ORIGINAL ARTICLE

Sarcopenia prevalence and risk factors in obese Tunisian adults

Prévalence et facteurs de risque de la sarcopénie chez des adultes tunisiens obèses

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Abstract

Introduction: Sarcopenia is a clinical condition defined as low skeletal muscle mass and function. It has been identified and described as a geriatric syndrome, but it may arise in individuals with obesity at any age.
Aim: screen for sarcopenia in obese adults and identify the nutritional, clinical and biological risk factors associated with the development of sarcopenic obesity (SO+).
Methods: Descriptive cross-sectional study, including 53 obese patients. Screening for sarcopenia has been established according to pathological thresholds proposed by the European Society for Clinical Nutrition and Metabolism (ESPEN) and the European Association for the Study of Obesity (EASO).
Results: Mean age was 44.34±13.51 years. Prevalence of Sarcopenia was 7.5% (SO+). The average intakes of calorie, lipids and saturated fatty acids were higher in SO+. A statistically significant relationship was found between low skeletal muscle mass (SMM/W) and the average intake of vitamin PP (p=0.014) and vitamin B9 (p=0.009). Mean BMI (45.86 kg/m² for SO+ versus 39.29 kg/m² for SO-; p=0.03) and mean visceral fat (16.55 l for SO+, versus 10.93 l for SO-; p=0.043) were significantly higher in SO+. A statistically significant relationship was found between insulin resistance and low (SMM/W), as attested by mean insulinemia (28.81 µIU/mL for low SMM/W, versus 14.48 µIU/mL for normal SMM/W; p=0.004) and HOMA index (7.94 for low SMM/W, versus 3.49 for normal SMM/W; p=0.002), which were higher in cases of low (SMM/W).
Conclusion: We recommend promoting a balanced, low-energy-density diet to improve insulin sensibility and thus reduce the risk of sarcopenia. Regular physical activity is also strongly recommended.

Key words: Obesity, Sarcopenia, Sarcopenic obesity, Body composition.

Résumé

Introduction: La sarcopénie est une pathologie liée au vieillissement, mais qui peut toutefois se développer à un âge jeune, étant favorisée par de nombreux autres facteurs tels que l'obésité.
Objectifs: Dépister la sarcopénie chez les obèses adultes et identifier les facteurs de risque nutritionnels, cliniques et biologiques liés à l'apparition de l'obésité sarcopénique (OS+).
Méthodes: Étude descriptive transversale, incluant 53 patients obèses. Le dépistage de la sarcopénie a été établi selon les seuils pathologiques proposés par la Société Européenne de Nutrition Clinique et de Métabolisme (ESPEN) et l'Association Européenne pour l'Étude de l'Obésité (EASO).
Résultats: L'âge moyen était de 44,34±13,51 ans. La prévalence de la sarcopénie était de 7,5%. L'apport moyen calorique, en lipides et en acides gras saturés était plus élevé chez les OS+. Une relation statistiquement significative était retrouvée entre la masse musculaire squelettique (SMM/W) faible et l'apport en vitamine PP (p=0,014) et en vitamine B9 (p=0,009).
L'IMC moyen (45,86 kg/m² pour OS+ versus 39,29 kg/m² pour OS- ; p=0,03) ainsi que la graisse viscérale moyenne (16,55 l pour OS+ versus 10,93 l pour OS- ; p=0,043) étaient significativement plus élevés en cas d'OS+. Une relation statistiquement significative a été trouvée entre l'insulinorésistance et la (SMM/W) faible, attestée par l'insulinémie moyenne (28,81 µUI/mL pour SMM/W faible versus 14,48 µUI/mL pour SMM/W normal ; p=0,004) et l'indice de HOMA (7,94 pour SMM/W faible versus 3,49 pour SMM/W normal ; p=0,002).
Conclusion: Une alimentation équilibrée et une activité physique régulière sont recommandées pour améliorer la sensibilité à l'insuline et réduire le risque de sarcopénie.

Mots clés: Obésité, Sarcopénie, Obésité sarcopénique, Composition corporelle.

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LA TUNISIE MEDICALE-2024; Vol 102 (08): 465-471 DOI: 10.62438/tunismed.v102i8.4965

Introduction

Obesity is a major public health problem, associated with numerous co-morbidities and significant additional healthcare costs (1). Obesity is defined as an increase in fat mass relative to non-fat mass, with adverse effects on health. This definition does not quantify adiposity but implies that a certain level of adiposity is associated with health risk. However, few data are available on proportions of fat and lean tissue, especially in case of skeletal muscle depletion defining sarcopenia, which is associated with physical disability, injuries and mortality (1).
Sarcopenic obesity is a new clinical entity in which severe obesity and low muscle mass occur simultaneous. Its complex pathophysiology involves the mechanisms of age-related muscle loss, such as anabolic resistance to nutritional factors, but may also reveal some degree of lipotoxicity. The effects of lipotoxicity on protein metabolism are currently being investigated (2).
Several studies have assessed the prevalence of sarcopenia. It varies widely depending on the study, the population analyzed and the definitions used. The estimated prevalence among obese people was 5-10% (3). This body phenotype needs to be defined based on anthropological or functional criteria because of its underestimated impact on health, and in order to better appreciate the degree of obesity severity beyond body mass index (BMI), which is now recognized as an insufficient criterion for defining this chronic disease with multiple comorbidities.
A group of international experts; the European Society for Clinical Nutrition and Metabolism (ESPEN) and the European Association for the Study of Obesity (EASO) have developed diagnostic criteria to define sarcopenic obesity (4).
The objectives of our work were to:
- Assess the frequency of sarcopenia in obese adults.
- Identify the nutritional, clinical and biological risk factors associated with sarcopenic obesity.

Methods

Study population

This was a descriptive cross-sectional study involving 53 obese patients who consulted the Human Obesity Research Unit of the National Institute of Nutrition and Food Technology of Tunis (INNTA), between November 2022 and February 2023.
Our population was selected according to the following criteria:

Inclusion criteria:
- BMI ≥ 30 Kg/m2
- Patients aged between 18 and 64 years
- Patients who have given their consent to participate in the study

Non-inclusion criteria:
- Pregnancy, breast-feeding.
- Patients on long-term corticosteroid therapy.
- Patients with pathologies that may lead to sarcopenia, such as cancer, renal failure, liver failure, endocrine pathologies.
- Patients who have undergone bariatric surgery.

Methods

Population general characteristics:
Sociodemographic data: Age, gender and socio-economic level were recorded.

Assessment of physical activity:
Physical activity was assessed using a simplified (semi-quantitative) WHO questionnaire that takes into account sedentary activities and physical exercise (5).
Patients were classified according to their level of physical activity: high, medium or low.

Nutritional survey:
Dietary intake of the patients was obtained using dietary history questionnaires performed by a trained nutritionist. The amounts of each food consumed estimated in reference to common size contains (bowls, cups and glasses). Standard measuring cups and spoons in a diary were taught to each patient (6). Nutritionist Pro software was used to analyze the nutrient intake of the patients (Nutrilog online; this software uses the CIQUAL 2020 composition table, which has been validated and made available by ANSES (French Food Safety Agency) (7, 8).

Anthropometric measures:
- Measurements of height, weight and body composition (Lean mass (kg), Skeletal muscle mass (SMM), Fat mass (kg), Percentage of body fat (% Fat), Visceral fat level) using professional TANITA bioimpedance were included.
- BMI and severity obesity were determined (9).
- Waist circumference (WC in cm) and type of obesity were specified (10).

Biological parameters:
A biological assessment was performed after 12 hours of fasting. Biological results included:
- Fasting blood glucose and HbA1c: interpretation of results was based on the American Diabetes Association (ADA) 2022 criteria (11).
- A complete lipid profile
- Creatinine (µmol/l), uric acid (µmol/l)
- Insulinemia and determination of HOMA Index: Normal insulinemia values range from 2.6 to 24.9 µIU/Ml.
The HOMA index was calculated using the following formula:
HOMA-IR= (glucose X insulin) /22.5
Any value above 2.4 indicates the presence of insulin resistance.

Screening for sarcopenia:
Screening for sarcopenia has been established according to pathological thresholds proposed by the European Society for Clinical Nutrition and Metabolism (ESPEN) and the European Association for the Study of Obesity

(EASO) (4).

- Assessment of muscle mass:

Muscle mass was assessed by the ratio of SMM to body weight.

- SMM (Kg) was measured using Tanita BC 418 MA bioimpedancemetry (BIA).

-The ratio of SMM to weight was calculated using the formula:

SMM(kg) / Actual weight (kg)

- The percentage of SMM to weight, according to the formula:

SMM(kg)/Actual weight (kg) X 100

A reduction in muscle mass is defined as a decrease in the percentage of SMM to weight (SMM/W), based on the criteria established by Janssen et al (12).

- Body fat assessment:

Body fat was measured directly by impedancemetry. Results were interpreted according to age and sex, according to Gallagher et al recommendations (13).

- Measurement of muscle strength :

Muscular strength, which reflects the quality of skeletal muscle fibres, was estimated using the Hand-grip (HG) method. The definition of impaired muscle strength was based on the criteria provided by Dodds et al (14).

Statistical Analysis

Statistical analysis was carried out using SPSS software version 19.0. Absolute frequencies and relative frequencies (percentages) were calculated for the qualitative variables. We calculated medians (interquartile range (IQR)) for quantitative variables.

The non-parametric Mann Whitney test was used to compare small samples. Percentage comparisons on independent series were carried out using Pearson's chi-square test, and in case of non-validity of this test by Fisher's two-tailed exact test. The significance level was set at $p<0.05$.

Ethics approval and consent to participate

Once participants were informed about the objectives of the study and the data collection process, they signed a letter of informed consent in compliance with the guidelines of the declaration of Helsinki.

Results

The general characteristics of our population were represented in table 1.

Median visceral fat was 11.35 [5.97-16.76] l. Median body fat percentage was 46.2 [39-54] %. Almost all patients (95%) had a high body fat percentage. Median (SMM/W) percentage was 29.3 [24-34] %. More than half of patients (55%) had low (SMM/W).

Sarcopenia was present in 7.5% of the population (SO+). The median age of the obese sarcopenic was 50 [43-64] years, compared with 44 [20-52] years for the non-sarcopenics (p=0.444). Half of SO+ patients were men, compared with 18% of SO- patients (p=0.134).

Fifty percent of sarcopenic obese patients (SO+) had a low socioeconomic status, versus 4% of non-sarcopenic obese patients (SO-). The difference was statistically significant (p=0.004).

All sarcopenic obese people were sedentary, compared with only 78% of non-sarcopenic obese people. The difference was statistically significant (p<0.001).

Table1. General characteristics of the population

Parameters	N=53
Age, median (range), years	44.34 (20-64)
Gender	
Men (%)	21
Women (%)	79
Socio-economic level	
High (%)	4
Middle (%)	89
Low (%)	7
Severity of obesity	
Obesity class 1 (%)	25
Obesity class 2 (%)	32
Obesity class 3 (%)	43
BMI[a], median (range), Kg/m²	39.78 (33.86-45.7)
waist circumference, median (range), cm	
Men	125 (114-136)
Women	120 (109-131)

a **BMI**=Body Mass Index

Regarding the nutritional profile, median energy intake was 3100 [2530-3670] kcal/d in SO+ and 2800 [2124-3476] kcal/d in SO- (p=0.886). The median intakes of lipids (141 [106-176] g/d for SO+ versus 115 [91-139] g/d for SO-; p=0.195) and saturated fatty acids (30 [23-37] mg/d for SO+ versus 27 [19-35] mg/d for SO-; p=0.622) were higher in sarcopenic obese people, but with no significant difference. There were no significant difference between the two groups for protein intake (99 [65-102] g/d for SO+ versus 91 [59-95] g/d for SO-; p=0.553). Median cholesterol intake was significantly higher for SO+ than for SO- (355 [296-383] mg/24h versus 302 [261-346] mg/24h respectively; p<0.001). The relationship between median vitamin intake and sarcopenia is shown in table 2. There was no statistically significant difference between the two groups.

Table 2. Vitamin intake and sarcopenia

Median (IQR)	SO*+	SO-	P
Vitamin A (µg/d)	138.43 (131.05-145.81)	185.66 (176.31-195.01	0.818
Vitamin D (µg/d)	9.88 (7.38-12.38)	9.27 (7.15-11.39)	0.372
Vitamin E (mg/d)	27.03 (22.78-31.28)	24.16 (19.91-28.41)	0.618
Vitamin C (mg/d)	159.15 (143.67-174.63)	131.40 (115.92-146.88)	0.468
Vitamin B1 (mg/d)	1.49 (1.04-1.94)	1.32 (0.87-1.77)	0.515
Vitamin B2 (mg/d)	1.54 (1.15-1.93)	1.79 (1.4-2.18)	0.851
Vitamin PP (mg/d)	27.3 (23.33-31.27)	18.56 (14.59-22.53)	0.052
Vitamin B5 (mg/d)	7.17 (5.39-8.95)	6.73 (4.95-8.51)	0.708
Vitamin B6 (mg/d)	1.71 (1.18-2.24)	1.86 (1.33-2.39)	0.732
Vitamin B9 (µg/d)	463.5 (338.2-588.8)	368.31 (262.91-473.71)	0.195
Vitamin B12 (µg/d)	2.29 (1.6-2.98)	8.04 (7.35-8.73)	0.783

***SO**= Sarcopenic Obesity

Furthermore, a statistically significant relationship was found between low (SMM/W) and the median intake of

vitamin PP (p=0.014) and vitamin B9 (p=0.009) (table 3).

Table 3. Vitamin intake and skeletal muscle mass

Median (IQR)	Low SMM/W[a]	Normal SMM/W [b]	P
Vitamin A (µg/d)	210.66 (203.38-218.04)	147.58 (138.13-157.03)	0.298
Vitamin D (µg/d)	9.56 (7.06-12.06)	9.02 (6.9-11.14)	0.128
Vitamin E (mg/d)	26.74 (22.49-30.99)	21.51 (17.26-25.76)	0.082
Vitamin C (mg/d)	146.20 (130.72-161.68)	118.14 (109.49-126.79)	0.163
Vitamin B1 (mg/d)	1.40 (0.95-1.85)	1.24 (0.79-1.69)	0.250
Vitamin B2 (mg/d)	1.47 (1.08-1.86)	2.13 (1.74-2.52)	0.341
Vitamin PP (mg/d)	21.86 (17.89-25.83)	16.04 (12.07-20.4)	**0.014**
Vitamin B5 (mg/d)	7.21 (5.43-8.99)	6.22 (4.44-8)	0.115
Vitamin B6 (mg/d)	2.01 (1.48-2.54)	1.65 (1.12-2.18)	0.133
Vitamin B9 (µg/d)	420.41 (295.05-545.81)	321.21 (219.61-422.81)	**0.009**
Vitamin B12 (µg/d)	2.4 (1.61-2.87)	1.9 (1.27-2.5)	0.298

a Low SMM/W= Low skeletal muscle mass ;
b Normal SMM/W= Normal skeletal muscle mass

Regarding anthropometric parameters, median BMI and visceral fat were significantly higher in sarcopenic obesity (table 4). Similarly, median BMI, percentages of severe obesity and fat mass were significantly higher in cases of low SMM/W (table 5).

Table 4. Anthropometric measurements and sarcopenia

	SO[a] +	SO -	p
Weight, median (range), (kg)	123.23 (116.73-130.63)	106.3 (99.7-110.5)	0.137
Height, median (range), (m)	1.65 (1.61-1.67)	1.64 (1.60-1.65)	0.963
BMI[b], median (range), (kg/m²)	**45.86 (45-46.83)**	**39.29 (38.94-40.58)**	**0.03**
Waist circumference, median (range), (m)			0.775
Men	1.70 (1.68-1.72)	1.77 (1.75-1.76)	
Women	1.58 (1.54-1.62)	1.61 (1.59-1.63)	
FAT % (%)	45	46	0.755
High (%)	100	94	0.222
Normal (%)	0	6	
Visceral fat, median (range), (l)	**16.55 (14.25-18.85)**	**10.93 (9.43-12.43)**	**0.043**

a SO= Sarcopenic Obesity ; **b BMI**= Body Mass Index

Table 5. Anthropometric measurements and skeletal muscle mass

	Low SMM/W [a]	Normal SMM/W	P
Weight, median (range), (kg)	115.8 (112.5-118.1)	97.65 (94.45-100.85)	**< 0.001**
Height, median (range), (m)	1.67 (1.66-1.69)	1.61 (1.60-1.63)	**0.017**
BMI[b], median (range), (kg/m²)	41.57 (40.82-41.84)	37.62 (36.89-37.95)	**0.006**
Waist circumference, median (range), (m)			0.129
Men	1.76 (1.75-1.77)	1.75 (1.73-1.77)	
Women	1.63 (1.59-1.67)	1.61 (1.58-1.64)	
FAT % (%)	49	42	**< 0.001**
High (%)	100	87	**< 0.001**
Normal (%)	0	13	
Class III Obesity (%)	59	25	**0.048**
Visceral fat, median (range), (l)	12.21 (9.81-14.61)	10.65 (8.55-12.75)	0.300

a SMM/W= skeletal muscle mass ; **b BMI**= Body Mass Index

The study of biological parameters revealed a statistically significant relationship between insulin resistance and low SMM/W, as attested by median insulinemia (28.81 [22.51-35.11] µIU/mL for low SMM/W, versus 14.48 [12.23-16.73] µIU/mL for normal SMM/W; p=0.004) and HOMA index (7.94 [2.59-8.37] for low SMM/W, versus 3.49 [2.35-4.78] for normal SMM/W; p=0.002), which were higher in cases of low SMM/W. However, there was no statistically significant difference in biological parameters or Homa index between sarcopenic (SO+) and non-sarcopenic (SO-) obese subjects.

Discussion

Sarcopenia is an age-related pathology that increases considerably the risk of weakness, poor physical performance and mortality due to the progressive loss of muscle strength and mass (15). However, sarcopenia is not restricted to the elderly but can also occur earlier in life, especially when associated with obesity (2).

In this study, we were interested in assessing the prevalence of sarcopenia among obese adults, and identifying the nutritional, clinical and biological risk factors associated with the development of sarcopenic obesity.

In our study, sarcopenia was found in 7.5% of patients according to ESPEN and EASO criteria. Similar results were found in the study by Lee et al (16), who reported a prevalence varying between 5-10%.

Several definitions of sarcopenic obesity were developed (17). This heterogeneity influences the prevalence of sarcopenia from one definition to another, which ranged from 2.75% to over 20% (18).

The prevalence of sarcopenia also depends on geographic region, age and several other parameters. It varies from 1% to 29% in the elderly, 14% to 33% in those with long-term care and 10% in those with acute hospital care (19).

A systematic review and meta-analysis performed by Liu C, summarized the current clinical evidence relevant to SO and included 106 clinical studies with 167,151 elderlies. The estimated prevalence of SO was 9% in both men and women (20).

The median age of our obese sarcopenic patients was 50 years. A study carried out in Korea in 2009 revealed a median age of 55.5 years in sarcopenic obese adults (21). We found no significant relationship between age and sarcopenic obesity, unlike most studies that have shown a relationship between aging and sarcopenic obesity (22). Indeed, ageing leads to a relative increase in visceral abdominal fat and a progressive loss of strength and muscle mass (23).

The study by Ribeiro Santos et al carried out between 2015 and 2017 in Brazil highlighted a significant relationship between age and sarcopenic obesity (p=0.018) (24). Age was a significant determinant of sarcopenic obesity, with a prevalence of 0.4% in people aged 20 - 29.9 years, 2.6% in those aged 60 - 69.9 years, 4.2% in those aged 70 - 79.9 years and 12.2% in those aged 80 - 89.9 years (25).

We found no relationship between gender and sarcopenic obesity (p=0.134). Our results were comparable to those

reported in the literature (24, 26, 27).
However, the study by Lu et al found that the prevalence of sarcopenic obesity was higher in men (13.94%) than in women (7.14%) (28).
Patients aged between 18 and 90 were included in the study by Wagenaar et al, which showed an overall prevalence of sarcopenic obesity of 0.9% in men and 1.4% in women (25).
We found a statistically significant relationship between socio-economic level and sarcopenic obesity (p=0.004). Social and economic changes in low- and middle-income countries are driving an increase in the ageing population. Combined with the additional burden of poverty and inequality, these changes contribute to increased food insecurity, obesity and its associated pathologies (29). Declining economic income contributes to food insecurity and consequently to lower quality of nutritional and protein intake, influencing the development of sarcopenic obesity (30). Nevertheless, the study by Ribeiro Santos et al found no relationship between income and sarcopenic obesity (24).
We found a statistically significant relationship between physical inactivity and sarcopenic obesity (p<0.001). Studies have shown that physical inactivity is considered as a risk factor for sarcopenic obesity (19). The study by Ma J et al found that sarcopenic obese people had a lower level of physical activity than healthy people (31). Another study reported that elderly people with low muscle strength who were insufficiently active were at higher risk of sarcopenia (24). In the study by Lu L et al, a high level of physical activity was associated with a lower prevalence of sarcopenic obesity in men (28).
In our patients, median caloric intake was higher in the sarcopenic obese, but without significant difference (OS+=3100 kcal/d vs. OS-=2800 Kcal/d; p=0.886). A study by Lynch et al demonstrated that a high-calorie diet combined with sedentary lifestyle contributes to the development of sarcopenic obesity (32).
We did not identify any relationship between protein intake and sarcopenic obesity. However, several studies have reported a strong association between low protein intake and sarcopenic obesity (19).
In our study, median intakes of lipids (OS+=141 g/d vs. OS-=115 g/d) and saturated fatty acids (OS+=30 mg/d vs. OS-=27 mg/d) were higher in sarcopenic obese subjects, but with no significant difference, probably due to the small sample size. On the other hand, the Lynch study confirmed that excess intake of saturated fatty acids can lead to the development of sarcopenic obesity (32).
A statistically significant relationship was found between BMI and sarcopenic obesity (OS+ =45.86 kg/m² vs OS-=39.29 kg/m²; p=0.03) as well as with low SMM/W (low SMM/W=41.57 kg/m² vs normal SMM/W=37.62 kg/m²; p=0.006). Several studies have shown that BMI is associated with sarcopenic obesity (p<0.001) (26, 31) and low SMM/W (33). A Korean study conducted by Hwang J assessing the gender-specific prevalence and risk factors of sarcopenic obesity in the community-dwelling population aged 75-84 years, found that SO risk factors in both males and women included BMI and Waist Circumference, showing statistical significance (p < 0.05) (26). Unlike our results, which found no significant relationship between waist circumference and sarcopenic obesity.
Sarcopenic obesity was associated with visceral fat (OS+=16.55 l vs OS-=10.93 l; p=0.043). This result was in agreement with the literature (34). Indeed, an increase in visceral fat was associated with a decrease in SMM in postmenopausal women (35).
Our results showed a significant relationship between fat mass and low SMM/W (low SMM/W=49.25% vs. normal SMM/W=42.52%; p <0.001). A study by De Lorenzo et al approved that people with normal weight associated with high fat mass had a higher risk of sarcopenia than those with normal fat mass (0.6% vs. 14.1% in men; 1.4% vs. 36.5% in women) (36). We also found a significant relationship between obesity severity and low SMM/W (p=0.048). Indeed, adults with class II or III obesity would be more likely to be affected by sarcopenic obesity according to a study by Wang M et al (37).
We found a significant relationship between HOMA index and low SMM/W (low SMM/W=7.94 vs. normal SMM/W=3.49; p=0.002). Our results were similar to those reported in the literature. Indeed, insulin resistance in obese people can lead to a decrease in muscle mass (38). Several studies showed that sarcopenic obesity was associated with increased HOMA index and insulin resistance (39).
Our study did not find a relationship between lipid parameters and sarcopenic obesity. In contrast, the study by Hwang J et al reported associations between blood triglyceride levels (p<0.001) and cholesterol (p=0.009) (26). Other studies considered high HDL-cholesterol levels to be a risk factor for sarcopenia (40).

Study limitation

The population sample was limited, due to the study's short duration. Nevertheless, our study can be considered a starting point for further work. It would be interesting to complete the study and extend the size of the population. For sarcopenic obesity risk factors, only nutritional, anthropometric and biological parameters were studied. Measurements of inflammatory markers and vitamin D were not performed, as they are not common practice.

Conclusion

According to our study, low socio-economic level, sedentary lifestyle, BMI, viceral fat and insulin resistance were the risk factors associated with sarcopenic obesity.
In the light of our results and those of the literature, we recommend promoting a balanced, low-energy-density diet to improve insulin sensibility and thus reduce the risk of sarcopenia and associated comorbidities. Regular physical activity and limiting sedentary activities are also strongly recommended.

Abbreviations list
ADA : American Diabetes Association
BMI : Body Mass Index
EASO : European Association for the Study of Obesity
ESPEN : European Society for Clinical Nutrition and Metabolism
HG : Hand-Grip
HOMA-IR : Homeostasis Model Accessment of Insuline Resistance
MUFA : MonoUnsaturated Fatty Acids
PUFA : PolyUnsatured Fatty Acids
SFA : Saturated Fatty Acids
SMM : Skeletal Muscle Mass
SMM/W : Skeletal Muscle Mass/ Weight
SO : Sarcopenic Obesity
UI : Unité Internationale
WC : Waist circumference
WHO : World Health Organization

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