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The Correlation Between Sarcopenia and Metabolic Syndrome in Elderly Patients At The Geriatric Outpatient Clinic of Wangaya Regional General Hospital in Denpasar

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Abstract

This is an observational study with a retrospective approach conducted using medical record data from geriatric polyclinic patients at Wangaya Hospital from December 2025 to February 2026. Samples were obtained using the total sampling method from medical records. This study included patients over 65 years of age who had measurements of weight, height, SARC-F value, and hand grip strength. The diagnosis of sarcopenia and its components (high SARC-F, low hand grip strength, low muscle mass index, and sarcopenia) were associated with the incidence of metabolic syndrome. Data are presented as numerical values, percentages, and prevalence ratio (PR) accompanied by a 95% confidence interval (CI). Statistical testing was performed using the Fisher Exact Test, with significance set at $P < 0.05$. Bivariate analysis was conducted to examine the association of each component with metabolic syndrome. The results show that hand grip strength (PR 0.55, CI 0.14–1.01, P = 0.05) has an almost significant relationship, and low muscle mass index (PR 0.55, CI 0.08–0.91, P = 0.04) has a significant relationship with metabolic syndrome. Other components, such as SARC-F score (PR 0.55, CI 0.13–1.20, P = 0.10) and sarcopenia (PR 0.48, CI 0.07–1.79, P = 0.28), did not show a significant association with metabolic syndrome. The findings are not conclusive. Further research is recommended using a larger sample size and standard reference methods such as dual-energy X-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA), computed tomography (CT), or magnetic resonance imaging (MRI) to calculate muscle mass.

INTRODUCTION

The aging process is a natural phase in human life. Although the process of human aging is very diverse and complex, this diversity is characteristic of the elderly population. The elderly can be defined as a population aged 65 years and above in developed countries and 60 years and above in developing countries. According to the World Health Organization (WHO) (Singh & Bajorek, 2014), in 2020 there were an estimated 1 billion people over the age of 60, and it is estimated that by 2030 this will increase to 1.4 billion (1 in 6 people will be 60 years old or older) and will increase again to 2.1 billion by 2050 (World Health Organization, 2025; Central Statistics Agency, 2024). In Indonesia itself, based on the Central Statistics Agency in 2024, 12% of Indonesia's population is elderly (Handajani et al., 2024). At the research site, namely Wangaya Hospital Denpasar, the number of geriatric patient visits at the geriatric polyclinic during December 2025–February 2026 was 982; therefore, researchers were interested in conducting research at this hospital.

Sarcopenia is defined as a progressive and pervasive skeletal muscle disorder associated with an increased likelihood of adverse outcomes such as falls, fractures, physical disability, and death. Sarcopenia generally occurs in the elderly population and is one of the main sources of health problems for the elderly (Papadopoulou, 2020; Shafiee et al., 2017). It is estimated that 10%–16% of the elderly worldwide experience sarcopenia. A study in China with a population of 6,172 participants aged 60–94 found that the prevalence of sarcopenia, intermediate sarcopenia, and severe sarcopenia was 38.5%, 18.6%, and 8.0%, respectively (Cruz-Jentoft et al., 2019; Papadopoulou, 2020; Yuan & Larsson, 2023).

Metabolic syndrome is a diverse set of conditions that increase the risk of stroke, heart problems, and diabetes. Metabolic syndrome can be assessed using several factors such as obesity levels, blood glucose, blood pressure, and cholesterol parameters. Muscles are known to play a strong role in glucose metabolism through insulin, where the loss of muscle mass is associated with insulin resistance and metabolic syndrome (Collins et al., 2018; Kim & Park, 2018). In patients with sarcopenia, there is a loss of muscle mass that is often replaced by fat. This condition is frequently associated as a risk factor for metabolic syndrome (National Heart Lung and Blood Institute, 2022; Nishikawa et al., 2021).

The novelty of this study lies in several aspects. First, this study is the first to examine the correlation between sarcopenia and metabolic syndrome in elderly people in Bali using medical records from Wangaya Hospital, Denpasar. Second, this study analyzes each component of the sarcopenia diagnosis (high SARC-F, low hand grip strength, low muscle mass index) separately, rather than just the overall sarcopenia diagnosis (Murat et al., 2021). Third, this study identifies discrepancies between SARC-F scores and hand grip strength in an elderly population with certain comorbidities. Fourth, this study uses the Lee formula adapted for Asian populations as an alternative measure of muscle mass in settings with limited facilities (Lee et al., 2024; Voulgaridou et al., 2024; White et al., 2019; Yang et al., 2019).

The aim of this study was to determine the correlation between sarcopenia and metabolic syndrome in elderly patients at the geriatric clinic of Wangaya General Hospital, Denpasar. Specifically, this study aimed to: (1) identify the prevalence of each component of sarcopenia (high SARC-F, low hand grip strength, low muscle mass index, and sarcopenia) in the sample; (2) analyze the correlation of each component of sarcopenia with metabolic syndrome; (3) compare the findings with previous studies; and (4) identify the limitations of the use of SARC-F and Lee's formula in the elderly population with comorbidities.

METHOD

Research sample

This study is an observational research with a retrospective approach, this study was conducted using medical record data on geriatric polyclinic patients at Wangaya Hospital from December 2025 to February 2026. Samples were taken using *the total sampling* method obtained from medical records. In this study, the researcher took samples from patients over the age of 65 years who had an examination of weight, height, SARC F value, and hand grip strength.

Criteria for diagnosis of sarcopenia

The criteria for establishing the diagnosis of sarcopenia are based on the European Working Group on Sarcopenia in Older People (EWGSOP). Diagnosis enforcement is carried

out in stages by scoring Strength, Assistance with walking, Rise from a chair, Climb stairs, and Falls (SARC-F) for screening where a score of ≥4 is suspected as sarcopenia, then grasping strength to determine muscle function where a value of <27 kg in men or <16 kg in women is assessed as muscle weakness and (Cruz-Jentoft et al., 2018) appendicular skeletal muscle mass (ASMM) to find out the patient's muscle mass that can be calculated with the Lee formula (ASMM = 0.244 x BB (in kg) + 7.8 x TB (in m) + 6.6 (if male) – 0.098 x age – 4.5 (in Asian race)). This ASMM will then be changed to (Lee et al., 2000) a muscle mass index (MMI) where in men <7.0 kg/m2 is considered low and in women <5.5 kg/m2 is considered low. The way the diagnosis of Sarcopenia is established can be seen in **Figure 1** (Cruz-Jentoft et al., 2018).

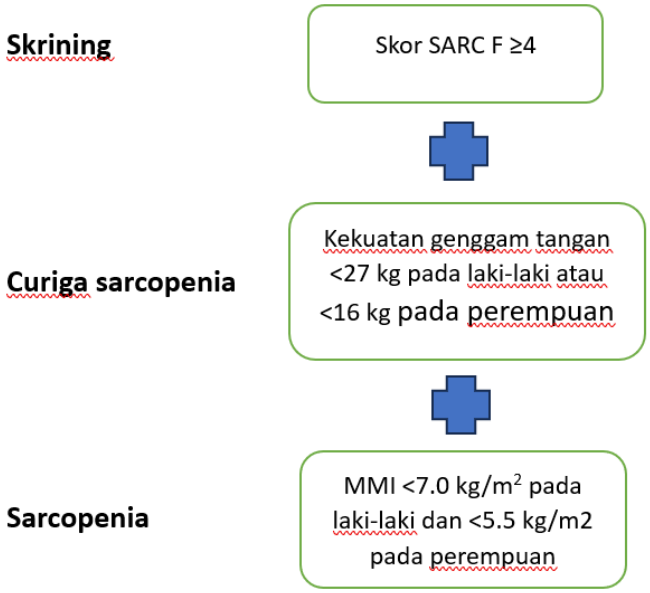

Figure 1. Flow of diagnosis of sarcopenia

Criteria for diagnosis of metabolic syndrome

Metabolic syndrome is a collection of factors that can increase the risk of cardiovascular and metabolic diseases which include insulin resistance, central obesity, dyslipidemia, and hypertension (Mohamed et al., 2023). There are several criteria that can be used to diagnose metabolic syndrome. One of them is that at least 3 out of 5 criteria are met, namely obesity, problems with sugar metabolism (blood sugar above normal), hypertension, high triglycerides or *low high density lipoprotein* (HDL). Data on blood sugar, blood pressure, and fat profile of patients are obtained from the patient's medical records, while (Peterseim et al., 2024) *Body Mass Index* (BMI) is obtained from body weight divided by height squared. BMI is said to be *underweight* if the BMI is below 18.5, normal if the BMI is 18.5-22.9, *overweight* if the BMI is 23 to 24.9, Obesity I if the BMI is 25 to 29.9 and Obesity II if the BMI is 30 and above (World Health Organization, 2000).

Analysis

Each stage of the diagnosis of sarcopenia including its components (high SARC-F, low hand strength, low MMI, and sarcopenia) associated with the incidence of metabolic syndrome is as follows: in the form of numerical data, percentages and *prevalence ratio* (PR)

which will be accompanied by *a Confident Interval*, then a statistical test is carried out using *the Fischer Exact Test*, considered significant if P<0.05.

RESULTS AND DISCUSSION

In this study, 70 samples were obtained, with the composition as shown in **table 1**. The data on the number of respondents by gender and the average MMI for each gender varied quite a bit. The number of male respondents was 41 (59%) and the number of female respondents was 29 (41%). The proportion of male patients is 1.4x more than female patients. The average age of males is 72.5 ± 5.5, and females are 73.4 ± 6. Female BMI averaged 22.3 ± 4.8 and male BMI averaged 22.9 ± 3.7. There was no significant difference between average age and BMI in males and females (they had a difference of 0.9 and 0.6, respectively). Meanwhile, the average MMI for men is 8.5 ± 1.0 and the average MMI for women is 5.6 ± 1.3, this shows that men have an MMI with a value of 2.9 higher than women.

Table 1. Overview of the research sample

Gender	Number of Respondents	Average Age	Average BMI	Average MMI
Women	29 (41%)	73.4 ± 6	22.3 ± 4.8	5.6 ± 1.3
Male	41 (59%)	72.5 ± 5.5	22.9 ± 3.7	8.5 ± 1.0
Total	70 (100%)	72.9 ± 5.5	22.6 ± 3.9	7.3 ± 1.7

Table 2. Body Mass Index Overview

BMI	Male	Women	Total
Normal	15 (37%)	13 (45%)	28 (40%)
Underweight	6 (15%)	6 (21%)	12 (17%)
Overweight	7 (17%)	3 (10%)	10 (14%)
Obesity I	12 (29%)	5 (17%)	17 (24%)
Obesity II	1 (2%)	2 (7%)	3 (4%)

A picture of the patient's BMI can be seen in **(Table 2).** The number of men with normal BMI, *underweight, overweight,* obesity I, and obesity II was 15 (37%), 6 (15%), 7 (17%), 12 (29%), and 1 (2%), while in women the normal BMI, *underweight, overweight, obesity* I, and obesity II were 13 (45%), 6 (21%), 3 (10%), 5 (17%), and 2 (7%). It was found that men have a tendency to overweight (overweight-obesity II) while women have a tendency to have a low BMI (underweight). In men, it was found that 30 (48%) respondents had an excess BMI and 6 (15%) had a low BMI, while in female respondents 10 (34%) had an excess BMI and 6 (21%) had a low BMI. It can be seen that the excess BMI in men is 14% higher than in women while the low BMI is 6% higher than in women.

Table 3 shows the number of patients with high SARC-F scores, low grip strength, low MMI, suspected sarcopenia, and sarcopenia in each sex and total. This table also shows the sum of each component that intersects with metabolic syndrome. If viewed from each stage of sarcopenia diagnosis, namely from high SARC-F scores, suspected sarcopenia, and until a definitive diagnosis of sarcopenia, it is known that the number decreases more than twice at each stage (high SARC-F score (46 (66%)), suspected sarcopenia (20 (29%)), and sarcopenia

(10 (14%))). Interestingly, if viewed based on gender, a large decrease only occurred in men, even the decrease from suspected sarcopenia to sarcopenia in women only decreased by 4%. Interestingly, although the number of each component is quite high, the part that intersects with metabolic syndrome is quite low, even in the low MMI + metabolic syndrome section, and sarcopenia + metabolic syndrome in male patients reaches the number 0.

Table 3. Overview of the components of sarcopenia and metabolic syndrome in samples

	Male		Women		Total	
	Yes	No	Yes	No	Yes	No
High SARC F Score	28 (68%)	13 (32%)	18 (62%)	11 (38%)	46 (66%)	24 (34%)
Low Handgrip Strength	23 (56%)	18 (44%)	16 (44%)	13 (45%)	39 (56%)	31 (44%)
Low MMI	4 (10%)	37 (90%)	17 (59%)	12 (41%)	21 (30%)	49 (70%
Sarcopenia	3 (7%)	38 (93%)	7 (24%)	22 (76%)	10 (14%)	60 (86%)
Metabolic Syndrome	15 (37%)	26 (63%)	12 (41%)	17 (59%)	27 (39%)	43 (61%)
High SARC F Score + Metabolic Syndrome	4 (10%)	37 (90%)	2 (7%)	27 (93%)	6 (9%)	64 (91%)
Low Hand Grip Strength + Metabolic Syndrome	6 (15%)	35 (85%)	5 (17%)	24 (83%)	11 (16%)	59 (84%)
Low MMI + Metabolic Syndrome	0 (0%)	41 (100%)	4 (14%)	25 (86%)	4 (6%)	66 (94%)
Sarcopenia + Metabolic Syndrome	0 (0%)	41 (100%)	2 (7%)	27 (93%)	2 (3%)	68 (97%)

The correlation of each component to metabolic syndrome was carried out by bivariate analysis of each component. From this data, it can be seen that hand-held strength (PR 0.55, CI 0.14-1.01, P=0.05) has an almost significant relationship and low MMI (PR 0.55, CI 0.08-0.91, P=0.04) has a significant relationship with metabolic syndrome. Other components such as the SARC F SCORE (PR 0.55, CI 0.13-1.20, P=0.10) and sarcopenia (PR 0.48, CI 0.07-1.79, P=0.28) themselves did not have a significant association with Table 4 metabolic syndrome.

Table 4. Correlation of each component of sarcopenia to metabolic syndrome

Variable	PR	95% CI	P
High SARC F Score	0.55	0.13–1.20	0.10
Low Handgrip Strength	0.55	0.14–1.01	0.05
Low MMI	0.55	0.08–0.91	0.04
Sarcopenia	0.48	0.07–1.79	0.28

Sarcopenia in general occurs in the elderly population and is one of the main sources of health problems for older adults. A decrease in skeletal muscle mass and strength directly results in a reduction in the functional capacity required to perform daily activities. This condition often manifests as a decrease in gait speed and muscle fatigue that arises faster when doing even light activities. As a result, older adults with sarcopenia tend to restrict their

movements to avoid discomfort or fatigue, which marks the beginning of a transition to a sedentary lifestyle.

From physiological and metabolic aspects, skeletal muscle is not just a means of movement but one of the largest endocrine and metabolic organs that plays an important role in glucose homeostasis. The loss of muscle mass in sarcopenia leads to a decrease in surface area for insulin-stimulated glucose removal, thus triggering insulin resistance. This phenomenon is often exacerbated by the infiltration of fat into muscle tissue (myosteatosis), which creates a chronic pro-inflammatory environment through the release of cytokines such as tumor necrosis factor alpha (TNF-α) and interleukin 6 (IL-6), which ultimately accelerates the progression of metabolic syndrome components in the elderly.

Metabolic syndrome itself is a collection of factors that can increase the risk of cardiovascular and metabolic diseases, which include insulin resistance, central obesity, dyslipidemia, and hypertension. Various factors such as socioeconomic status, lack of physical activity, smoking habits, family history of diabetes, obesity, and sedentary lifestyle can increase the risk of metabolic syndrome. There are several pathomechanisms underlying metabolic syndrome in triggering systemic complications, namely the influence of central obesity conditions, insulin resistance, and chronic low-level inflammation. The accumulation of dysfunctional adipose tissue triggers the massive release of free fatty acids and pro-inflammatory cytokines (such as TNF-α and IL-6), which then disrupt insulin signaling and create oxidative stress states and prothrombotic conditions. These clinical manifestations collectively cause endothelial dysfunction that accelerates atherosclerosis of the cardiovascular system, triggers steatosis in liver organs, and activates protein catabolism pathways that degrade skeletal muscle mass, thereby significantly increasing the risk of mortality and disability in its sufferers.

The aging process is accompanied by significant changes in muscle mass and quality, with the rate of decline in muscle mass reaching 1–2% per year after the age of 50. This progressive decline is the main pathophysiological basis for the occurrence of metabolic disorders and sarcopenia in the geriatric population. Sarcopenia contributes directly to the pathogenesis of insulin resistance due to a decrease in the metabolic surface area for glucose uptake. Metabolic syndrome, characterized by visceral obesity, increases the secretion of pro-inflammatory cytokines such as TNF-α and IL-6. This low-level chronic inflammatory status is catabolic to skeletal muscle because it activates pathways that degrade muscle proteins, thereby accelerating the progression of sarcopenia. This condition often leads to sarcopenia-obesity, in which there is an accumulation of body fat along with a decrease in muscle mass, which has a more severe clinical impact than either condition alone. The infiltration of fat into the muscles (myosteatosis) in people with metabolic syndrome decreases the quality and contractility of muscle fibers, resulting in a decrease in physical strength and daily activities. This decrease in physical activity then exacerbates fat accumulation and insulin resistance, which further suppresses muscle protein synthesis through inhibition of the mTOR pathway. Therefore, the integration between metabolic disorders and muscle degeneration is a strong predictor of increased risk of functional disability, cardiovascular disease, and mortality in the elderly population.

In this study, the researchers assessed each component of the sarcopenia diagnosis and its relationship to the incidence of metabolic syndrome. In theory, muscles are important organs

in metabolic processes, especially glucose metabolism. Patients with sarcopenia have low muscle mass, which should be a risk factor for metabolic syndrome. However, this study found that high SARC-F scores and sarcopenia were not associated with metabolic syndrome, whereas low hand grip strength and low muscle mass index were protective factors for metabolic syndrome.

From these findings, several possibilities emerge. First, although age, gender, and BMI of patients appear to be fairly evenly distributed, the number of patients with a diagnosis of sarcopenia is too small. Even among male patients, only 3 had sarcopenia, and none of them had metabolic syndrome. To improve future research, it is recommended to use a larger sample size.

The second possibility is related to study limitations. The researchers calculated the patients' muscle mass index using Lee's formula. However, according to EWGSOP2 recommendations, muscle mass should ideally be assessed using dual-energy X-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA), or cross-sectional area of lumbar muscle by computed tomography (CT) or magnetic resonance imaging (MRI). Since the calculation used only the patients' BMI, it cannot fully assess muscle mass accurately, particularly in obese patients with sarcopenia, as higher BMI correlates with higher muscle mass index in this formula.

Interestingly, the researchers also found a discrepancy between SARC-F scores and hand grip strength. Many patients with high SARC-F scores had good hand grip strength. The SARC-F questionnaire, although recognized, has limitations: first, it has low to moderate sensitivity but high specificity, making it more suitable for detecting severe sarcopenia. Second, the SARC-F score is derived from patient self-report, introducing subjectivity regarding their perception of muscle function. In addition, hand grip strength testing has limitations in certain patients—for example, those with a history of stroke (though improved), neuropathy, or frozen shoulders—which may affect their ability to grasp. In clinical settings, many patients have these types of comorbidities, so additional criteria or examinations may be needed to accurately assess muscle function.

CONCLUSION

In this study, researchers did not find a strong association between Sarcopenia and metabolic syndrome and high SARC F scores and metabolic syndrome. Researchers found that low hand-grip strength and low MMI tend to be protective factors of metabolic syndrome. In the process, the researchers found a mismatch between the SARC F score and the hand grip strength where some of the samples with low hand grip strength had a low SARC F score as well. This may be due to the strong subjectivity of the SARC F score and the need for other muscle ability measurements to get a picture of overall muscle function. This study is not conclusive, it is recommended that other researchers study with a larger sample, and use standard references such as DXA, BIA, CT or MRI to calculate muscle mass.

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