ABSTRACT

Background: Nowadays, sarcopenia incidence is increasing along with the increment of the elderly population in the world. Sarcopenia is widely associated with obesity. As the prevalence in the elderly population rise, the relationship between sarcopenia and obesity can be assessed through the components of sarcopenia, including decreased muscle mass, muscles strength and physical performance (walking speed) and its relationship to body mass index and waist circumference to determine the sarcopenia obesity.

Aim: This study aims to determine the correlation between obesity and sarcopenia in adults and the geriatric population at Banjar Ujung Village, Kesiman, East Denpasar.

Method: This research is a cross-sectional study. The research subjects were the adult and geriatric population in Banjar Ujung Village who participated in social service activities in December 2018 and conducted consecutive sampling techniques.

Results: Total of 98 subjects, divided into 54 adult populations and 44 elderly population were included in this study subject criteria. In bivariate analysis, muscles strength had significant correlation with body mass index ($r = 0.32, P = 0.02$) and waist circumference ($r = 0.29, P = 0.03$). The walking speed also had significant correlation with with body mass index ($r = 0.26, P = 0.04$) whereas had no correlation with waist circumference ($r = 0.14, P = 0.18$) in the elderly population.

Conclusion: In the elderly population, muscles strength significantly correlates with body mass index but not waist circumference.

KEYWORDS

Obesity, Sarcopenia, Sarcopenia obesity, Muscles mass, Muscles strength, walking speed
(decreased muscle mass, muscles strength and physical performance). In recent years, several studies have been conducted to develop criteria for early screening, diagnosis, and management of sarcopenia. Early diagnosis and intervention are essential to decrease clinical conditions leading to poor outcomes. The prevalence of sarcopenia is currently said to be increasing due to the increasing elderly population around the world.[1,2] Several studies show that the prevalence of sarcopenia in the world today is 5-25% at the age of 66 to 70 years old and increased to 11-50% at the age of over 80 years.[3] Several studies conducted in Asia showed low prevalence in Hong Kong and Korea but showed high prevalence in Japan. Studies of sarcopenia in Asia are still too few compared to studies conducted in western countries.[4] Indonesia is the eighth largest country with a geriatric population and the fourth largest in Asia. A study by Setiati et al in 2011 found the prevalence of sarcopenia in the geriatric population was 33.99% in women and 38.3% in men.[5]

In recent years, the prevalence of obesity in the geriatric population has increased. In the United States, it reaches 30% in both genders aged 60 and above. In the aging process, the fat mass progressively increases. The rise in abdominal visceral fat and decreased subcutaneous abdominal fat are the signs of aging process. Baumgartner, in 2000 introduced the terminology sarcopenic obesity (SO), a condition characterized by the presence of low muscles mass and high body fat mass. Obesity sarcopenia is class II sarcopenia with central obesity (waist circumference ≥ 90 cm for men and ≥ 85 cm for women).[6] The exact number of sarcopenia prevalence is limited due to lack of definition and alteration of body composition value. In 14 years, prospective studies conducted in the elderly population (> 60 years) by the National Health and Nutrition Examination Survey (NHANES) III showed that the ratio of occurrence of obesity sarcopenia increases with age. Women are higher than men over 80%, with around 48% and 27.5%, respectively. In South Korea’s Korean Sarcopenic Obesity Study, a prospective cohort study with a healthy population sample of 20 to 80 years old, the prevalence of obesity sarcopenia range from 1.3-15.4% in men and 0.8-22.3% in women.[7]

The handgrip strength assessment is a physical strength examination, a quick test to assess muscle strength in general. We found that weak handgrip strength is associated with diabetes mellitus disease and several cardiometabolic risk factors in the elderly. In addition, the strength of the handgrip can predict the nutritional status of an individual. It would even identify neuromuscular abnormalities, i.e. spinal musculature atrophy, muscular dystrophy and sarcopenia in the elderly. However, the prevalence between muscle strength and obesity is unclear. Data from the InCHIANTI study showed 3.2 - 8.7% using weak knee extensor strength using both a high BMI and a wide waist circumference. Investigators from the Cardiovascular Health Study use low handgrip strength and high waist spasm to define decreased muscle mass and obesity. At the same time, data from FNIH classified 4.1% of men and 14% of women with obesity using high body mass index and decreased muscles strength. The study from Cruz Jentof et al. showed the strength of the handgrip as one of the indicators of sarcopenia. Handgrip strength measurements can be assessed quickly compared to dual-energy x-ray absorptiometry (DXA) and bioelectrical impedance (BIA) examinations. Based on the measurement of handgrip strength, the ratio of grip to body mass index can be used as a reference for the elderly population.[7] Limited studies were conducted in Indonesia to assess the relationship between sarcopenia components and obesity, general obesity using body mass index (BMI) and waist circumference to define central obesity. In this study, we conduct the relationship between obesity and sarcopenia in adult and elderly populations in order to determine the differences in each age group.

Method

Study Design

This cross-sectional design study was conducted in Banjar Ujung Village, Denpasar District, Bali Province, Indonesia, in December 2018.

Sample

Subject recruitment was conducted by inviting all 40 years old and above residing in Desa Banjar Ujung Kesiman. Subjects were included with the consecutive sampling method. Furthermore, data retrieval is carried out after obtaining informed consent from the subject. Inclusions criteria in this study are subjects more or equal to 40 years old and agreed to participate in this study. Exclusions criteria in this study are severe cognitive function impairment and cannot be interviewed due to socio-linguistic problems and/or aphasia.

Data collection

Data was collected through history taking, general physical examination, anthropometric measurements using a height measuring device and weight using a weight scale, then calculated manually using a calculator to get a body mass index, waist circumference using measurement in centimetre size. Handgrip strength measurement using digital handgrip dynamometer microFET brand on the dominant hand, walking speed measurement in 4.57 meters measured by stopwatch and muscles mass measurement using Bioelectrical Impedance Analysis (BIA) Omron HBF-375 Karada Scan brand. All process was carried out on the same day at the specified location.

Study Variable

The research variables analyzed in this study were determined based on previous studies and the clinical judgment of researchers. Obesity is an independent variable, while sarcopenia is a dependant variable.

Variable operational definition:

1. Sarcopenia is defined as a condition where there is a decrease in muscles mass, muscles strength assessed by the strength of the handgrip and a decrease in physical performance that is assessed by a decrease in walking speed.

a. Muscle mass was measured using Bioelectrical Impedance Analysis (BIA) brand Omron HBF-375 Karada Scan. Muscle mass is considered low in women aged 40-59 years if < 24.1; < 23.9 in women aged more than 60 years old; Muscle mass is considered low in men aged 40-59 years if < 33.1; < 32.9 in men aged more than 60 years old.

b. Muscles strength in this study assessed the strength of handgrip measured by digital handgrip dynamometer brand microFETs on dominant hands. The results were obtained in handgrip strength with kilogramms (kg). Handgrip strength is considered to decrease in men when handgrip strength is < 26 kg and <18 kg for women.
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1. Describes the characteristics of the study sample that consists of 114 people participated in this study. Ninety-eight people who met the inclusion criteria and were willing to participate in the study. The person needs to reach a distance of 4.57 meters. Walking speed is said to be decreased when the value is below 0.8 m/sec.

2. Central obesity is measured by measuring waist circumference using a meter, said to be central obesity when the waist circumference in men is more than equal to 90 cm and in women more than equal to 80 cm.

3. Obesity sarcopenia is defined as a sarcopenia condition with central obesity.

4. Body Mass Index (BMI) obtained by calculating weight in kilograms divided by height multiplied by height in units of meters and then classified into underweight (BMI < 18.5 kg/m2), normal (BMI 18.5 – 24.9 kg/m2), overweight (BMI 25.0 - 29.9 kg/m2) and obesity (> 30 kg/m2).

5. Gender determined based on the Identity Card (KTP)

6. The age stated in the year is determined based on the date, month and year of birth based on ktp. If the date of birth is unknown, we use December 31st as the year of the significant event occurs. In this study, we categorized the population into the adult population of 40 to 59.9 years old and the elderly population that is over 60 years old.

**Statistical analysis**

Data analysis used Statistical Package for the Social Science (SPSS) version 23.0 software. Mean and standard deviations were used to present numeric variables. Univariate analysis is used to present frequency and percentage data of categoric variables. Pearson correlation tests are used to test correlations bivariate between free and dependent variables.

**Results**

1. **Population Study Characteristic**

A total of 114 people participated in this study. Ninety-eight people who met the inclusion criteria and were willing to participate in the study were 54 adults and 44 older adults. Table 1 describes the characteristics of the study sample that consists of gender, body mass index, muscles mass, waist circumference, muscles strength and walking speed.

The sample consisted of 33 male participants (33.7%) and 65 female (66.3%). Based on BMI values of the entire population group, 54.1% was classified as normal, 30.6% was classified as overweight and 8.2% obese.

2. **Prevalence of obesity and sarcopenia in adult and elderly populations**

Obesity, according to BMI in this study, was only found in 14% in the adult population and 0% in the elderly population. However, in the elderly population, 68% was central obesity. The characteristics of the sarcopenia parameter in this study consisted of decreased muscle mass, muscle strength, and walking speed. Sarcopenia in this study was more common in the elderly than adults (79.5% vs 44.4%). This is supported by the prevalence of decreased muscles mass in the elderly compared to adults with considerable value (95% vs 55%), decreased muscles strength (50% vs 11%) and a decrease in walking speed that is not much different between the elderly and adult populations (75% vs 74.11%). In this study, we found that the prevalence of obesity sarcopenia in the elderly population is higher than adult population (54.5% vs 42%).

3. **Correlation between obesity and sarcopenia in adult and elderly populations**

Pearson correlation test (bivariate) is used to test the correlation between muscles mass, muscles strength and walking speed against BMI and waist circumference. Table 3 shows Pearson correlation test results. In this study, in the adult population muscles mass has a negative correlation ($r = -0.17$, $p = 0.11$) with BMI, while in the elderly population muscles mass has a positive correlation but not significant both with BMI ($r = 0.01$, $p = 0.48$) and waist circumference ($r = 0.11$, $p = 0.24$).

In the elderly population, muscles strength has a significant positive correlation to BMI ($r = 0.32$, $p = 0.02$) and waist circumference ($r = 0.29$, $p = 0.03$). Walking speed in the elderly population has a significant positive correlation to BMI ($r = 0.26$, $p = 0.04$) and positive correlation but not significant to waist circumference ($r = 0.14$, $p = 0.18$). In the total population of the study, muscles strength has a significant positive correlation to BMI ($r = 0.28$, $p = 0.002$) and waist circumference ($r = 0.24$, $p = 0.007$). Walking speed in the total population indicates significant positive correlation to BMI ($r = 0.35$, $p < 0.01$).

**Discussion**

In geriatric populations, it is said that BMI measurement is not reliable in assessing obesity, using measurement of waist circumference and measurement of body composition as parameters has more meaning than BMI in geriatric populations, and this may be due to the aging process that is always followed by a progressive loss of muscles mass and muscles strong and also an increase in fat mass even in individuals with a normal BMI.[8] A study by Seo et al. in Korea in 2015 showed that the prevalence of general obesity and central obesity has a peak value in the population between age 60 to 70 and decrease after that age. According to the National Health Insurance Service, the frequency of obesity between ages of 70 and 79 increased from 37.6% in 2006 to 36.6% in 2015, and in the age of more than 80 years old, the frequency of obesity increased from 21.9% in 2006 to 27.5% in 2015. The corresponding data showed that central obesity is found generally in geriatric populations compared to adulthood (40-49 years).[9] In a prospective cohort study conducted in South Korea, the Korean Sarcopenic Obesity Study on healthy individuals with a range of age 20-80 years found the prevalence of obesity sarcopenia between 1.3–15.4% in males and 0.8%–22.3% in females.[7] Makasazu et al. research in 2019 with 117 subjects showed a significant decline in handgrip strength in both groups of sarcopenia and obese sarcopenia compared to the normal group and obesity only group ($p < 0.05$). However, the walking speed has no association in the sarcopenic obesity and sarcopenia group.[10] In 2017, a study in Brazil by Santos et al. involving 116 subjects between 80 and 95 years old found that sarcopenic obesity increases the risk of slower walking speed and mobility disorders in the population over 65 years; this study is supported by Stenholm et al.’s research. Several risk factors can influence the occurrence of sarcopenic obesity in geriatric populations; for instance, is insulin resistance. Sarcopenic obesity increases the risk of metabolic syndrome in the Korean population. However, the study only examined muscles mass instead of muscles strength.[11]
### Table 1 Population study characteristic

| Characteristics                              | Adult (n=54) | Elderly (n=44) | Total (n=98) |
|----------------------------------------------|--------------|----------------|--------------|
| **Gender, n (%)**                            |              |                |              |
| Male                                         | 14 (42.4)    | 19 (57.6)      | 33 (33.7)    |
| Female                                       | 40 (61.5)    | 25 (38.5)      | 65 (66.3)    |
| **Body mass index (kg/m2)**                  |              |                |              |
| Underweight                                  | 0 (0)        | 7 (100)        | 7 (7.1)      |
| Normal                                       | 26 (49.1)    | 27 (50.9)      | 53 (54.1)    |
| Overweight                                   | 20 (66.7)    | 10 (33.3)      | 30 (30.6)    |
| Obese                                        | 8 (100)      | 0 (0)          | 8 (8.2)      |
| **Waist circumference (cm)**                 | 88.89±8.33   | 86.63±8.41     | 87.87±8.4    |
| Muscles mass (%)                             | 25.42±3.45   | 23.96±3.32     | 24.77±3.45   |
| Muscles strength (kg)                        | 29.10±10.17  | 22.76±8.51     | 26.25±9.9    |
| Walking speed (m/min)                        | 0.69±0.12    | 0.57±0.18      | 0.64±0.16    |

1 Mean±SD  2 Measured by BIA

### Table 2 Prevalence of obesity and sarcopenia in adult and elderly populations

|                          | Adult (n=54) | Elderly (n=44) | Total (n=98) |
|--------------------------|--------------|----------------|--------------|
| **Obesity (BMI)**        | 14.8%        | 0              | 8.2%         |
| Central obesity (waist circumference) | 83%          | 68%            | 76.5%        |
| **Sarcopenia**           | 44.44%       | 79.5%          | 60.2%        |
| Decreased Muscles Mass (%)| 55%          | 95%            | 73.5%        |
| Decreased Muscles strength (kg) | 11.11%      | 50%            | 28.6%        |
| Decreased Walking speed (m/s) | 74.1%       | 75%            | 74.5%        |
| Sarcopenic obesity       | 42.6%        | 54.5%          | 48%          |

### Table 3 Correlation between obesity and sarcopenia

|                          | Adult (r;p) | Elderly(r;p) | Total (r;p) |
|--------------------------|-------------|--------------|-------------|
|                          | BMI         | WS           | BMI         | WS           | BMI         | WS           |
| **Muscles mass**         | -0.17;0.11  | 0.05;0.36    | 0.01;0.48   | 0.11;0.24    | 0.03;0.40   | 0.10;0.16    |
| **Muscles strength**     | 0.04;0.39   | 0.17;0.11    | 0.32;0.02*  | 0.29;0.03*   | 0.28;0.002* | 0.24;0.007*  |
| **Walking speed**        | 0.16;0.12   | 0.04;0.37    | 0.26;0.04*  | 0.14;0.18    | 0.35;<0.01* | 0.12;0.10    |

*p-value means
In bivariate analysis, our study has failed to show the relationship between muscles mass and BMI levels and waist circumference in adult and elderly populations; it explains that several factors contribute to the aging processes, such as deterioration of neuromuscular structure and function, including loss of muscles mass, decreased alpha motor neurons, low levels of steroid hormones decreased protein intake and decreased physical activity.[12,13] Mark et al. reported that intramuscular adipose tissue is inversely related to physical performance in old age. Aging changed the proportion of type I muscles fibres to type II muscles fibre, called muscles fibre atrophy.[14]

The study also showed a significant correlation between muscles strength and BMI or waist circumference. On the other hand, the study conducted by Valenzuela et al. involving 203 obese individuals 18 to 75 years old showed that muscles strength and BMI do not correlate with adult and elderly populations.[13] Aging process of muscles strength is caused by a decrease in contractile protein (loss in muscles fibres caused by changes in muscles and or neurons), reducing muscles ability would change the length of muscles fibres and alter the central nervous system normalize motor neuron unit.[13] Studies from Keevil et al. involving 8844 subjects with an age range of 48 to 92 years old showed that handgrip strength increased in the normal BMI and overweight whereas plateau in the obesity group.

Studies from Keevil illustrated an inverse correlation between muscles strength and waist circumference, with each 10 cm increase in waist circumference followed by a decrease in muscles strength of 3.56 kg. BMI stretches the difference in body size and composition associated with increased muscle strength while the waist circumference difference is related to decreased muscle strength, such as central obesity. The increase in central obesity is something that negatively affects muscles strength. Abdominal fat secretes cytokines and hormones called adipokine, for instance, TNF-α, IL-6, adiponectin, leptin and resisting. Adipokine is necessary for immunomodulation, inflammatory response, energy, fatty acids and glucose metabolism; dysregulation occurs when central obesity or abdominal obesity is present. An observational study showed that an interaction between inflammation and increased plasma fasting glucose leads to decreased muscle strength.[15]

The study also showed a significant correlation between walking speed and BMI but did not correlate with waist circumference in geriatric populations. These findings contradict those conducted by Stoever et al. in 2017, which showed a stronger correlation between muscles mass index and walking speed compared to muscles strength. A study from Krause et al. also showed a strong positive correlation between muscles mass and muscles grip strength but not with walking speed.[16] The same results were also shown by a study from Teguo et al., this study showed that from 1002 study subjects over 65 years old, walking speed and BMI had no significant correlation, slower walking speed was found in subjects that were overweight, overweight and obese compared to patients with normal BMI. BMI value represents the risk factors of reduction in walking speed, sensitivity to stressors and having negative outcomes in the elderly population. Overweight and obesity are associated with sarcopenia. Reduced walking speed in individuals with spontaneous obesity occurs due to impairment of balance and fatigue. Excessive adipose tissues can alter the optimal ratio of lean mass and affect the quality and function of skeletal muscles.[17]

This study is not a longitudinal study that explains the causal relationships. Furthermore, the population of this study is limited to rural areas in Kesiman, which does not generally represent any races, topography, or lifestyle.

Based on these limitations, it is necessary to conduct further longitudinal studies with larger geriatric population coverage to elaborate on the causal relationship and give a broad generalization. Adding several other biomarkers that determine the risk factors for obesity sarcopenia in geriatrics is suggested.

**Conclusion**

This study shows that certain components of sarcopenia correlate with obesity, using both body mass index and waist circumference to determine central obesity. In this study, muscle strength reduction as a component of sarcopenia correlates to body mass index and waist circumference in the elderly population but not in the adult population. Slower walking speed in the elderly is related to body mass index compared to waist circumference. There is no correlation between muscle mass to body mass index and waist circumference in adult and elderly populations, which makes this study interesting. Reduction in muscle mass and strength is influenced by several factors, including physical inactivity and dependency towards others in daily life, resulting in an increased fall and mortality risk. Therefore, with this study, it is expected that early screening of sarcopenia in the elderly population should always be carried out to lower the risk of falls and reduce mortality rates.

**Conflict of Interest:**

No conflict of interest.

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