ORIGINAL ARTICLE

Obesity as a Risk Factor for Probable Sarcopenia in Female Older Adult at Integrated Health Posts (Posyandu) in Indonesia: A Cross-sectional Study

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ABSTRACT

Introduction: Sarcopenia, characterized by muscle loss and dysfunction, affects 20% of older adults, but risk factors remain understudied in Indonesian women. This study examined probable sarcopenia prevalence and obesity-related risk factors among community-dwelling female older adults. **Materials and Methods:** This cross-sectional study included 154 female older adults aged 60-69 years (mean 64.08 ± 2.70 years). Probable sarcopenia status was defined by through muscle mass and muscle strength. Diagnosis required Appendicular Skeletal Muscle (ASM) adjusted height squared below 5.85 kg/m and handgrip strength (HGS) below 18.6 kg. Additional measures comprised body composition (BIA), physical activity (IPAQ-SF), BP, total cholesterol, and FBG. Group differences in numeric variables were assessed using Independent t-tests (normal distribution) or Mann-Whitney tests (non-parametric). Associations were analyzed with chi-square, while logistic regression identified predictors of the binary outcome. **Result:** Our study showed that 40.9% of subjects were identified as probable sarcopenia. BMI, percent body fat, visceral fat, ASMI, and dominant HGS were significantly lower in the sarcopenia group ($p<0.001$). Only BMI, visceral fat, diastolic BP, and FBG were associated with probable sarcopenia ($p<0.05$). However, logistic regression identified obesity as the most significant independent risk factor for probable sarcopenia (OR=3.973; 95% CI: 2.003-7.880), suggesting that obesity strongly predicts probable sarcopenia in this population. **Conclusion:** Obesity may independently increase the risk of probable sarcopenia, especially in female older adults, alongside metabolic diseases. Integrating muscle-strengthening exercise, a balanced diet, and routine muscle assessments into obesity management to mitigate sarcopenia risk and enhance health outcomes in the community setting is necessary.
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Keywords: Female Older Adults, Muscle Mass, Obesity, Physical Activity, Sarcopenia

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INTRODUCTION

Sarcopenia is a condition marked by muscle mass loss, reduced muscle strength, and poor physical function. It is a significant health concern among older female adults [1,2]. Sarcopenia is linked to various harmful health outcomes, such as functional decline, immobility, falls, fractures, hospitalization, and increased mortality [3,4]. International studies found that sarcopenia prevalence ranged from 26.9% to 58% in inpatient rehabilitation wards and from 50.9% to 60.2% in geriatric facilities [5–7]. The prevalence of sarcopenia with comorbidity among inpatient and outpatient communities ranged from 27.4% to 54% in those aged ≥ 60 years [2,8–10].

Sarcopenia appears to be more prevalent in Asian populations than in other regions of the world. Data from the Indonesia Longitudinal Aging Study (INALAS) indicates that the prevalence of sarcopenia among community-dwelling older adults is 17.6%, suggesting that one in five individuals in this population is affected by this condition [11]. Reports have linked sarcopenia to factors such as age, gender, comorbidities, physical activity, smoking, body mass index (BMI), waist-to-hip ratio (WHR), and hip circumference, along with skeletal

muscle mass and strength [6–9,12,13]. Sarcopenia can be evaluated through handgrip strength (HGS), which serves as a measure of muscle strength. Subsequently, the assessment of muscle reduction is conducted using Appendicular Skeletal Muscle (ASM) and its adjusted form, the ASM Index (ASM/height), which accounts for height squared. These evaluations are based on guidelines established by the 2019 Asian Working Group for Sarcopenia (AWGS) and the 2018 revision of the European Working Group on Sarcopenia in Older People (EWGSOP2) [1,13,14]. The instrument was validated for older Indonesians with co-morbidities [11,15–17].

As people age, they frequently develop several comorbidities. Sarcopenia has many risk factors that overlap with chronic diseases such as cardiovascular disease, diabetes, hypertension, and chronic kidney disease, which increases the likelihood of multimorbidity [18]. In older adults, a higher number of chronic diseases correlates with an increased prevalence of sarcopenia [19].

Female older adults in Indonesia may be particularly susceptible to sarcopenia as they are more likely to be physically inactive and thus more at risk of declining muscle mass and muscle strength as a result of low daily physical activity [20,21]. At the same time, obesity is also a widespread health problem among female older adults, which is further supported by low physical activity [21,22]. Adult women, especially in Indonesia, are more at risk of obesity than men. This also increases the risk of cardiovascular disease, and other chronic conditions [17].

The complicated relationship between sarcopenia and obesity in older people has been the subject of recent research, which suggests the existence of a possible 'obesity paradox'. Obesity has been associated with a 34% lower likelihood of sarcopenia [23] and a 15% lower risk of death in adults with sarcopenia obesity (SO) compared to those with sarcopenia non-obesity (SNO) [24]. Higher muscle mass and strength in the lower body muscles of the obese elderly may account for this protective effect [25]. However, according to Liu et al., SO is also associated with a higher risk of metabolic diseases, cardiovascular diseases, and functional impairment [23]. Obesity may indicate an earlier biological phase with higher life expectancy in the elderly, as the interaction between muscle, adipose tissue, and environmental factors in aging is complex [24]. To manage SO in the elderly, current research focuses on exercise and nutritional therapy [26].

However, the concept of the 'obesity paradox', which shows sometimes contradictory findings in various populations, demonstrates the complexity of the relationship between obesity and sarcopenia, which requires further research, especially in a unique context such as Indonesian female older adults. There is still a lack of studies focusing on this vulnerable population at the community primary healthcare level, such as Posyandu. Therefore, this study aimed to investigate probable sarcopenia prevalence and obesity-related risk factors among community-dwelling female older adults visiting integrated health posts (Posyandu) in Indonesia to provide important insights into the unique determinants of sarcopenia in this population by looking at the association between the two conditions that are common in this setting. These results may differ from results in other populations and can be used as a basis for more targeted interventions and screening strategies at the community primary healthcare level.

MATERIALS AND METHODS

Study participants

This study was conducted as a cross-sectional study from September to October 2024 in the West Bogor sub-district of Indonesia. We included 154 women (60 – 69 years) from an integrated health posts (Posyandu) under the Public Health Center in this research. The sampling method used was proportional random sampling. Initially, the size of the eligible population was determined by age and gender in the three sub-districts (Gunung Batu, Loji, and Pasir Mulya). First, the total sample size for each neighbourhood was calculated, followed by the total population of the three sub-districts. The proportion of the elderly in each sub-district relative to the total population was then multiplied by the predetermined minimum sample size (based on the sample calculation formula). Since each sub-district has a Posyandu, the target population for each Posyandu was determined. The sample representing each Posyandu was calculated by dividing the village population by the elderly proportion in the sub-district, multiplied by the Posyandu's target population. Finally, samples were randomly selected from each Posyandu using Excel.

To be eligible for the study, participants needed to be within the age range of 60 to 69, capable of standing, and able to communicate verbally. Additionally, they were required to fast for 10 to 12 hours before their visit. Those who could not attend either of the two scheduled visits were disqualified from the study. Cadres from the integrated care post utilized social media and phone calls to notify participants about the visit schedule.

Anthropometric Measurement

A stadiometer was used to measure height, and a Bio Impedance Analysis (BIA) Karada Scan Body Composition Monitor (model HBF-375, OMRON, Japan) was utilized to assess weight, BMI, and body composition. According to Asian demographic standards, the BMI categories are as follows: underweight (BMI < 18.5), normal weight (BMI ≥ 18.5 and < 24.9), overweight (BMI ≥ 25.0 and < 27.0 kg/m), and obese (BMI ≥ 27.0 kg/m) [27]. Body fat percentage data were utilized to categorize adipose tissue and other body components. Women were

classified into three groups: normal (25%–34.9%), high (35.0%–39.9%), and very high (≥ 40%) [28]. According to the OMRON HBF-375 guideline, visceral fat levels were classified into two categories: low (≤10 points) and high (>10 points) [29]. Waist-to-hip ratio (WHR) was determined using abdominal and hip circumference measurements taken with a measuring tape. A WHR of 0.85 or higher indicates an increased risk of metabolic syndrome in women [30].

Skeletal Muscle Measurement

The total skeletal muscle mass was divided by the square of height (measured in kg/m) to calculate the Appendicular Skeletal Muscle Index (ASMI). An ASMI of less than 5.85 kg/m for women was considered indicative of low muscle mass, while an ASMI greater than 5.85 kg/m indicated preserved muscular mass [31].

Handgrip Strength (HGS) Measurement

Handgrip strength (HGS) was assessed using an electronic hand dynamometer (model number: EH101; Zhongshan Camry Electronic Co. Ltd., Zhongshan, China) to evaluate the muscle strength of the participants. Measurements were conducted with the dominant hand and the elbow flexed at a 90° angle, yielding optimal performance for HGS evaluation. Participants were instructed to grip the handlebar as tightly as possible during three attempts, maintaining the grip for 3-5 seconds before checking the displayed value. Each attempt took approximately one minute before proceeding to the next, with the highest value recorded as the final measurement. The Asian Working Group for Sarcopenia (AWGS) defined the cutoff points for low HGS as less than 28.5 kg for men and less than 18.6 kg for women [31].

Determination of Probable Sarcopenia

Three key criteria were utilized to diagnose sarcopenia: physical performance, muscle mass, and muscle strength. Low appendicular skeletal muscle mass (ASM) combined with diminished muscle strength or physical performance serves as an indicator of sarcopenia. A diagnosis was confirmed when hand grip strength (HGS) is below 18.6 kg and when the ASM per height squared (ASM/height) falls below 5.85 kg/m . Individuals were classified as not having sarcopenia if they experienced a reduction in muscle mass only or if they did not show any decline in muscle strength or physical performance [31]. Because the door-to-door data collection method prevented us from conducting physical performance tests in the field, we were only able to measure two regions to confirm probable sarcopenia based on muscle mass and muscle strength. However, detecting low physical performance is crucial for predicting adverse outcomes; thus, it is important to assess the severity of sarcopenia. Therefore, our objective was to determine the probable sarcopenia.

Physical Activity Measurement

A questionnaire and interviews were conducted to collect information on exercise habits. Specifically, data were gathered on daily physical activity over the past seven days using the International Physical Activity Questionnaire-Short Form (IPAQ-SF). This questionnaire evaluated an individual's level of physical activity through metabolic equivalent (MET) values associated with various activities. The MET score was determined by multiplying the type of physical activity by its intensity, measured in minutes and days. The MET values include: walking at 3.3 MET, moderate activity at 4.0 MET, and vigorous activity at 8.0 MET. Exercise levels were categorized as follows: less than 600 METs-min/week was considered low, 600 METs-min/week to less than 1500 METs-min/week was categorized as moderate, and 1500 METs-min/week or more was classified as high [32].

Health Biomarker Measurement

A digital sphygmomanometer (OMRON HEM-7120) was utilized to measure systolic blood pressure (SBP) and diastolic blood pressure (DBP). The Joint National Committee (JNC VIII) classified blood pressure into the following categories: 1) normal: systolic is less than 120 mmHg and diastolic is less than 80 mmHg; 2) prehypertension: systolic ranges from 120 to 139 mmHg, or diastolic ranges from 80 to 89 mmHg; 3) stage 1 hypertension: Systolic ranges from 140 to 159 mmHg, or diastolic ranges from 90 to 99 mmHg; 4) Stage 2 Hypertension: Systolic is 160 mmHg or higher, or diastolic is 100 mmHg or higher [33].

Measurement of total cholesterol (TC) and fasting blood glucose (FBG) was carried out using the strip test method, by a portable device for the simultaneous measurement (GCU meter device brand Easy Touch 3 in 1 for cholesterol and Accu-Check Active glucometer). Blood was taken from capillary blood vessels using a blood lancet and a test strip, and then the data was read using both devices. Cut-off points for TC are desirable (<200 mg/dL), slightly high/borderline (200-239 mg/dL), and high (≥240 mg/dL) [34]. Cut-off points for fasting blood glucose levels are normal (70-99 mg/dL), pre-diabetes (100-125 mg/dL), and diabetes (≥126 mg/dL) [35].

Data analysis

The data were analyzed using IBM Statistical Package for Social Sciences (SPSS) version 26.0. The study considered several independent variables, including smoking history, exercise habits, physical activity, body mass index (BMI), waist-to-hip ratio (WHR), visceral fat, body fat percentage, appendicular skeletal muscle index (ASMI), handgrip strength (HGS), blood pressure, fasting blood glucose (FBG), and cholesterol levels. Probable sarcopenia status served as the dependent variable. The continuous variable's normality was examined using the Kolmogorov-Smirnov test. The categorical

variables were expressed as frequency and percentage. For continuous variables and normal data distributions, the mean and standard deviation were used, whereas for non-normal data distributions, the median and interquartile range/IQR were used. Variables of numeric data were analysed by an Independent t-test for normal parametric data and Mann-Whitney for non-parametric data to assess differences between groups. To examine the association between the variables, a chi-square test was used. To determine which predictor variables are significantly related to the binary outcome and the direction of the relationship (increasing or decreasing the probability of the outcome occurring) logistic regression was used. Statistical significance was established at a p-value of less than 0.05.

Ethical aspects

The present study adhered to the principles of the 1983 Declaration of Helsinki as revised in 2013, based on research on human subjects [36]. The Ethics Committee of the Research Ethics Committee Semarang State Health Polytechnic gave their approval to the project with number 1062/EA/KEPK/2024. All subjects signed the informed consent forms before collecting the data.

RESULTS

Descriptive analysis of this study revealed diverse characteristics of the subjects (Table I). Regarding lifestyle, the majority (91.6%) of subjects did not smoke, most 66.9% had no exercise habit, and the majority (72.7%) also had low physical activity. In terms of nutritional status and body composition, less than half (42.2%) of the subjects were obese based on BMI, and most (85.7%) were at risk of metabolic syndrome based on WHR. The majority of subjects also had a high percentage of body fat (42.9%), and high visceral fat (50%). Subjects also had a higher proportion of low muscle mass (73.4%) based on ASMI. According to physical strength, more than half (55.2%) of the subjects showed low HGS in the dominant hand.

Table I: Characteristics of subjects

Variables	n	%
Smoking History		
Smoking	13	8.4
Not Smoking	141	91.6
Exercise Habit		
Exercise	51	33.1
Non Exercise	103	66.9
Physical activity		
Low (< 600 METs-min/week)	112	72.7
Moderate (≥ 600 - < 1500 METs-min/week)	19	12.3
High (≥ 1500 METs-min/week)	23	14.9
Body Mass Index (BMI)		
Underweight (< 18.5 kg/m^2)	4	2.6
Normal (≥ 18.5 - < 25.0 kg/m^2)	57	37.0
Overweight (≥ 25.0 - < 27.0 kg/m^2)	28	18.2
Obese (≥ 27.0 kg/m^2)	65	42.2
Waist-to-Hip Ratio (WHR)		
Normal (< 0.85)	22	14.3
High Risk (≥ 0.85)	132	85.7
Percent Body Fat (%BF)		
Normal (25% - 34.9%)	31	20.1
High (35.0% - 39.9%)	66	42.9
Very High (≥ 40%)	57	37.0
Visceral Fat (VF)		
Low (≤ 10 points)	77	50.0
High (> 10 points)	77	50.0
Appendicular Skeletal Muscle Index (ASMI)		
Low (< 5.85 kg/m^2)	113	73.4
Preserved (≥ 5.85 kg/m^2)	41	26.6
Dominant Hand Grip Strength (HGS)		
Low (< 18.6 kg)	85	55.2
Normal (≥ 18.6 kg)	69	44.8
Systolic Blood Pressure (SBP)		
Normotension (< 120 mmHg)	8	5.2
Prehypertension (120 mmHg – 139 mmHg)	39	25.3
Stage 1 Hypertension (140 mmHg – 159 mmHg)	50	32.5
Stage 2 Hypertension (≥ 160 mmHg)	57	37.0
Diastolic Blood Pressure (DBP)		
Normotension (< 80 mmHg)	25	16.2
Prehypertension (80 mmHg – 89 mmHg)	50	32.5
Stage 1 Hypertension (90 mmHg – 99 mmHg)	45	29.2
Stage 2 Hypertension (≥ 100 mmHg)	34	22.1
Total Cholesterol		
Normal (< 200 mg/dL)	18	11.7
Borderline (200 – 239 mg/dL)	60	39.0
High (≥ 240 mg/dL)	76	49.4
Fasting Blood Glucose (FBG)		
Normal (70 – 99 mg/dL)	104	67.5
Prediabetes (100 – 125 mg/dL)	30	19.5
Diabetes (≥ 126 mg/dL)	20	13.0
Probable Sarcopenia Status		
Sarcopenia	63	40.9
Non-Sarcopenia	91	59.1

Values are presented as frequency, n (%)

Regarding comorbidities, the three main comorbidities in this finding were hypertension, hypercholesterolemia, and diabetes. The proportions of stage 1 and 2 hypertension based on SBP were 32.5% and 37.0%, and based on DBP were 29.2% and 22.1%. In addition, nearly half of the subjects (49.4%) had high total cholesterol levels, and 13% had confirmed diabetes based on FBG. Finally, almost half (40.9%) of the subjects showed probable sarcopenia.

Table II presents the body composition characteristics and comorbidities between all study subjects, the group with sarcopenia, and the group without sarcopenia (non-sarcopenia). The data showed that the median age of the subjects in the sarcopenia and non-sarcopenia groups was 64 years (range: 60-69 years). Some characteristics that were found to be significantly different between the two groups were BMI, body fat percent, visceral fat, ASMI, and dominant HGS ($p<0.05$). Mean BMI, body fat percentage, visceral fat, ASMI, and dominant HGS were found to be lower in the sarcopenia group and vice versa.

Table II: Characteristics of body compositions and comorbidities between subjects

Variables	All subjects n = 154	Sarcopenia n = 63	Not Sarcopenia n = 91	p-value
Age (year)	64.08 (4)	64.00 (5)	64.00 (4)	0.685[b]
Body Mass Index (kg/m^2)	26.25±4.35	24.08±3.52	27.75±4.26	<0.001[a*]
Waist-to-Hip Ratio	0.92 (0.07)	0.91 (0.09)	0.92 (0.07)	0.747[b]
Percent Body Fat (%)	38.95 (5.5)	37.70 (5.4)	39.80 (4.6)	0.026[b*]
Visceral Fat (point)	10.50 (6.6)	8.5 (5.0)	12.00 (8.0)	<0.001[b*]
Appendicular Skeletal Muscle Index (kg/m^2)	5.40 (1.20)	4.90 (1.10)	5.70 (1.20)	<0.001[b*]
Dominant Hand Grip Strength (kg)	16.31±4.92	12.51±3.69	18.94±3.83	<0.001[a*]
Systolic Blood Pressure (mmHg)	150.91±20.98	150.63±20.54	151.10±21.38	0.893[a]
Diastolic Blood Pressure (mmHg)	90.00 (16)	88.00 (14)	92.00 (17)	0.098[b]
Total Cholesterol (mg/dL)	102.40±36.00	237.92±37.39	241.15±39.87	0.613[a]
Fasting Blood Glucose (mg/dL)	93.50 (19)	91.00 (16)	94.00 (23)	0.214[b]

Values are presented as mean±standard deviation and median (interquartile range/IQR) *: significant difference $p<0.05$; a: Independent-T Test; b: Mann-Whitney-U Test

Table III highlights the association between various characteristics, body components, and comorbidities with the incidence of sarcopenia. The data showed that there was a highly significant difference in proportion ($p<0.001$) between the sarcopenia and non-sarcopenia groups based on BMI category (obese and non-obese). The proportion of non-obese subjects was higher in the sarcopenia group than in the non-sarcopenia group, and vice versa for the obese group. As for the visceral fat variable, there was also a significant difference in proportion ($p<0.001$) between the sarcopenia and non-sarcopenia groups. The proportion of subjects with low visceral fat was higher in the sarcopenia group compared to the non-sarcopenia group, and vice versa for the group with high visceral fat.

Table III: Association between characteristics, body composition, and comorbidities with sarcopenia

Variables	Sarcopenia n (%)	Not Sarcopenia n (%)	p-value[a]
Smoking History			
Smoking	4 (30.8)	9 (69.2)	0.437
Not Smoking	59 (41.8)	82 (58.2)	
Exercise Habit			
Not Exercise	43 (41.7)	60 (58.3)	0.764
Exercise	20 (39.2)	31 (60.8)	
Physical activity			
Sedentary	45 (40.2)	67 (59.8)	0.763
Non-Sedentary	18 (42.9)	24 (57.1)	
Body Mass Index (BMI)			
Obese	26 (28.0)	67 (72.0)	0.000*
Non-Obese	37 (60.7)	24 (39.3)	
Waist-to-Hip Ratio (WHR)			
High Risk	54 (40.9)	78 (59.1)	1.000
Normal	9 (40.9)	13 (59.1)	
Percent Body Fat (%BF)			
High	48 (39.0)	75 (61.0)	0.343
Normal	15 (48.4)	16 (51.6)	
Visceral Fat (VF)			
High	21 (27.3)	56 (72.7)	0.001*
Low	42 (54.5)	35 (45.5)	
Systolic Blood Pressure (SBP)			
Hypertension	60 (41.1)	86 (58.9)	0.574[b]
Not Hypertension	3 (37.5)	5 (62.5)	
Diastolic Blood Pressure (DBP)			
Hypertension	50 (38.8)	79 (61.2)	0.218
Not Hypertension	13 (52.0)	12 (48.0)	
Total Cholesterol			
High	55 (40.4)	81 (59.6)	0.745
Normal	8 (44.4)	10 (55.6)	
Fasting Blood Glucose (FBG)			
Diabetes	16 (32.0)	34 (68.0)	0.119
Non Diabetes	47 (45.2)	57 (54.8)	

Values are presented as frequency, n (%) *: significant difference $p<0.05$; a: Chi-square Test; b: Fisher's Exact Test

The group with sarcopenia had lower proportions of BMI, body fat percentage, visceral fat, ASMI, and dominant HGS than the group without sarcopenia. The variables of smoking history, exercise habit, physical activity, WHR, body fat percentage, SBP, DBP, TC, and FBG showed no statistically significant difference in proportion ($p>0.05$) between the sarcopenia and non-sarcopenia groups.

Table IV presents the results of logistic regression analysis to identify whether obesity (based on BMI) is a risk factor for probable sarcopenia. Based on the logistic regression analysis, it can be concluded that obesity statistically significantly affects the odds of developing probable sarcopenia ($p<0.05$), which means that obesity is a risk factor for probable sarcopenia. Obese subjects had almost 4 times higher odds of developing probable sarcopenia compared to non-obese subjects. The 95% confidence interval that does not include a value of 1 (2.003 to 7.880) further strengthens the significance of this association.

Table IV: Logistic Regression Analysis of Obesity Risk Factors for Sarcopenia

Variable	B	p	OR (95% CI)*
BMI (Obesity)	1.379	<0.001	3.973 (2.003-7.880)

*Logistic Regression; B: (Coefficient of regression); OR (Odds ratio); CI (Confidence Interval)

DISCUSSION

General Discussion

Sarcopenia is one of the most common muscle dysfunctions encountered in female older adults. It can be diagnosed when the muscle functions below its expected level despite having adequate mass. This study was the first to investigate probable sarcopenia in older female adults (60–69 years) in Bogor City, revealing a high prevalence rate (40.9%), consistent with findings in other Asian populations (e.g., 15.7% in Chinese women [37]). The most significant risk factor that appears to be a common characteristic within the population is obesity. Notably, 42.2% are obese, and a large majority of those (85.7%) had a WHR indicating a high risk of metabolic disorder. Some authors have also mentioned that obesity, especially according to BMI, is one of the leading factors that could mostly be related to sarcopenia (OR 3.97 by logistic regression), a condition that is almost always accompanied by inflammation and insulin resistance [38,39]. Furthermore, the decline of grip strength (55.2% of subjects) and muscle mass was further strongly found to be the effect of sarcopenia, frailty, and disability [40,41]. Although hypertension (69.5% together stage 1 & 2) and dyslipidemia (49.4%) have been on the increase, they are long-standing problems in the aging population and an example of how metabolic syndrome entails end-organ dysfunction. Ultimately, these findings underscore the complex interplay of obesity, muscle decline, and metabolic dysfunction in aging, highlighting key targets for intervention.

Association of Sarcopenia and Obesity

The findings of this study suggest a complex relationship between sarcopenia and obesity. Although the sarcopenia group had a lower BMI, in line with other studies associating low BMI with sarcopenia risk [42–44]. The proportion of sarcopenia was also higher in the non-obese group. This contradiction with logistic regression results likely stems from the complex relationship between adiposity and muscle mass, explained by 'Sarcopenic Obesity' (SO). It is also known that obesity and sarcopenia in the elderly are pathophysiological syndromes and a bidirectional intertwining involved in the dysfunctional interaction between the adipose tissue and skeletal muscle [45,46]. In addition, obesity stimulates the dysfunction of adipose tissue, which elevates the levels of pro-inflammatory adipokines and intramyocellular fat, promoting mitochondrial dysfunction, insulin resistance, and excessive mitochondrial dysfunction, and this effect further enhances muscular atrophy via pro-inflammatory myokines [47]. SO leads to an elevated risk of disability, morbidity, and mortality [48].

While some studies provide a protective effect of obesity against sarcopenia based on grip strength [42], other studies show this increased risk of sarcopenia with high body fat [44,49]. This association seems to be dependent on the definition of obesity, as an association with obesity based on BMI is protective against sarcopenia. However, unlike BMI, a higher body fat percentage seems to increase the risk of sarcopenia [49]. Our study also found that those without sarcopenia tended to have higher BMI, body fat, and visceral fat, hinting at a possible protective effect. Our findings are also supported by a study that found a higher BMI is associated with a lower chance of experiencing sarcopenia (OR = 0.69), indicating that individuals with higher body weight may retain more muscle mass [49]. One study also supports our findings regarding visceral fat, which tends to be higher in the group without sarcopenia. The study revealed that moderate visceral fat thickness (VFT) may correlate with better muscle mass, thus serving as a protective factor against the risk of sarcopenia [50].

This study emphasises the importance of comprehensive body composition assessment to identify probable sarcopenia risk. Although low BMI is commonly associated with sarcopenia (Tables II & III), Table IV shows obesity (based on BMI) as a significant risk factor in logistic regression, indicating the complex effects of obesity on the development of probable sarcopenia, including potential worsening of muscle function through inflammation and insulin resistance. However, the relationship between obesity and probable sarcopenia requires further research with more detailed body composition measurements to understand SO and

other factors.

Limitations

Due to our study's design, which only captured a single point in time, we cannot definitively reveal whether obesity causes probable sarcopenia. Long-term studies are necessary to observe changes over time. Moreover, our findings may be specific to this particular group, and further research across diverse populations is required to confirm these results. We only identified body fat composition, such as visceral fat level and percent body fat, but not visceral fat thickness, which could probably be an alternative method for determining sarcopenia.

CONCLUSIONS

In conclusion, obesity is potentially an independent risk factor for the development of probable sarcopenia in addition to metabolic disease risk, particularly in female older adults. Comprehensive prevention strategies that focus on increasing physical activity through exercise that builds muscle strength, a combination of a nutritionally balanced diet, and regular and comprehensive assessment of body composition, muscle mass and function, in the clinical practice of obesity management are essential to define sarcopenia risk in order to reduce the risk of sarcopenia and improve health in high-risk populations.

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