertension, DM: diabetes mellitus, HL: hyperlipidemia, PCOS: polycystic over disease, GER: gastroesophageal reflux, CAD: coronary artery disease, COAH: chronic obstructive pulmonary disease

Risk factors affecting the development of sarcopenia in patients are provided in Table 4. Among all variables, the six-minute walk test, handgrip, and PLT values included in the model in the univariate analysis, affected the development of sarcopenia, respectively (P<0.001, P<0.001, P=0.040). It was determined that the diagnosis of sarcopenia decreased as the success of the patients in the six-minute walk test and the handgrip values increased, and each increase in the PLT value increased the risk of sarcopenia. Variants, which had significant changes in univariate analysis, were re-evaluated in multivariate analysis. We observed a difference in the six-minute walk test and handgrip values (P<0.001). It was found that an increase in

the six-minute walk test in the patients decreased the risk of sarcopenia 0.94 times, and an increase in the handgrip value decreased the risk of sarcopenia 0.63 times.

Table 4: Risk factors in the development of sarcopenia

Variables	Univariate		Multivariate	
	Odds ratio (95% GA)	*P*-value	Odds ratio (95% GA)	*P*-value
Waist circumference (cm)	1.03 (1.00-1.06)	0.089		
Hip circumference (cm)	1.04 (1.00-1.07)	0.057		
Weight (kg)	1.02 (1.00-1.04)	0.089		
BMI (kg/m^2)	1.06 (1.00-1.13)	0.052		
PBF (%)	1.09 (1.00-1.21)	0.063		
6 min walking test (m)	**0.95 (0.93-0.97)**	**<0.001**	**0.94 (0.91-0.96)**	**<0.001**
Handgrip (kg)	**0.76 (0.67-0.87)**	**<0.001**	**0.63 (0.49-0.80)**	**<0.001**
LDL (mg/dl)	1.01 (1.00-1.02)	0.056		
PLT (10^3/ul)	**1.01 (1.00-1.02)**	**0.040**	1.00 (0.99-1.01)	0.721
DM	1.71 (0.59-4.95)	0.319		

BMI: body mass index, PBF: percent body fat, LDL: low density lipoprotein, PLT: platelet, DM: diabetes mellitus

Discussion

Our aim in this study was to examine sarcopenic obesity among a group of obese and morbidly obese Turkish patients. Our population consisted of female patients, and sarcopenia was detected in 21.5%. According to BMI values, sarcopenia was detected in six patients with a BMI of 30-35; five patients with a BMI of 35-40, and in 18 patients with a BMI >40. This shows that sarcopenia due to low muscle strength increases with age in female patients. In addition, there was a difference in waist and hip circumference, the six-minute walk test and handgrip values among all patients.

Low muscle strength in the elderly has been determined by the European Working Group on Sarcopenia as the main criterion for investigating sarcopenia. If the grip strength is low, cause of death due to functional limitation risks will be increased [10]. Sarcopenia diagnosis is confirmed if muscle mass and quality are both low. According to these criteria, in our study probable sarcopenia was detected in 26 women and the confirmed sarcopenia was detected in 3 patients. Additionally, in this study, skeletal muscle mass was adjusted for height^2. Although this is the most widely used method in sarcopenia definitions, it has been shown to fail in obese individuals with sarcopenia [16,17].

Kemmler et al. [17] studied sarcopenic obesity and sarcopenia in a group of German females over 70 years of age, and their results were almost identical to the prevalence rate of sarcopenia due to EWGSOP (4.9% versus 4.5%). Additionally, Beadurt et al. [18] also applied the same EWGSOP sarcopenia criteria to a CDW (cohort of community-dwelling) cohort of young multimorbid Belgian men (n=157) and identified much higher prevalence rates. The Korean study by Kim et al. [19] also found that the SO prevalence according to different definition indices ranged from 0.8 to 11.8% in women aged 40 to 59 years.

According to the World Health Organization's definition, the obesity prevalence in older adults in the United States is reported to be nearly 37.9% [20]. The mean age of our obese patients was 46.2 (12.9), and their distribution was: BMI 30-35 20.7%, BMI 35-40 17.2%, BMI >40 62.1%.

In this study, we tried to examine the possibility of sarcopenia in young and middle-aged women and the evaluation criteria in severely obese patients in Turkey. SO figures were low due to the age range of the selected study group. It is known that among European countries, the prevalence of obesity in the elderly has increased the most in Germany [21].

The reduced energy expenditure as a result of decreased muscle mass and physical activity level causes visceral fat and general body fat, which is especially significant. Loss of skeletal muscle, which is the largest target tissue sensitive to insulin, together with visceral fat, which appears as fatty liver, causes insulin resistance. This results in the onset of metabolic syndrome [22].

The variation in physical performance of sarcopenic and non-sarcopenic obese women is due to differences in muscle mass. As emphasized by Newman et al., we believe that it is important to identify obese individuals who do not appear sarcopenic but have decreased muscle mass masked by obesity [23].

In the comorbidity evaluation of our data, the rate of diabetes was higher in individuals with sarcopenia and there was no statistical relationship between the two groups in all diseases except DM as shown in Table 3. Sarcopenia prevalence was substantially higher in non-obese patients (48.1% vs 29.3%), and obesity and sarcopenic obesity were more common in patients with DM in a recent study conducted among nursing home patients [24].

The current study observed that the increase in the six-minute walking test and in the handgrip value decreased the risk of sarcopenia 0.94 and 0.67 times in the patients, respectively. In addition, Silva et al. indicated that sarcopenia prevalence varied between 11.1% and 13.9% due to low level of muscle quantity and muscle quality [25].

Our results align with similar studies. Our ASM (26.6 [4.6] kg) is comparable to Silva et al. [26] who determined no statistical difference in the adequacy of the total ASM (mean 24.9 [4.7] kg) of all subjects when comparing BMI degrees or age groups. When ASM (kg) was analyzed, it was seen that as BMI increased, the ASM(kg) value also increased a bit.

Limitations

There are some limitations in our research. First, standard protocols have not been established for the diagnosis of SO. Our study was a single center study and the low patient counts in a number of comparisons considerably limit the generalizability of our findings. Further studies with a larger number of patients are needed to compare sarcopenic obesity depending on body composition. The absence of a control group is another limitation. In addition, our study group age was a bit younger for the determination of sarcopenic obesity.

The strength of this study is that sarcopenic obesity is a condition rarely studied in middle-aged women. Another strength of this study is that the methods we used to measure patients' physical performance and body composition were valid, inexpensive, and noninvasive.

Conclusion

In our study, young and middle-aged obese female patients were evaluated. We concluded that as the success in the six-minute walk test and handgrip values increased, the diagnosis of sarcopenia decreased and each increase in PLT value increased the risk of sarcopenia. If patients have sufficient muscle strength, the prevalence of sarcopenia will decrease.

Low muscle mass and physical activity level reduce total energy expenditure, which leads to the accumulation of visceral fat and obesity. Among middle-aged women, obesity and sarcopenic obesity (SO) will be a public health problem in the future. Sarcopenic obesity has been studied mostly in older adults. More research is needed regarding the prevalence and reasons for SO among middle-aged female patients.

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