Eskisehir Medical Journal
Eskişehir Tıp Dergisi

Eskisehir Med J. 2023; 4(supp): 169-174
doi: 10.48176/esmj.2023.128

Araştırma Makalesi / Original Article

THE ASSESSMENT OF NEW ESPEN/EASO CRITERIA FOR SARCOPENIC OBESITY IN GERIATRIC OUTPATIENTS

GERİATRİK HASTALARDA YENİ ESPEN/EASO SARKOENİK OBEZİTE KRİTERLERİNİN DEĞERLENDİRİLMESİ

YELDA ÖZTÜRK[1] SERDAR CEYLAN[2] MERVE GÜNER[2] ARZU OKYAR BAŞ[2] MELTEM KOCA[2] MERT EŞME[2]
CAFER BALCI[2] BURCU BALAM DOĞU[2] MUSTAFA CANKURTARAN[2] MELTEM GÜLHAN HALİL[2]

[1]Department of Internal Medicine, Division of Geriatric Medicine, Eskişehir City Hospital, Ankara, Turkey
[2]Department of Internal Medicine, Division of Geriatric Medicine, Hacettepe University Faculty of Medicine, Ankara, Turkey

ÖZET

Giriş: Sarkopenik obezite (SO) prevalansı tüm dünyada artmaktadır. Tanısının konulması ve yönetimi önemlidir. Bu çalışma ayaktan geriatrik polikliniğine başvuran hastalarda sarkopenik obezite prevalansını yeni ESPEN/EASO kriterlerine göre belirlemeyi; ağırlık, boyun karesi ve vücut kütle indeksine (VKİ) göre düzeltilmiş iskelet kası kütlesinin etkisini ayrı ayrı incelemeyi hedefledi.

Yöntemler: Bu kesitsel çalışmaya geriatri polikliniğine başvuran 65 yaş ve üstü hastalar dahil edildi. Antropometrik ölçümler, kas kuvveti (Takei dijital kavrama gücü dinamometresi) ve vücut kompozisyonu (Body Stat Quadscan 4000 biyoempedans cihazı) değerlendirildi. İskelet kası kütlesi (İKK); ağırlık (A), VKİ ve boyun karesine göre düzeltildi. Azalmış kas kütlesi, İKK/A, İKK/VKİ ve İKK/boy^2 dahil olmak üzere 3 farklı şekilde değerlendirildi. SO prevalansı SO1 (İKK/A), SO2 (İKK/VKİ) ve SO3 (İKK/boy^2) olarak verildi.

Bulgular: Çalışmaya %62' si kadın olan 214 yaşlı yetişkin dahil edildi. Artmış VKİ veya bel çevresi ile birlikte pozitif sarkopeni taraması olarak tanımlanan sarkopenik obezite taraması, hastaların %28,5'inde saptandı (n=61). Sarkopenik obezite prevalansı SO1 (İKK/A), SO2 (İKK/VKİ) ve SO3 (İKK/boy^2) için sırasıyla %16,4, %15,0 ve %1,9 idi.

Sonuç: İskelet kası kütlesi, ağırlık veya VKİ'ye göre düzeltildiğinde sarkopenik obezite prevalansı daha yüksektir. Boyun karesine göre düzeltilen iskelet kası kütlesinin kullanılması, SO prevalansını olduğundan az çıkmasına yol açabilir.

Anahtar Kelimeler: sarkopenik obezite, obezite, sarkopeni, kas kütlesinde azalma

ABSTRACT

Introduction: The prevalence of sarcopenic obesity (SO) is increasing worldwide. It is important to diagnose and manage it. This study aimed to determine the prevalence of sarcopenic obesity in geriatric outpatients according to the new ESPEN/EASO criteria by investigating the effect of skeletal muscle mass adjusted for weight, height square, and body mass index (BMI), separately.

Methods: This cross-sectional study included patients aged 65 years and older, who applied to the geriatric outpatient clinic. Anthropometric measurements, muscle strength (Takei digital grip strength dynamometer), and body composition (Body Stat Quadscan 4000 bioimpedance analyzer) were taken. Skeletal muscle mass (SMM) was adjusted for weight (W), BMI, and height^2. Reduced muscle mass was assessed in 3 different ways including SMM/W, SMM/BMI, and SMM/height^2. The prevalence of SO were given as SO1 (SMM/W), SO2 (SMM/BMI), and SO3 (SMM/ height^2)

Results: There were 214 older adults included in the study with a 62% female rate. Sarcopenic obesity screening, defined by the concomitant existence of an elevated BMI or waist circumference, and positive sarcopenia risk was positive in 28.5% (n=61) of patients. The prevalences of sarcopenic obesity were 16.4%, 15.0%, and 1.9% for SO1 (SMM/W), SO2 (SMM/BMI), and SO3 (SMM/ height^2) respectively.

Conclusion: The prevalence of sarcopenic obesity is higher when skeletal muscle mass is adjusted by weight or BMI. Using skeletal muscle mass adjusted by height^2 causes underestimation of SO.

Keywords: sarcopenic obesity, obesity, sarcopenia, reduced muscle mass

Corresponding Author: Yelda Ozturk
E-mail: yeldaozturk67@gmail.com
ORCID: 0000-0003-3847-0967
Received Date: 15.08.2023 **Accepted Date:** 24.08.2023

Cite as: Ozturk Y, Ceylan S, Guner M, et al. The Assessment Of New Espen/Easo Criteria For Sarcopenic Obesity In Geriatric Outpatients. Eskisehir Med J. 2023; 4(supp): 169-174. doi: 10.48176/esmj.2023.128.

INTRODUCTION

Sarcopenic obesity (SO) is defined as the co-existence of excess adiposity and low muscle mass/function. Its prevalence is increasing due to both the aging world and the obesity epidemic. Sarcopenia and obesity are different entities, but they share common pathophysiological features and risk factors such as aging, lifestyle, production of inflammatory cytokines and reactive oxygen species, and endocrine alteration. On the other hand, they react synergistically to enhance each other (1-3).

Sarcopenic obesity is related to several disorders like cardiovascular disease, reduced bone mineral density, and all-cause mortality. It is crucial to find and manage subjects with sarcopenic obesity. High body fat in obesity may result in a relative reduction of skeletal muscle mass and also in the absence of absolute skeletal muscle loss. A relative reduction in skeletal muscle mass could therefore merely result from higher body fat. Individuals with obesity may conversely have higher absolute skeletal muscle mass relative to individuals without obesity. On the other hand, normal skeletal muscle mass according to reference ranges of the general population without obesity may cause inadequate muscle strength and performance in subjects with obesity. In light of these issues, it should be rational to normalize skeletal muscle mass to body mass (3). Nearly, the European Society for Clinical Nutrition and Metabolism (ESPEN) and the European Association for the Study of Obesity (EASO) published an expert consensus on a Definition and diagnostic criteria for SO. Firstly, they suggested screening patients with elevated body mass index (BMI) or waist circumference (WC), and positive markers of low skeletal muscle mass and function. Secondly, skeletal muscle functional parameters, increased fat mass, and reduced muscle mass are assessed for SO diagnosis (3).

In this study, we aimed to find out the prevalence of SO in geriatric outpatients according to the new ESPEN/EASO criteria. Therefore, we planned to investigate the effect of skeletal muscle mass adjusted for weight, height square (height^2), and BMI, separately.

METHODS

Study design and participants

This cross-sectional study was conducted in a university hospital's geriatric outpatient clinic (≥ 65 years). Subjects who were 65 years and older with normal cognitive status and who had the ability to cooperate were included. Patients were excluded if they had a cardiac pacemaker, metal implants, peripheral edemas, arm or leg amputation, and inability to stand for anthropometric measurements. The study was approved by the local ethics committee (approval number, 2022/17-12, GO 22/1059). Verbal and written informed consent was obtained from all participants. The study protocol was in line with the Declaration of Helsinki.

Katz's activities of daily living (ADL) (score 0-6) and Lawton-Brody's instrumental activities of daily living (IADL) (score 0-8) were used for functional assessment. The higher scores were related to higher independence (4, 5). Mini Nutritional Assessment short-form (MNA-SF) was used to screen malnutrition (score 0-14). It is categorized as malnutrition (score 0-7), at risk of malnutrition (score 8-11), and nutritionally normal (score 12-14) (6). Sarcopenia was screened by the SARC-F questionnaire. It contains questions about assistance in walking, rising from a chair, climbing stairs, falls, and strength. A score of 4 and over indicates positive sarcopenia screening (7, 8). Patients living with frailty were assessed on a 9-point clinical frailty scale (CFS). The score ranges between 1(very fit) and 9 (terminally ill). A score of 4 is called pre-frail and a score ≥5 is considered frail (9, 10).

Anthropometric measurements

Anthropometric measurements were obtained after overnight fasting. Height, weight, BMI, CC, and WC were recorded. Height (meter) and weight (kilogram) were measured in the upright position (TEM-BEKO 035×040 height and weight measuring machine, Istanbul, Turkey). BMI was calculated by dividing body weight in kilograms by height in meters squared (kg/m²). Calf circumference and WC were measured within 0.5 cm with plastic tape. Calf circumference was measured in a sitting position with a 90^o knee flexion at the widest part of the leg. Waist circumference was measured at the umbilicus level.

Muscle strength measurement and body composition

A Takei digital grip strength dynamometer (Takei Scientific Instruments Co, Niigata, Japan) was used to evaluate handgrip strength (HGS). Patients were asked to seat with adduction of shoulders, 90^o flexion of the elbow, and neutrally rotated forearm. Handgrip strength was performed three times by the dominant hand and the maximum value was taken into consideration. Body composition was analyzed using a multifrequency and tetrapolar technique using a Body Stat Quadscan 4000 bioimpedance analyzer (BodyStat Ltd, Douglas, Isle of Man, British Isles). Measurements were taken when lying in a supine position after overnight fasting. Fat-free mass index (FFMI), and percentage (fat%) were recorded. Fat-free mass was multiplied by 0.566 to predict total skeletal muscle mass (11).

Sarcopenic obesity classification and cut-off points

Sarcopenic obesity evaluation was completed through the latest consensus (12). Screening for SO was based on concomitant existence of an elevated BMI (≥30 kg/m²) or WC (≥102 cm for male, and ≥88 cm for female), and SARC-F score (12, 13). Diagnosis to confirm or reject SO followed a positive screening, it was performed in two steps. Firstly, HGS was performed for skeletal muscle function. Low muscle strength was defined according to cut-off values (HGS; <16 kg for women and <27 kg for men). If low muscle function was detected, the diagnostic algorithm continued

Table 1. Baseline characteristics of patients

Variables	Female (n=134)	Male (n=80)	Total (n=214)
Age, median (IQR)	72.0(68.0-78.0)	72.5(68.0-79.7)	72.0 (68.0-78.0)
ADL, median (IQR)	6.0(5.0-6.0)	6.0(6.0-6.0)	6.0(5.0-6.0)
IADL, median (IQR)	8.0(6.0-8.0)	8.0(8.0-8.0)	8.0(7.0-8.0)
Clinical frailty scale, median (IQR)	4.0(3.0-5.0)	3.5(3.0-4.0)	4.0(3.0-5.0)
SARC-F, median (IQR)	2.0(1.0-5.0)	1.0(0-4.0)	2.0(0-4.0)
MNA-SF, median (IQR)	12.0(10.0-14.0)	13.5(11.0-14.0)	12.0(10.0-14.0)
Calf circumference (cm), median (IQR)	35.0(31.0-38.0)	34.0(32.0-37.0)	34.0(31.0-38.0)
BMI (kg/m²), median (IQR)	31.6(28.0-35.3)	28.0(24.9-31.9)	30.1(26.8-33.8)
Waist circumference (cm), median (IQR)	100.0(92.0-110.0)	100.0(92.0-107.0)	100.0(92.0-110.0)
Handgrip strength (kg), median (IQR)	16.5(13.0-19.9)	27.0(19.6-30.8)	18.7(14.3-25.1)
Fat-free mass index (kg/m²), median (IQR)	16.8(15.2-18.5)	19.2(17.0-20.8)	17.4(15.9-19.4)
FAT%, median (IQR)	47.1(43.1-51.7)	31.1(27.4-36.0)	43.2(32.9-48.7)

ADL, activities of daily living; BMI, body mass index; IADL, instrumental activities of daily living; MNA-SF, mini-nutritional assessment short form; SARC-F, strength, assistance with walking, rising from a chair, climbing stairs and falls.

with the body composition assessment. Both reduced muscle mass and fat% were required for altered body composition. Increased fat% was defined through the population-specific thresholds for obesity as 27.3% for men and 40.7% for women (14).

Reduced muscle mass was assessed in three different ways as following;

1. Low skeletal muscle mass/ weight (SMM/W): The population-specific cutoff values of 40.6% for males and 33.2% for females were used which was defined by Bahat et al (15).
2. Low skeletal muscle mass/ BMI (SMM/BMI): The population-specific cutoff values of 1.049 for males and 0.823 for females were used which was defined by Bahat et al (15).
3. Low skeletal muscle mass/ height² (SMM/height²): The population-specific cutoff values of 9.2 kg/m² for

males and 7.4 kg/m² for females were used which was defined by Bahat et al(16).

Finally, three different results for SO were consisted of SO1 (SMM/W), SO2 (SMM/BMI), and SO3 (SMM/ height^2).

Statistical analysis

SPSS software, version 23 was used for the statistical analysis. The normality tests of variables were performed by using visual (histograms, probability plots) and analytical (Kolmogorov-Simirnow test) methods. Descriptive analyses were presented as percentages for categorical variables, means and standard deviations for normally distributed variables, and medians and interquartile range (IQR) for non-normally distributed and ordinal variables. The chi-square or Fisher exact test (when chi-square test assumptions do not hold due to low expected cell counts), where appropriate, was used to compare differences between the categorical variables. The Mann-Whitney U test was used to compare non-normally distributed variables. Student's t test was used to compare normally distributed variables.

RESULTS

A total of 214 patients, were included in the study. The median (25p-75p) age was 72.0 (68.0-78.0) with 62.6% (n=134) female rate. The baseline characteristics of patients for each sex were described in detail in table 1. There were 110 (51.4%) patients, whose body mass indexes (BMI) were ≥ 30kg/m², namely obesity group. The comparison of obesity and non-obesity group was presented in table 2. The rate of female sex was higher in obesity group (p<0.001). There were no differences in risk of sarcopenia (p=0.552), malnutrition (p=0.102), and frailty (p=0.722) between groups. Whereas, the rates of patients with low CC (p<0.001), low HGS (p=0.004), and low SMM/ height^2 (p<0.001), were lower; the rates of patients with high WC (p<0.001), high fat percentage (p<0.001), low SMM/W (p<0.001), and low SMM/BMI (p<0.001), were higher in obesity groups.

The seventy-three point eight percentage of all patients had high BMI or WC. Sarcopenia screening with SARC-F was positive in 36.4% of patients. Sarcopenic obesity screening, defined by the concomitant existence of an elevated BMI or WC, and positive sarcopenia risk, was positive in 28.5% (n=61) of patients. The second step for the diagnosis included 61 patients. It was shown in Table 3. Reduced muscle mass was assessed in 3 different ways including SMM/W, SMM/BMI, and SMM/height^2. The prevalence of SO was given as SO1 (SMM/W), SO2 (SMM/BMI), and SO3 (SMM/ height^2) in table 4. It was ranged from 1.9% to 16.4%.

Table 2. Characteristics of patients according to body mass index categories

Variables	BMI<30 (n=104)	BMI≥30 (n=110)	p
Age, median (IQR)	73.0(68.0-80.0)	71.0(68.0-75.2)	**0.022**
Sex, female, n(%)	52(50.0)	82(74.5)	**<0.001**
ADL, median (IQR)	6.0(5.0-6.0)	6.0(5.0-6.0)	0.654
IADL, median (IQR)	8.0(6.0-8.0)	8.0(7.0-8.0)	0.792
SARC-F ≥4, n(%)	40(38.5)	38(34.5)	0.552
MNA-SF ≤11, n(%)	44(44.9)	35(33.7)	0.102
Clinical frailty scale ≥4, n(%)	58(55.8)	64(58.2)	0.722
Low calf circumference, cm, n(%)	65(63.1)	21(19.3)	**<0.001**
High waist circumference, n(%)	48(46.2)	107(97.3)	**<0.001**
Low hand grip strength, n(%)	61(58.7)	43(39.1)	**0.004**
High fat%, n(%)	71(68.3)	105(95.5)	**<0.001**
Low SMM/height^2, n(%)	21(20.2)	1(0.9)	**<0.001**
Low SMM/W, n(%)	68(65.4)	101(91.8)	**<0.001**
Low SMM/BMI, n(%)	48(46.2)	91(82.7)	**<0.001**

ADL, activities of daily living; BMI, body mass index; IADL, instrumental activities of daily living; MNA-SF, mini-nutritional assessment short form; SARC-F, strength, assistance with walking, rising from a chair, climbing stairs and falls; SMM/W, total skeletal muscle mass adjusted by weight; SMM/BMI, total skeletal muscle mass adjusted by body mass index; SMM/ height^2, total skeletal muscle mass adjusted by height square.
Bold values indicated p<0.05

DISCUSSION

In this study, the prevalence of sarcopenic obesity in geriatric outpatients according to the new ESPEN/EASO criteria was presented. We adjusted skeletal muscle mass for weight, BMI, and height^2 were assessed, separately. The percentages of low SMM/W, low SMM/BMI, and low SMM/height^2 were 82.0%, 77.0%, and 6.6%, respectively among the patients with positive screening. The prevalence of sarcopenic obesity ranged from 1.9% to 16.4%. It was the lowest when low SMM/height^2 was used.

In comparison of patients with obesity (BMI ≥30 kg/m^2) and patients without obesity (BMI <30 kg/m^2), it was striking that, whereas the rate of low SMM/height^2 was lower in the obesity group; the rates of low SMM/W and low SMM/BMI were higher in obesity group. In this field, adjusting the measured SMM for 'body size' was stated to be more appropriate to avoid underdiagnoses of sarcopenia in patients with obesity.

Two patients with the same fat mass and skeletal muscle mass but with different BMI are not similar (17).

Table 3. Diagnostic procedure for the assessment of sarcopenic obesity.

SCREENING CRITERIA (n=214)		
High BMI/WC	BMI or WC, n(%)	158 (73.8)
Surrogate parameters for sarcopenia	SARC-F, n(%)	78 (36.4)
Positive screening	SARC-F + BMI or WC, n(%)	61 (28.5)
↓		
DIAGNOSIS (N=61)		
Altered skeletal muscle functional parameters	Handgrip strength, n(%)	40(65.6)
Altered body composition, Increased fat mass	Fat%	51 (83.6)
Altered body composition,		
Reduced muscle mass1	SMM/W, n (%)	50(82.0)
Reduced muscle mass2	SMM/BMI, n (%)	47(77.0)
Reduced muscle mass3	SMM/height^2, n (%)	4(6.6)

Legend: BMI, body mass index; SMM/W, total skeletal muscle mass adjusted by weight; SMM/BMI, total skeletal muscle mass adjusted by body mass index; SMM/ height^2, total skeletal muscle mass adjusted by height square; SO, sarcopenic obesity; WC, waist circumference; SARC-F, strength, assistance with walking, rising from a chair, climbing stairs and falls.

The adjustment of muscle mass by height^2 has been commonly applied in sarcopenia diagnosis as recommended by the European Working Group on Sarcopenia in Older People 2 (EWGSOP2). The authors make no recommendation to adjust for body size. However, they support the if data are available for a relevant normative population (18). Recently, studies showed that when muscle mass was adjusted by height^2 in subjects with obesity, sarcopenia prevalence was lower compared to other adjustment methods (17).

Table 4. Prevalence of sarcopenic obesity

Variables	**n (%)**
SO1 (SMM/W)	35(16.4)
SO2 (SMM/BMI)	32(15.0)
SO3 (SMM/ height^2)	4(1.9)

Legend: BMI, body mass index; SMM/W, total skeletal muscle mass adjusted by weight; SMM/BMI, total skeletal muscle mass adjusted by body mass index; SMM/ height^2, total skeletal muscle mass adjusted by height square; SO, sarcopenic obesity

The ESPEN/EASO consensus for SO highlighted the concept of relative or adequate muscle mass, and they recommended using skeletal muscle mass adjusted by weight (3). In our study, we found the lowest prevalence, when we adjust SMM by height^2 (1.9%). The prevalence's of SO1 (SMM/W) and SO2 (SMM/BMI) were closer to each other as 16.4%, and 15.0%, respectively. Our findings supported that skeletal muscle mass should be adjusted by weight or BMI for patients with obesity to avoid underestimation. Bahat et al. conducted a study including 1437 older adults, and they showed the SMM/BMI to be better associated with physical performance, functionality, and frailty (19). They also presented cut-off values (15). Yang et al. indicated that sarcopenic obesity was significantly related to frailty among older adults. They put forward the importance of intervention for sarcopenic obesity to prevent frailty (20). Despite the clinical significance of SO, it remains significantly underrecognized due to the heterogeneity in defining. It will be rational using the ESPEN/EASO consensus criteria by using population specific cut-off values for reduced muscle mass adjusted by weight or BMI.

This study has some limitations. Firstly, we included only geriatric outpatients. It cannot be generalized to community. Secondly, we did not investigate the sarcopenic obesity related factors. Future comparative studies in different older adult populations should be conducted and population specific cut-off values should be defined.

CONCLUSION

In conclusion, the prevalence of sarcopenic obesity is higher when skeletal muscle mass was adjusted by weight or BMI. Using skeletal muscle mass adjusted by height^2 may cause an underestimation of SO.

Ethics Committee Approval: The study was conducted with the approval of the Hacettepe University Ethics Boards and Commissions on 25.10.2022 with Project number GO 22/1059.

Informed Consent: Informed consent was obtained from all participants.

Authorship Contributions: YÖ, SC, AOB, MG, MK, and MGH were involved in the collection of the data and the clinical follow-up of the patients. YÖ, ME, CB, BBD, MC, and MGH are involved in the design and conception of the study. YÖ is the major contributor to writing the manuscript. All authors read and approved the final manuscript.

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

Financial Disclosure: No financial support has been received for this study.

REFERENCES

1. Malandrino N, Bhat SZ, Alfaraidhy M, Grewal RS, Kalyani RR. Obesity and Aging. Endocrinol Metab Clin North Am 2023;52(2):317-39.

2. Wei S, Nguyen TT, Zhang Y, Ryu D, Gariani K. Sarcopenic obesity: epidemiology, pathophysiology, cardiovascular disease, mortality, and management. Front Endocrinol (Lausanne) 2023;14:1185221.

3. Donini LM, Busetto L, Bischoff SC, et al. Definition and diagnostic criteria for sarcopenic obesity: ESPEN and EASO consensus statement. Clin Nutr 2022;41(4):990-1000.

4. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. STUDIES OF ILLNESS IN THE AGED. THE INDEX OF ADL: A STANDARDIZED MEASURE OF BIOLOGICAL AND PSYCHOSOCIAL FUNCTION. Jama 1963;185:914-9.

5. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 1969;9(3):179-86.

6. Rubenstein LZ, Harker JO, Salvà A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci 2001;56(6):M366-72.

7. Malmstrom TK, Morley JE. SARC-F: a simple questionnaire to rapidly diagnose sarcopenia. J Am Med Dir Assoc 2013;14(8):531-2.

8. Bahat G, Yilmaz O, Kılıç C, Oren MM, Karan MA. Performance of SARC-F in Regard to Sarcopenia Definitions, Muscle Mass and Functional Measures. J Nutr Health Aging 2018;22(8):898-903.

9. Özsürekci C, Balcı C, Kızılarslanoğlu MC, et al. An important problem in an aging country: identifying the frailty via 9 Point Clinical Frailty Scale. Acta Clin Belg 2020;75(3):200-4.

10. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. Cmaj 2005;173(5):489-95.

11. Deurenberg P, Pietrobelli A, Wang Z, Heymsfield S. Prediction of total body skeletal muscle mass from fat-free mass or intra-cellular water. International Journal of Body Composition Research 2004;2:107-14.

12. Donini LM, Busetto L, Bischoff SC, et al. Definition and Diagnostic Criteria for Sarcopenic Obesity: ESPEN and EASO Consensus Statement. Obes Facts 2022;15(3):321-35.

13. Lean ME, Han TS, Morrison CE. Waist circumference as a measure for indicating need for weight management. Bmj 1995;311(6998):158-61.

14. Bahat G, Kilic C, Topcu Y, Aydin K, Karan MA. Fat percentage cutoff values to define obesity and prevalence of sarcopenic obesity in community-dwelling older adults in Turkey. Aging Male 2020;23(5):477-82.

15. Bahat G, Tufan A, Kilic C, et al. Cut-off points for height, weight and body mass index adjusted bioimpedance analysis measurements of muscle mass with use of different threshold definitions. Aging Male 2020;23(5):382-7.

16. Bahat G, Tufan A, Tufan F, et al. Cut-off points to identify sarcopenia according to European Working Group on Sarcopenia in Older People (EWGSOP) definition. Clin Nutr 2016;35(6):1557-63.

17. Bahat G, Ozkok S. How to adjust muscle mass while defining sarcopenia component of sarcopenic obesity: is body weight sufficient enough to represent body size? Aging Clin Exp Res 2023;35(3):723-4.

18. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing 2019;48(1):16-31.

19. Bahat G, Kilic C, Ilhan B, Karan MA, Cruz-Jentoft A. Association of different bioimpedanciometry estimations of muscle mass with functional measures. Geriatr Gerontol Int 2019;19(7):593-7.

20. Yang M, Hu M, Zhang Y, et al. Sarcopenic obesity is associated with frailty among community-dwelling older adults: findings from the WCHAT study. BMC Geriatr 2022;22(1):863.