RESEARCH PAPER

Comparative Accuracy of NCEP-ATP III and IDF Criteria for Therapeutic Target Identification Among Elderly with Metabolic Syndrome and Sarcopenia

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ABSTRACT

Background: Metabolic syndrome and sarcopenia are highly prevalent age-related conditions that share common pathophysiological pathways, including insulin resistance, chronic low-grade inflammation, and alterations in body composition. Accurate identification of metabolic syndrome in the elderly may improve risk stratification and facilitate early interventions aimed at managing sarcopenia. However, differences between the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) and International Diabetes Federation (IDF) criteria may influence the identification of individuals at risk.

Methods: A cross-sectional analytic study was conducted among elderly aged ≥60 years. Sarcopenia was assessed according to the AWGS 2019 criteria using handgrip strength, 5-times chair stand test, and BIA. Metabolic syndrome was defined using both NCEP-ATP III and IDF criteria. Data were analyzed using Chi-square test and diagnostic classification performance, including accuracy, sensitivity, specificity, positive predictive value, negative predictive value, and kappa agreement, were also evaluated.

Results: A total of 125 participants were included, the prevalence of metabolic syndrome was 64.0% using NCEP-ATP III and 56.0% using IDF criteria, while sarcopenia was identified in 80.0% of participants. Metabolic syndrome was significantly associated with sarcopenia using both criteria. We found that NCEP-ATP III demonstrated higher classification performance, with greater accuracy, sensitivity, and kappa value compared to IDF criteria. It indicated the greater flexibility, which does not require central obesity as a mandatory diagnostic component.

Conclusions: Both NCEP-ATP III and IDF criteria were effective in identifying the association between metabolic syndrome and sarcopenia in the elderly. However, the NCEP-ATP III criteria demonstrated modestly superior overall diagnostic performance, suggesting greater utility for identifying older individuals at increased risk of sarcopenia who may benefit from early preventive and therapeutic strategies.

Keywords: *metabolic syndrome, sarcopenia, elderly, NCEP-ATP III, IDF*
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INTRODUCTION

Metabolic syndrome and sarcopenia represent two interrelated geriatric syndromes that frequently coexist in older adults and contribute substantially to morbidity, functional decline, and mortality. (1,2) Both conditions share common pathophysiological pathways characterized by insulin resistance, chronic low-grade inflammation, oxidative stress, mitochondrial dysfunction, and alterations in body composition. (3,4) As aging progresses, these mechanisms interact synergistically, resulting in progressive metabolic dysregulation and deterioration of skeletal muscle integrity.(5) Accumulating evidence suggests that beyond insulin resistance, excess visceral adiposity contributes to ectopic lipid accumulation within skeletal muscle fibers, a process known as myosteatosis, which adversely affects muscle strength and physical performance independent of muscle mass.(6,7) Furthermore, chronic exposure to hyperglycemia and

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dyslipidemia promotes mitochondrial injury, reactive oxygen species generation, and activation of proteolytic pathways, accelerating the progression of age-related muscle loss.(8,9) Controversy remains regarding the optimal diagnostic criteria for identifying individuals at greatest risk. The National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) and the International Diabetes Federation (IDF) criteria are the two most widely adopted definitions of metabolic syndrome in both clinical and epidemiological settings.(10,11) Although both criteria incorporate similar metabolic components, their diagnostic frameworks differ substantially. The NCEP-ATP III definition assigns equal weight to each metabolic component and requires the presence of any three of five abnormalities. In contrast, the IDF definition considers central obesity an obligatory prerequisite for diagnosis.(12,13)

Accurate identification may facilitate earlier implementation of targeted interventions, such as optimization of nutritional intake, structured resistance exercise programs, and aggressive management of metabolic abnormalities. Therefore, comparative evaluation of existing diagnostic criteria may provide clinically meaningful information for risk stratification and therapeutic planning among elderly.(14,15) Data comparing the performance of NCEP-ATP III and IDF criteria in relation to sarcopenia in the elderly remain limited, particularly in Southeast Asian populations.(16) Therefore, this study aimed to compare the diagnostic accuracy of the NCEP-ATP III and IDF criteria in identifying metabolic syndrome associated with sarcopenia in the elderly.

PATIENTS AND METHODS

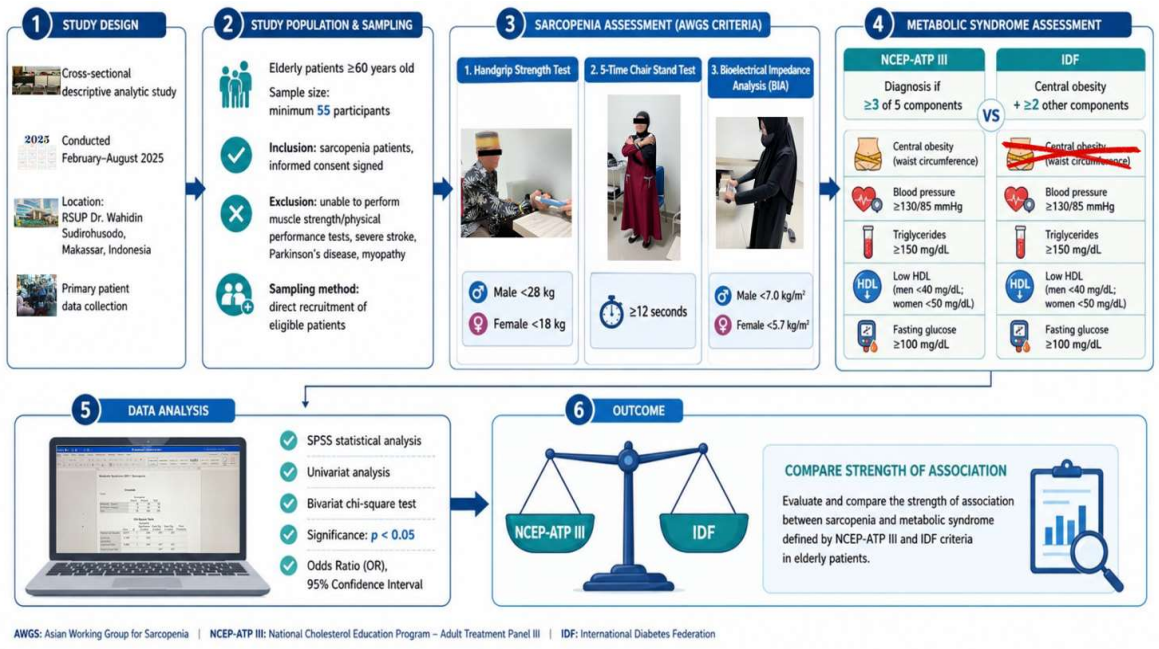

Figure 1: Research Flow

Study Design and Participants

A cross-sectional analytic study was conducted at Wahidin Sudirohusodo General Hospital, Makassar, Indonesia, between February and August 2025. The study included elderly aged 60 years or older who were recruited using consecutive sampling. Subjects who were willing to participate and signed written informed consent were included in the study. Exclusion criteria included severe cognitive impairment, inability to perform physical performance tests, acute critical illness, and incomplete clinical data.

Assessment of Sarcopenia

Sarcopenia was diagnosed according to the Asian Working Group for Sarcopenia (AWGS) 2019 criteria. Muscle strength was assessed using handgrip strength measured with a hand dynamometer. Low muscle strength was defined as handgrip strength <28 kg for men and <18 kg for women. Physical performance was evaluated using the 5-time chair stand test. Poor physical performance was defined as completion time ≥12 seconds. Muscle mass was assessed using bioelectrical impedance analysis (BIA). Low appendicular skeletal muscle mass index was defined according to AWGS 2019 cutoffs.(11,13,15) Participants fulfilling AWGS criteria for low muscle mass accompanied by low muscle strength and/or poor physical performance were classified as having sarcopenia.

Assessment of Metabolic Syndrome

Metabolic syndrome was evaluated using both NCEP-ATP III and IDF criteria. According to NCEP-ATP III criteria, metabolic syndrome was diagnosed when at least three of the following components were present: 1)Waist circumference >90 cm in men or >80 cm in women; 2)Triglycerides ≥150 mg/dL; 3)HDL cholesterol <40 mg/dL in men or <50 mg/dL in women; 4)Blood pressure ≥130/85 mmHg or antihypertensive treatment; 5)Fasting blood glucose ≥100 mg/dL or antidiabetic treatment. According to IDF criteria, central obesity was required as a mandatory component, accompanied by at least two of the remaining metabolic abnormalities.(11,17,18)

Data Collection

Demographic characteristics, anthropometric measurements, blood pressure, laboratory parameters, comorbidities, and medication history were obtained from interviews, physical examination, and medical records.

Statistical Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) software version 26. Continuous variables were presented as mean ± standard deviation or median and interquartile range according to data distribution. Categorical variables were presented as frequency and percentage. Associations between metabolic syndrome and sarcopenia were analyzed using Chi-square test. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Classification performance including sensitivity, specificity, positive predictive value, negative predictive value, accuracy, and kappa agreement was also evaluated. A p-value <0.05 was considered statistically significant.

Ethical Approval

This study was approved by the Biomedical Research Ethics Committee, Faculty of Medicine Hasanuddin University, Makassar, South Sulawesi, Indonesia under the protocol number UH25070542. All participants provided written informed consent before enrollment. The study was conducted according to the principles of the Declaration of Helsinki.

RESULTS

Baseline Characteristics

A total of 125 elderly were included in the study. Most participants were women (61.6%), while 38.4% were men. The majority of participants were aged 60–74 years (72.0%), followed by participants aged ≥75 years (28.0%). The prevalence of sarcopenia was 80.0%. Metabolic syndrome was identified in 64.0% of participants using NCEP-ATP III criteria and in 56.0% using IDF criteria.

Hypertension and hyperglycemia were the most frequent metabolic abnormalities observed in the study population. Participants with sarcopenia demonstrated higher prevalence of metabolic syndrome compared with participants without sarcopenia. The distribution of research subjects is presented in Table 1.

Table 1. Distribution of research subjects

Variables		n	%
Age	60-74 years old	90	72.00
	≥ 75 years old	35	28.00
Gender	Male	48	38.40
	Female	77	61.60
Waist Circumference	Normal	42	33.60
	Big	83	66.40
Blood Pressure	Normal	110	88.00
	High	15	12.00
Triglyceride	Normal	33	26.40
	High	92	73.60
High Density Lipoprotein	Normal	71	56.80
	Low	54	43.20
Fasting Blood Glucose	Normal	26	20.80
	High	99	79.20
Metabolic Syndrome (IDF)	Absent	55	44.00
	Present	70	56.00
Metabolic Syndrome (NCEP-ATP III)	Absent	45	36.00
	Present	80	64.00
Sarcopenia	Absent	25	20.00
	Present	100	80.00

Association between Metabolic Syndrome and Sarcopenia

Using NCEP-ATP III criteria, metabolic syndrome was significantly associated with sarcopenia (OR 2.83; 95% CI 1.16–6.94; p=0.020). Similarly, IDF criteria also demonstrated a significant association between metabolic syndrome and sarcopenia (OR 2.78; 95% CI 1.12–6.91; p=0.024). Despite similar odds ratios, NCEP-ATP III criteria demonstrated better classification performance than IDF criteria. The association between metabolic syndrome and sarcopenia is presented in Table 2.

Table 2: The Association between metabolic syndrome and sarcopenia

Variable		Sarcopenia		p-value	OR 95 CI
		Present	Absent		
Metabolic Syndrome (NCEP-ATP III)	Present	69 (69)	11 (44)	0.020*	2.833 (1.16-6.94)
	Absent	31 (31)	14 (56)		
Metabolic Syndrome (IDF)	Present	61 (61)	9 (36)	0.024*	2.781 (1.12-6.91)
	Absent	16 (64)	39 (39)		
Comparison test with Chi Square Test					

Significant codes: <0.0001 '****' <0.001 '***' <0.01 '**' <0.05 '*' not significant 'ns'

Classification Performance

The diagnostic performance of both metabolic syndrome criteria in identifying sarcopenia is presented in Table 3.

Table 3: The diagnostic performance of NCEP-ATP III and IDF criteria

Metric of Diagnostic	Metabolic Syndrome (NCEP-ATP III)	Metabolic Syndrome (IDF)
Accuracy	66.40%	61.60%
Sensitivity	69.00%	61.00%
Specificity	56.00%	64.00%
PPV	86.25%	87.10%
NPV	31.10%	29.10%
Kappa	19.20%	17.00%

PPV, positive predictive value; NPV, negative predictive value

NCEP-ATP III criteria demonstrated sensitivity of 69.0%, specificity of 56.0%, positive predictive value of 86.3%, negative predictive value of 31.1%, and overall accuracy of 66.4%. The kappa agreement between NCEP-ATP III-defined metabolic syndrome and sarcopenia was 19.2%. Meanwhile, IDF criteria demonstrated sensitivity of 61.0%, specificity of 64.0%, positive predictive value of 87.1%, negative predictive value of 30.9%, and overall accuracy of 61.6%. The kappa agreement between IDF-defined metabolic syndrome and sarcopenia was 17.0%. Overall, NCEP-ATP III criteria showed higher sensitivity, accuracy, and kappa agreement compared with IDF criteria, whereas IDF criteria demonstrated higher specificity and positive predictive value.

The higher sensitivity observed in NCEP-ATP III indicates that this criterion was more capable of correctly

identifying participants with sarcopenia who also had metabolic syndrome. The lower sensitivity observed in IDF criteria may be related to its requirement for central obesity as a mandatory diagnostic component, potentially excluding metabolically unhealthy in elderly population with reduced muscle mass but without overt abdominal obesity.

NCEP-ATP III also demonstrated higher kappa agreement than IDF criteria. Although both kappa values remained within the fair agreement range, the higher kappa value in NCEP-ATP III suggests better concordance between metabolic syndrome classification and sarcopenia status. This finding may indicate that the metabolic abnormalities detected by NCEP-ATP III better reflect the pathophysiological processes associated with sarcopenia in the elderly.

In contrast, IDF criteria demonstrated slightly higher specificity (64.0% vs 56.0%) and positive predictive value (87.1% vs 86.3%). Higher specificity indicates that IDF criteria were somewhat better at correctly identifying participants without sarcopenia. Similarly, the slightly higher positive predictive value suggests that participants classified as having metabolic syndrome by IDF criteria were marginally more likely to truly have sarcopenia. However, these differences were relatively small and occurred at the expense of lower sensitivity.

The negative predictive values of both criteria remained relatively low (31.1% for NCEP-ATP III and 30.9% for IDF criteria), indicating that absence of metabolic syndrome could not reliably exclude the presence of sarcopenia. This finding suggests that sarcopenia in the elderly multifactorial and may also be influenced by aging, nutritional deficiencies, physical inactivity, hormonal changes, chronic inflammation, and comorbid diseases independent of metabolic syndrome status.

Metabolic Syndrome Components and Sarcopenia

Among individual with metabolic syndrome components, hypertension and hyperglycemia were the most prevalent abnormalities among participants with sarcopenia. Low HDL cholesterol and hypertriglyceridemia were also more frequently observed in participants with sarcopenia compared with non-sarcopenic participants. Central obesity was less consistently observed among participants with sarcopenia, particularly among elderly with reduced body mass index and low muscle mass. Overall, we found that NCEP-ATP III may provide better screening performance for identifying the association between metabolic syndrome and sarcopenia in the elderly. The broader metabolic-based approach of NCEP-ATP III, which does not require central obesity as a mandatory criterion, may allow more comprehensive detection of metabolically unhealthy elderly with altered body composition and reduced skeletal muscle mass.

DISCUSSION

This study demonstrated that metabolic syndrome was significantly associated with sarcopenia among elderly using both NCEP-ATP III and IDF criteria. Elderly with metabolic syndrome had approximately 2.8-fold higher odds of sarcopenia compared with those without metabolic syndrome. These findings support the growing evidence that metabolic abnormalities and skeletal muscle dysfunction are closely interconnected in aging populations.(19,20)

Several mechanisms may explain the association between metabolic syndrome and sarcopenia. Insulin resistance is considered one of the principal pathophysiological pathways linking both conditions. Skeletal muscle is the primary site of insulin-mediated glucose uptake. In elderly individuals with metabolic syndrome, impaired insulin signaling suppresses anabolic pathways, particularly the phosphatidylinositol 3-kinase/Akt/mTOR pathway, resulting in reduced muscle protein synthesis and accelerated muscle degradation. Persistent insulin resistance also promotes mitochondrial dysfunction and oxidative stress, further contributing to loss of muscle mass and impaired muscle quality.(21,22,23,24)

Chronic low-grade inflammation, commonly referred to as “inflammaging,” also plays a central role in the development of sarcopenia among individuals with metabolic syndrome. Increased production of pro-inflammatory cytokines such as tumor necrosis factor-alpha, interleukin-6, and C-reactive protein stimulates proteolysis and inhibits muscle regeneration.(25,26) Chronic inflammation additionally contributes to endothelial dysfunction and impaired muscle perfusion, thereby worsening skeletal muscle function.(27)

Another important mechanism involves visceral adiposity and ectopic fat accumulation within skeletal muscle. Excess visceral fat promotes lipotoxicity and myosteatosis, leading to reduced muscle strength and physical performance.(28) Adipose tissue-derived adipokines such as leptin, adiponectin, resistin, and myostatin may further influence muscle metabolism and contribute to sarcopenic changes.(29) These pathophysiological interactions support the concept that metabolic syndrome and sarcopenia should not be viewed as separate entities but rather as interrelated components of metabolic aging.

Our findings are consistent with previous studies conducted in Asian populations. Ishii et al. reported that elderly population in Japan with metabolic syndrome had significantly higher prevalence of sarcopenia.(6) Similarly, Park et al. demonstrated a significant relationship between sarcopenia and metabolic syndrome in Korean adults using data from the Korea National Health and Nutrition Examination Survey.(5) Nishikawa et al. also highlighted the bidirectional relationship between metabolic syndrome and sarcopenia through mechanisms involving insulin resistance, chronic inflammation, and mitochondrial dysfunction.(3)

The prevalence of sarcopenia in the present study was relatively high compared with community-based studies. This finding may be explained by several factors. First, the study was conducted in a tertiary referral hospital where patients commonly have multiple comorbidities and more

severe metabolic abnormalities. Second, reduced physical activity, nutritional deficiencies, and chronic diseases among hospitalized or clinic-based elderly populations may contribute to accelerated muscle loss. Third, differences in ethnicity, body composition, and diagnostic criteria may influence prevalence estimates across studies.

An important finding of this study was that NCEP-ATP III criteria demonstrated better classification performance than IDF criteria in identifying the association between metabolic syndrome and sarcopenia. Although both criteria showed statistically significant associations and similar odds ratios, NCEP-ATP III demonstrated higher sensitivity, accuracy, and kappa agreement.

This difference may be explained by the distinct diagnostic approaches used by both criteria. The IDF criteria require central obesity as a mandatory component for diagnosis.(30,31) However, elderly individuals with sarcopenia frequently experience altered body composition characterized by reduced muscle mass, decreased body weight, and redistribution of adipose tissue. (32,33) Consequently, some elderly may develop insulin resistance, dyslipidemia, hypertension, and hyperglycemia despite not fulfilling waist circumference criteria for central obesity.(34)

In contrast, the NCEP-ATP III criteria use a more flexible metabolic-based approach because no single component is mandatory for diagnosis. Elderly can therefore be classified as having metabolic syndrome based on combinations of metabolic abnormalities even in the absence of overt central obesity. This broader diagnostic approach may better reflect the metabolic heterogeneity observed in the elderly with sarcopenia.(35)

Our findings also suggest that metabolic dysfunction in elderly populations may not always be adequately represented by anthropometric measurements alone. In sarcopenic individuals, reduced muscle mass can coexist with metabolic abnormalities despite relatively normal waist circumference or body mass index. This condition is sometimes referred to as metabolically obese normal-weight phenotype. Therefore, reliance on central obesity as an obligatory criterion may underestimate the burden of metabolic syndrome in the elderly with sarcopenia.(36,37)

Despite the superior performance of NCEP-ATP III criteria, the overall differences between both criteria remained modest. Odds ratios were nearly identical, and kappa agreement values remained relatively low in both criteria. Therefore, the findings should not be interpreted as evidence that one criterion completely replaces the other. Rather, both definitions remain clinically useful for identifying elderly individuals at increased metabolic and functional risk.

The present study has several clinical implications. Early identification of metabolic syndrome in the elderly with sarcopenia may contribute interventions targeting modifiable metabolic risk factors, including physical inactivity, obesity, dyslipidemia, hypertension, and impaired glucose metabolism. Comprehensive management involving nutritional optimization, resistance exercise, glycemic control, and cardiovascular risk reduction may help prevent progression of sarcopenia and functional decline.(38,39)

This study has several limitations. First, the cross-sectional design does not allow causal inference regarding the temporal relationship between metabolic syndrome and sarcopenia. Second, the study was conducted in a single tertiary referral center, which may limit generalizability to broader community populations. Third, residual confounding factors such as dietary intake, physical activity, socioeconomic status, inflammatory biomarkers, and hormonal profiles were not comprehensively evaluated. Fourth, the sample size was relatively limited, which may affect statistical precision.

Despite these limitations, this study provides important evidence regarding the relationship between metabolic syndrome and sarcopenia in Indonesian elderly population. To our knowledge, few studies in Indonesia have directly compared NCEP-ATP III and IDF criteria in relation to sarcopenia. The findings contribute additional evidence supporting the importance of metabolic assessment in elderly populations with declining muscle health.

Future longitudinal studies with larger multicenter populations are needed to evaluate causal relationships between metabolic syndrome and sarcopenia and to determine which metabolic syndrome criteria best predict adverse clinical outcomes among elderly.

CONCLUSIONS

Metabolic syndrome was significantly associated with sarcopenia among elderly regardless of the diagnostic criteria applied. Both the NCEP-ATP III and IDF criteria demonstrated the ability to identify elderly individuals with metabolic syndrome who were at increased risk of sarcopenia. However, the NCEP-ATP III criteria showed modestly superior diagnostic performance, characterized by higher accuracy, sensitivity, and overall agreement compared with the IDF criteria.

These findings suggest that the NCEP-ATP III criteria may provide greater clinical utility for risk stratification and identification of older adults vulnerable to sarcopenia. Early recognition of this high-risk population may support timely implementation of preventive and therapeutic strategies aimed at preserving muscle health and reducing adverse geriatric outcomes.

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Conflict of Interest
The authors declare that there are no conflicts of interest related to this study.

Authors Contribution

All authors contributed to study conception and design.

Nur Atikah Harmianty Putri, Wasis Udaya, and Haerani Rasyid performed data collection and data analysis.

All authors contributed to interpretation of data and manuscript drafting.

All authors critically revised the manuscript and approved the final version of the manuscript.

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