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Correlation Between Body Mass Index and Calf Circumference in Assessing the Nutritional Status of the Elderly

[1]Cecilia Antolin, [2]Meilani Kumala

[1]Medical Study Program, Faculty of Medicine, Tarumanagara University, Jakarta
[2]Department of Nutrition, Faculty of Medicine, Tarumanagara University, Jakarta

Corresponding author: Cecilia Antolin, e-mail: cecilia.405220110@gmail.com
Co-author: MK; Meilani Kumala, e-mail: meilanik@fk.untar.ac.id,
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Abstract

An increase in fat mass and a decrease in muscle mass are common physiological changes observed in the elderly. The loss of muscle mass increases the risk of sarcopenia, which negatively affects physical function. Therefore, accurate assessment of nutritional status in the elderly is essential. Body Mass Index (BMI) is commonly used; however, it cannot distinguish between fat mass and muscle mass. Calf circumference serves as a simple and practical anthropometric alternative to estimate muscle mass but does not reflect fat mass. The combination of both measurements has respective strengths and limitations in determining nutritional status. This study aims to determine the correlation between BMI and calf circumference in assessing the nutritional status of elderly individuals aged ≥46 years. This research employed an analytical observational design with a cross-sectional approach, conducted at three locations during the 2024–2025 period. A total of 75 respondents who met the inclusion and exclusion criteria were included. Data were obtained through measurements of height, weight, and calf circumference. The analysis showed a significant correlation between BMI and calf circumference ($p < 0.05$). Conclusion: Calf circumference can serve as an important additional indicator in assessing the nutritional status of the elderly. The significant correlation between BMI and calf circumference found in this study highlights that both parameters can serve as simple and practical indicators for evaluating the nutritional status of the elderly. Using both measurements together may enhance early detection of nutritional problems, particularly those related to muscle mass loss in the elderly population.

Keywords: Body mass index; Calf circumference; Elderly; Nutritional status

Introduction

The elderly population is projected to increase steadily over the years. According to Statistics Indonesia (Badan Pusat Statistik), life expectancy in Indonesia reached 70.17 years for men and 74.18 years for women in 2023. (Badan Pusat Statistik Indonesia, 2023) The aging process is characterized by physical changes, including an increase in body fat mass and a decrease in skeletal muscle mass, which may lead to sarcopenia. (Hajek et al., 2015)Previous studies have reported that the prevalence of sarcopenia among older adults in Indonesia ranges from 9.1% to 59%.(Rahayu et al., 2023)

According to the Asian Working Group for Sarcopenia 2019 (AWGS'19), calf circumference measurement can be used as an indicator of muscle mass in older adults. Calf circumference is a non-invasive, simple, and cost-effective

anthropometric method. (Piodena-Aportadera et al., 2022) Previous studies have shown that a calf circumference of less than 31 cm serves as a reliable clinical indicator for diagnosing sarcopenia. (NurAsyura, 2016.)Sarcopenia in older adults is closely associated with malnutrition; however, those with overnutrition are also at greater risk of developing various other diseases. (Xu et al., 2022)

The prevalence of obesity among older adults in Indonesia is approximately 18.8%, with the highest proportion found in the 55–64 age group (23.1%). (N K Retno Triandhini et al., 2018) Nutritional status is commonly assessed using Body Mass Index (BMI), calculated from height and weight. (Wang et al., 2023) According to the Asia-Pacific cut-off values, undernutrition is defined as a BMI <18.5 kg/m², while overnutrition is defined as a BMI ≥23 kg/m². (Ren et al., 2022) However, BMI does not account for fat-free mass. (Prof et al., 2000) In some cases, older adults may present with a normal BMI yet have a disproportionately high percentage of body fat compared to muscle mass.(Gill et al., 2015) Furthermore, BMI derived from inaccurate height measurements (e.g., due to spinal deformities such as kyphosis) may lead to misclassification of nutritional status. (Raymond & Morrow, 2012.) Therefore, additional clinical assessments are required to ensure accuracy. According to the Mini Nutritional Assessment–Short Form (MNA-SF), calf circumference measurement is included as one of the indicators used to assess nutritional status in the elderly. (Permana Ratumanan & Feinisa Khairani, 2022) Previous studies have reported that calf circumference reflects changes in fat-free mass with aging, thus serving as an important measure to prevent malnutrition among older adults. (Carrier et al., 2019)

Both BMI and calf circumference are simple anthropometric indicators used to assess nutritional status. However, their relationship in reflecting the nutritional condition of the elderly remains to be clarified. Therefore, this study aims to determine the correlation between BMI and calf circumference in assessing the nutritional status of elderly individuals. Research investigating the relationship between BMI and calf circumference in this population remains limited; therefore, the present study seeks to explore the prevalence of BMI and calf circumference among older adults, described according to their distribution in individuals aged ≥46 years.

Methods

This study employed an analytical-observational design with a cross-sectional approach to examine the correlation between Body Mass Index (BMI) and calf circumference in determining the nutritional status of older adults aged ≥46 years. The research was conducted at three sites: Panti Werdha Wisma Mulia, Panti Werdha Bina Bhakti, and Rumah Misi PTB during the period of 2024–2025. The study population comprised older adults aged ≥46 years residing in the study sites who met the inclusion (elderly individuals aged ≥46 years) and exclusion criteria (elderly individuals who are bedridden or require a wheelchair for mobility). A total of 75 respondents were enrolled, consisting of 24 men and 51 women using simple random sampling. The instruments included a self-administered questionnaire covering demographic data, dietary intake (2 × 24-hour recall), medical history, as well as BMI and calf circumference measurements. BMI is categorized into five groups: underweight (<18.5 kg/m^2), normal (18.5-22.9 kg/m^2), overweight (23-24.9 kg/m^2), obese I (25-29.9 kg/m^2), and obese II (≥30 kg/m^2). Calf circumference is divided into two categories: low (<31 cm) and normal (≥31 cm).

BMI was derived from weight and standing height measurements, utilizing a digital scale for weight (with the respondent in an erect, forward-facing position) and a microtoise for height. Calf circumference was measured using a

measuring tape at the widest part of the calf while the respondent was seated with their knees bent at a 90-degree angle and their feet flat on the ground. The digital scale is placed on a flat, hard surface and ensured to start at "0.0," while the microtoise is ensured to be made of non-stretchable material and installed to encircle the widest part of the calf.Data collection was conducted using primary sources, and the statistical association was analyzed through Spearman's Rho Correlation and scatter plot for visual interpretation.

Results

Based on nutritional status, all male respondents (13 individuals; 17.3%) were classified as having normal nutritional status, and none were found to have class II obesity. Among female respondents, 24 individuals (32%) had normal nutritional status, while only two (2.7%) were classified as having class II obesity.

Table 1. Distribution of Respondents Characteristics Based on BMI in Males and Females

	BMI					
	Underweight	**Normal**	**Overweight**	**Obese 1**	**Obese 2**	**Total**
Male	2 (2.7%)	13 (17.3%)	1 (1.3%)	8 (10.7%)	0 (0%)	24 (32%)
Female	11 (14.7%)	24 (32%)	5 (6.7%)	9 (12%)	2 (2.7%)	51 (68%)
Total	13 (17.3%)	37 (49.3%)	6 (8%)	17 (22.7%)	2 (2.7%)	75 (100%)

Table 2 below shows that the majority of male respondents, 16 individuals (21.3%), had a normal calf circumference, while the majority of female respondents, 31 individuals (41.3%), also had a normal calf circumference.

Table 2. Distribution of Respondents Calf Circumference Characteristics in Males and Females

	Calf Circumference	
	Low	**Normal**
Male	8 (10.7%)	16 (21.3%)
Female	31 (41.3%)	20 (26.7%)
Total	39(52%)	36 (48%)

Table 3 below is a table showing the caloric intake on the first and second day among male and female elderly participants. The results show that a large proportion of the elderly had insufficient caloric intake on the first day, with 41 respondents (54.7%), and on the second day, 31 respondents (41.3%) were found to have insufficient caloric intake.

Table 3. Characteristics of Caloric Intake Levels on the First and Second Day

Caloric Intake Level	**Frequency on the First Day (%)**	**Frequency on the Second Day (%)**
Adequate	8 (10,6%)	14 (18,7%)
Insufficient	41 (54,7%)	31 (41,3%)
Excessive	26 (34,7%)	30 (40 %)
Total	75 (100%)	75 (100%)

Table 4 Based on the table below, a total of 28 respondents (37.7%) had a history of hypertension, 21 respondents (28%) had type II diabetes, and 6 respondents (8%) had gout. From these results, the majority of respondents had a history of hypertension.

Table 4. Characteristics of Respondents Medical History

Medical History	Frequency	Prescentage (%)
Hypertension		
Yes	28	37,3
No	47	62,7
Type II Diabetes Mellitus		
Yes	21	28
No	54	72
Gout		
Yes	6	8
No	69	92

Based on the Spearman's rho correlation test, a correlation was observed between calf circumference and Body Mass Index (BMI) among male respondents (n = 24). P-value < 0.01 indicated a statistically significant correlation. The R^2 value of 0.510 demonstrated a statistically relevant association, while the correlation coefficient of 0.744 indicated a strong positive correlation.

Table 5. Correlation Between BMI and Calf Circumference Among Male Respondents

Paramater			Calf Circumference	BMI
Spearman's rho	Calf Circumference	*Correlation Coefficient*	1.000	.744
		Sig. (2-tailed)	.	<.001
		N	25	24
	BMI	*Correlation Coefficient*	.744	1.000
		Sig. (2-tailed)	<.001	.
		N	24	24

*** Correlation is significant at the 0.01 level (2-tailed).*

Based on the scatter plot, a correlation was observed between calf circumference and Body Mass Index (BMI) among male respondents, in which a larger calf circumference was associated with a higher BMI value. The 95% confidence interval for the correlation coefficient ranged from 0.477 to 0.885.

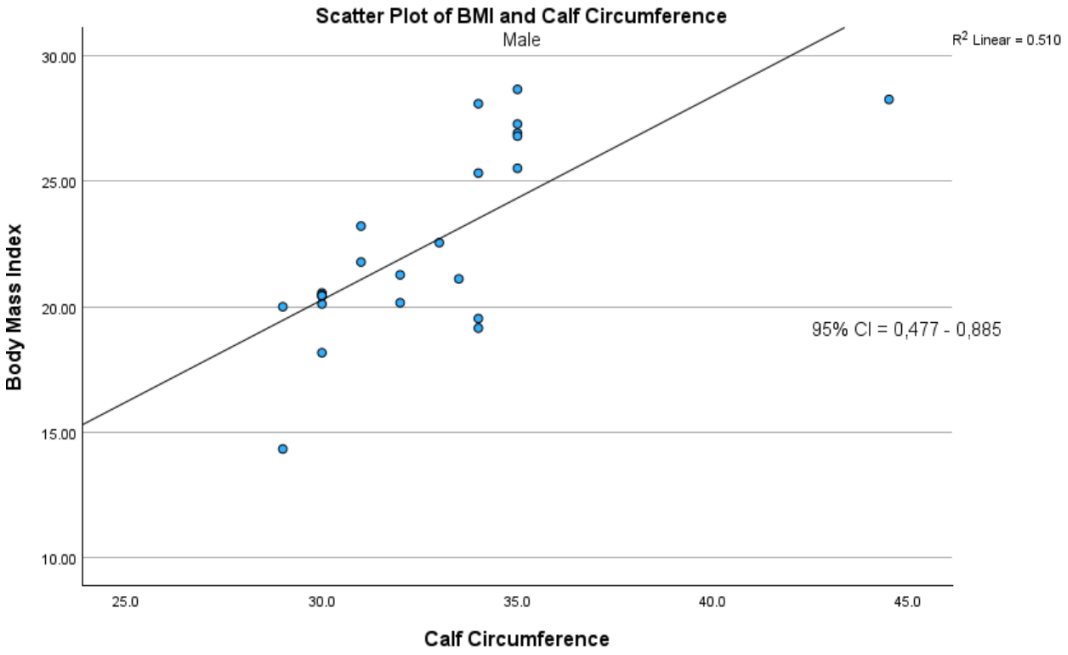

Figure 1. Scatter Plot of Body Mass Index and Calf Circumference in Male Respondents

Based on the Spearman's rho correlation test, a correlation was found between calf circumference and Body Mass Index (BMI) among female respondents (n = 51). A p-value < 0.01 indicated a statistically significant correlation. The R^2 value of 0.627 demonstrated a statistically relevant association, while the correlation coefficient of 0.822 indicated a strong positive correlation.

Table 6. Correlation Between BMI and Calf Circumference Among Female Respondents

Paramater			Calf Circumference	BMI
Spearman's rho	Calf Circumference	*Correlation Coefficient*	1.000	.744
		Sig. (2-tailed)	.	<.001
		N	25	24
	BMI	*Correlation Coefficient*	.744	1.000
		Sig. (2-tailed)	<.001	.
		N	24	24

*** Correlation is significant at the 0.01 level (2-tailed).*

Based on the scatter plot, a correlation was observed between calf circumference and Body Mass Index (BMI) among female respondents, in which a larger calf circumference was associated with a higher BMI value. The 95% confidence interval for the correlation coefficient ranged from 0.702 to 0.896.

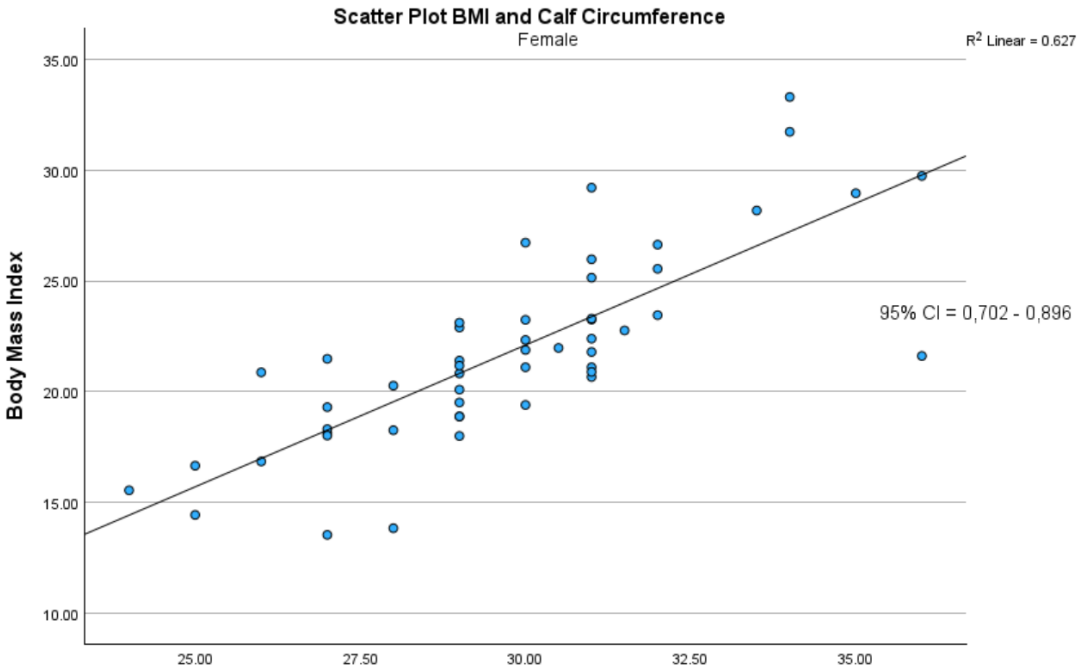

Figure 2. Scatter Plot of Body Mass Index and Calf Circumference in Female Respondents

Discussion

Based on the findings, 37 respondents (49.3%) were classified as having normal nutritional status, consisting of 24 females and 13 males. In line with previous studies, 16 respondents (55.2%) were found to have a normal BMI. (Putra & Febianingsih, 2019) The distribution of Body Mass Index (BMI) among the total 75 respondents, encompassing both males and females, showed that the majority had a normal BMI, 37 respondents. Generally, aging adults tend to have a shorter stature due to physiological aging factors, which can result in less accurate measurements when using a microtoise. However, other influencing factors, such as physical activity and adequate dietary intake, were observed. (Carrier et al., 2019) The majority of respondents maintained a monitored intake and engaged in routine physical activities within the nursing home, as obtained through direct questionnaires administered to the respondents. Consequently, the BMI measurements performed still demonstrated a strong and consistent correlation in the determination of the elderly individual nutritional status.

A significant correlation was found between BMI and calf circumference ($p < 0.05$) in both males and females. This correlation was established through direct measurements of calf circumference, height, and body weight. The findings indicate that a higher BMI is generally accompanied by a larger calf circumference, which is associated with increased muscle mass. This is in line with previous research suggesting that calf circumference is a simple and useful indicator for predicting frailty in older adults living in the community. Respondents with a low calf circumference tended to have lower BMI and inadequate nutritional intake, reflecting a state of malnutrition. (Carrier et al., 2019) Consistent with earlier studies, malnutrition accompanied by a loss of fat-free mass in older adults contributes to reduced metabolic reserves, underscoring the essential role of muscle in maintaining body function. Thus, calf circumference was found to be significantly correlated with BMI.

Although both Body Mass Index (BMI) and calf circumference are anthropometric indicators used to assess nutritional status, they represent different physiological components. BMI reflects general body composition but cannot differentiate between fat mass and muscle mass, whereas calf circumference predominantly represents muscle mass due

to the dominance of skeletal muscle in the calf region. In this study, the correlation between BMI and calf circumference was analyzed to determine whether BMI, despite its limitations, is still associated with indicators of muscle mass in the elderly. The findings revealed a significant correlation between the two parameters, suggesting that BMI remains relevant as a simple nutritional indicator, while calf circumference provides complementary information regarding muscle mass status. Together, these measurements may offer a more comprehensive understanding of nutritional assessment in older adults.

Several limitations of this study should be noted. First, the sample size was relatively small due to time constraints, and difficulties in scheduling data collection with the nursing homes, which may have affected the accuracy of the results. Second, the data collection process relied on direct interviews with older adult respondents, in which the validity of responses was limited by age-related memory decline.

Conclusion

This study demonstrated a significant correlation between body mass index (BMI) and calf circumference in older adults. Among the male respondents, 13 were classified as having normal nutritional status, while 10 were categorized as overweight to obesity class II. In the female group, 24 respondents had normal nutritional status, and 16 were classified as overweight to obesity class II. Regarding calf circumference, 8 male respondents had a measurement of less than 31 cm, while 16 had a normal calf circumference (≥31 cm). In the female group, 31 respondents had a calf circumference of less than 31 cm, whereas 20 had a normal calf circumference (≥31 cm). In conclusion, there was a statistically significant correlation (p-value < 0.05) between BMI and calf circumference among older adults aged ≥46 years, in both male and female respondents.

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Author Contribution and Competing Interest

The author independently carried out the entire research process, starting from conceptualization, data collection, analysis, and interpretation of results, to manuscript writing. The supervisor was involved throughout the writing process. The author declares no competing interests.

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