HIGH PREVALENCE OF LOW MUSCLE STRENGTH AND POOR PHYSICAL PERFORMANCE IN PRE-ELDERLY AND ELDERLY COMMUNITIES IN RURAL CIREBON, INDONESIA: A PUBLIC HEALTH MEASUREMENT INITIATIVE

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Abstract

Introduction: Sarcopenia, characterized by progressive muscle decline, threatens functional independence and global health sustainability. Early identification of low muscle strength is critical in community settings that lack advanced diagnostic tools. This cross-sectional study aimed to measure the prevalence of low muscle strength and identify key physical factors in a combined pre-elderly (45-59 years) and elderly (≥ 60 years) cohort, aligning with the concept of community-based physical fitness measurement. **Methods:** We conducted a cross-sectional study among 62 participants (67.7% female; 61.3% elderly) in Cirebon, Indonesia. Probable sarcopenia was screened using the Asian Working Group for Sarcopenia (AWGS 2019) criteria: Low Muscle Strength (handgrip < 28 kg for men, < 18 kg for women) and Low Physical Performance (≥ 12.0 sec chair stand). Analysis included non-parametric tests and a multivariate logistic regression adjusting for age and calf circumference. **Results:** Low muscle strength prevalence was high at 66.1% (n = 41). Strength was significantly higher in males (20.30 kg) than females (15.66 kg, p-value = 0.004). Physical performance was poor, with 80.6% of the population meeting the criteria for slowness (median = 13.98 sec). Multivariate analysis identified calf circumference as a significant independent protective factor for both low strength (AOR: 0.77; 95% CI: 0.62–0.92; p-value = 0.008) and poor performance (AOR: 0.77; 95% CI: 0.57–0.96; p-value = 0.043). Advanced age was a significant predictor specifically for low muscle strength (AOR: 4.41; 95% CI: 1.23–17.6; p-value = 0.026). No significant associations were found with body mass index (BMI), blood sugar, cholesterol, smoking, or job status (p-value > 0.05). **Conclusion:** The high prevalence of low muscle strength in this pre-elderly and elderly cohort, independently predicted by smaller calf circumference, signals a critical public health threat. This functional decline is primarily driven by physical and age-related factors, not socioeconomic status. Our findings demand urgent, community-based strength training programs to empower healthy aging and preserve functional independence.

Keywords: calf circumference, low muscle strength, physical performance, probable sarcopenia, rural health

Introduction

The global demographic landscape is undergoing a profound structural transformation. In 2020, for the first time in recorded history, the count of individuals aged 60 and older outnumbered children under five years. This represented a significant demographic transition occurring with unprecedented speed. This shift is particularly prominent in countries with lower and middle incomes (LMICs), where the majority of the world's elderly population is anticipated to live by 2050.[1,2] Indonesia exemplifies this trajectory, having officially entered its aging phase in 2012 and presently supporting over 33 million citizens aged 60 and above. While enhanced healthcare has extended life expectancy to 74 years, it has not proportionally lengthened healthy life years. With projections suggesting nearly one in four Indonesians will be elderly by 2050,[3] the paramount public health objective has transformed from merely prolonging life to safeguarding functional capacity and averting widespread dependency.[4,5]

The key contributor to this functional deterioration is sarcopenia, a condition of progressive muscle mass and strength loss affecting middle-aged and older adult.[6–9] Skeletal muscle mass peaks in early adulthood and begins a gradual decline, losing approximately 5% by age 50.[10] This decline accelerates after middle age, with annual losses of 1% to 2% leading to a substantial cumulative reduction by age 80[11]. This deterioration signifies the decline of a vital metabolic organ essential for mobility, posture, and energy regulation.[12,13] The clinical implications are severe; this muscle loss is a primary factor in falls, physical disability, and increased mortality risk. The pronounced decline in physical function associated with this syndrome is particularly evident following injuries.[14–16] Among elderly individuals who experience a hip fracture due to a fall linked to this condition, only a small proportion regain the ability for independent ambulation,[17,18] imposing considerable strain on individual well-being and national healthcare systems.

Given the severity of these outcomes, early detection and intervention are critical to mitigate muscle loss.[6,19] The concept of probable sarcopenia, which allows for early identification based on reduced muscle strength and physical performance, as proposed by the Asian Working Group (AWGS) for Sarcopenia, enables intervention even without advanced imaging.[20–22] In resource limited community settings, anthropometric measurements such as calf circumference have emerged as practical clinical tools, demonstrating reliability in predicting muscle mass, strength, and performance across diverse populations.[23] However, the relationship between these simple measures and actual functional outcomes remains underexplored in the Indonesian population, especially regarding sex specific differences and the crucial period for individuals approaching old age, between 45 and 59 years, where early interventions can be most impactful. To address this gap, this study aims to quantify the prevalence of low muscle strength and identify key physical predictors within a combined cohort of pre-elderly and elderly individuals in rural Cirebon, Indonesia. We thereby establishing a community-based physical fitness measurement for targeted interventions to preserve functional independence.

Materials and Methods

Study Design, Setting, and Participants

We conducted a cross-sectional study integrated into a community service initiative in Kudukeras Village, Babakan District, Cirebon, West Java, in November 2023. This collaboration between the Faculty of Medicine and Health at Universitas Muhammadiyah Jakarta and Al-Fathonah Islamic Boarding School aimed to identify individuals exhibiting characteristics of probable sarcopenia among residents in a rural community with limited access to advanced diagnostic imaging.[24]

Participants were recruited from the general population of Kudukeras Village, with inclusion criteria targeting individuals aged 45 years and older, encompassing both the pre-elderly (45–59 years) and elderly (≥60 years) cohorts. All participants provided their written informed consent after receiving a thorough explanation of the study procedures. We conducted the research in adherence to established ethical standards, ensuring the confidentiality of all participants and their voluntary engagement in the study.

Data Collection

We collected general health information, including body mass index (BMI), random blood sugar (RBS), and total cholesterol levels. We calculated BMI by dividing body weight in kilograms by height squared in meters squared. For RBS and total cholesterol measurements, we utilized an Easy Touch CGU meter device. Additionally, we gathered data on past medical history and personal information through questionnaires, which included details on job and smoking status.

We conducted anthropometric measurements to assess physical status. Body weight was recorded in kilograms (kg). We estimated participants' height using the knee-height measurement method, which offers enhanced accuracy for the aging population. This measurement was taken from the anterior base of the knee to the sole of the foot while the participant was seated with their legs at a 90-degree angle. We specifically assessed calf circumference (CC) in centimeters at the widest part of the calf using a non-elastic tape, employing it as a vital indicator of physical status within this resource constrained environment.

The core of the data collection involved physical fitness and sarcopenia screening, performed following the Asian Working Group (AWGS) for Sarcopenia 2019 algorithm adapted for community settings.[25] We assessed muscle strength through isometric grip strength measurements using a handgrip dynamometer. Participants performed the test in a standing or stable sitting position with their arm at their side. As per the AWGS criteria, we defined low muscle strength as less than 28 kg for men and less than 18 kg for women.

We evaluated physical performance using the Five-Times Chair Stand Test (5T-CST), which assesses lower body power. Participants stood up and satdown five times as quickly as possible without using their arms for support. Based on the AWGS 2019 guidelines, a completion time of 12 seconds or greater indicated low physical performance, signifying slowness. We identified probable sarcopenia by the presence of either low muscle strength and low physical performance, aligning with the diagnostic approach for primary care and community settings.

Statistical Analysis

We summarized baseline characteristics by employing descriptive statistics to characterize demographic and health-related data. Continuous variables were reported as the Mean ± Standard Deviation (SD) or the Median with its Interquartile Range (IQR), based on normality testing, while categorical variables were summarized by their frequencies and percentages. To examine differences in baseline characteristics between sexes, we utilized independent t-tests or Mann-Whitney U tests for continuous data and applied Fisher's exact tests for categorical data. We then calculated the prevalence of sarcopenia indicators, specifically low muscle strength and low physical performance and reported prevalence estimates along with their respective 95% Confidence Intervals (CI).

To identify key physical predictors associated with probable sarcopenia, we implemented a two-stage predictive modeling approach. Initially, we conducted bivariate analyses to screen for potential explanatory variables; variables demonstrating a probability value less than 0.25 were considered for inclusion in subsequent multivariable models. Subsequently, we constructed multivariable logistic regression models to ascertain variables independently associated with low muscle strength and with low physical performance. Due to sample size limitations precluding sex-stratified analysis, we included sex as a confounding variable within these models to appropriately adjust for its potential influence on the outcomes. In the final multivariable models, we considered a probability value less than 0.05 statistically significant. We performed all the analysis using the R statistical software version 4.4.1.

To ensure the stability and reliability of our multivariable logistic regression models, we evaluated the adequacy of our sample size using the Events Per Variable (EPV) criterion. The EPV is a standard measure used to determine if the number of outcome events is sufficient to support the number of independent variables in a model without risking overfitting.[26] For the assessment of low muscle strength, we achieved an EPV of 10.25 (41 events/4 variables), and for poor physical performance, we achieved an EPV of 12.5 (50 events/4 variables). Since both models meet the recommended threshold of at least 10 EPV, our study provides sufficient statistical power to identify key physical predictors within this cohort.

Results

A total of 62 participants from Kudukeras Village were included in this study, comprising individuals from both the pre-elderly (45–59 years) and elderly (≥60 years) age groups. The study population was characterized by a high participation rate during the community health initiative. Overall, we identified a significant burden of probable sarcopenia indicators, with 66.1% of participants exhibiting low muscle strength and 80.6% demonstrating low physical performance. Distinct variations in these indicators were observed between male and female participants, reflecting the diverse physical health status within this rural community.

The baseline characteristics of the study participants, stratified by sex, are presented in Table 1. The cohort consisted of 42 females (67.7%) and 20 males (32.3%), with a median age of 62 (IQR: 53–71) years. Statistical analysis revealed that males had significantly higher handgrip strength compared to females [20.3 (17.67–23.55) kg vs. 15.66 (13.1–20.73) kg, p-value = 0.004]. There were also highly significant differences in lifestyle factors; active smoking was exclusively reported among males [7 (77.8%) vs. 0 (0%), p-value < 0.001], and a higher proportion of males were currently employed [12 (60%) vs. 5 (12.2%), p-value < 0.001].

Table 1. Baseline Characteristics of Participants by Sex

Variables	Total (n = 62)	Male (n = 20)	Women (n = 42)	P-value
Sex, n (%)	62 (100%)	20 (32.3%)	42 (67.7%)	-
Age (years); Median (IQR)	62 (53 – 71)	64 (57.5 – 71.5)	61.5 (51.25 – 70)	0.205**
Job Status*				**<0.001#**
Jobless	14 (100%)	5 (25%)	35 (83.3%)	
Retired	4 (100%)	3 (75%)	1 (25%)	
Teacher/ Lecturer	5 (100%)	3 (60%)	1 (25%)	
Farmer	9 (100%)	6 (66.7%)	3 (33.3%)	
Private employee	3 (100%)	3 (100%)	0 (0%)	
Smoking Status*				**0.001#**
Yes	7 (100%)	7 (100%)	0 (0%)	
No	44 (100%)	2 (4.5%)	42 (95.5%)	
Handgrip Strength (kg); Median (IQR)	17.7 (14.71 – 22.3)	20.3 (17.67 – 23.55)	15.66 (13.1 – 20.73)	**0.004****
Calf Circumference (cm); Median (IQR)	32 (29 – 36)	31 (27 – 33.25)	34 (29 – 36)	0.112**
BMI (kg/m2); Mean ± SD	24.36 ± 3.81	23.01 ± 4.26	25.01 ± 3.44	0.076***
Chair Stand Test (sec); Median (IQR)	13.98 (12.24 – 17.93)	12.24 (11.2 – 14.99)	14.57 (12.24 – 18.41)	**0.055****
Random Blood Sugar (mg/dL); Median (IQR)	125 (101.25 – 167)	135.5 (111 – 153.5)	124.5 (100.25 – 171.75)	0.988**
Total Cholesterol (mg/dL); Median (IQR)	224 (196.5 – 242)	209.5 (188.25 – 242)	226 (208.25 – 249.25)	0.295**

Job Status has 1 no response; Smoking Status has 11 no responses (*).
P-values calculated using Mann-Whitney U test (**); Independent T-test (***).
Categorical p-value calculated using Fisher's Exact Test (#).

Conversely, no significant differences between sexes were found for age (p-value = 0.205), calf circumference (p-value = 0.112), or BMI (23.01 ± 4.26 for males vs. 25.01 ± 3.44 for females, p-value = 0.076). Metabolic markers, including random blood sugar (p-value = 0.988) and total cholesterol (p-value = 0.295), were similar across groups. The five-times chair stand test showed a trend toward faster times in males, though it did not reach statistical significance [12.24 (11.2–14.99) sec vs. 14.57 (12.24–18.41) sec, p-value = 0.055].

The prevalence of sarcopenia indicators as shown in Figure 1, specifically low muscle strength and low physical performance is summarized based on the AWGS 2019 criteria. The overall prevalence of low muscle strength in the total population was 66.1% (41 out of 62 participants). When analyzed by sex, males exhibited a higher prevalence of low muscle strength compared to females (80% vs. 59.5%), although this difference did not reach statistical significance (p-value = 0.154).

Regarding physical performance, low physical performance (defined as a five-times chair stand test ≥12.0 seconds) was observed in 80.6% (50 out of 62 participants) of the total population. Females showed a higher prevalence of slowness compared to males (85.7% vs. 70%), but similar to muscle strength, the difference between sexes was not statistically significant (p-value = 0.177).

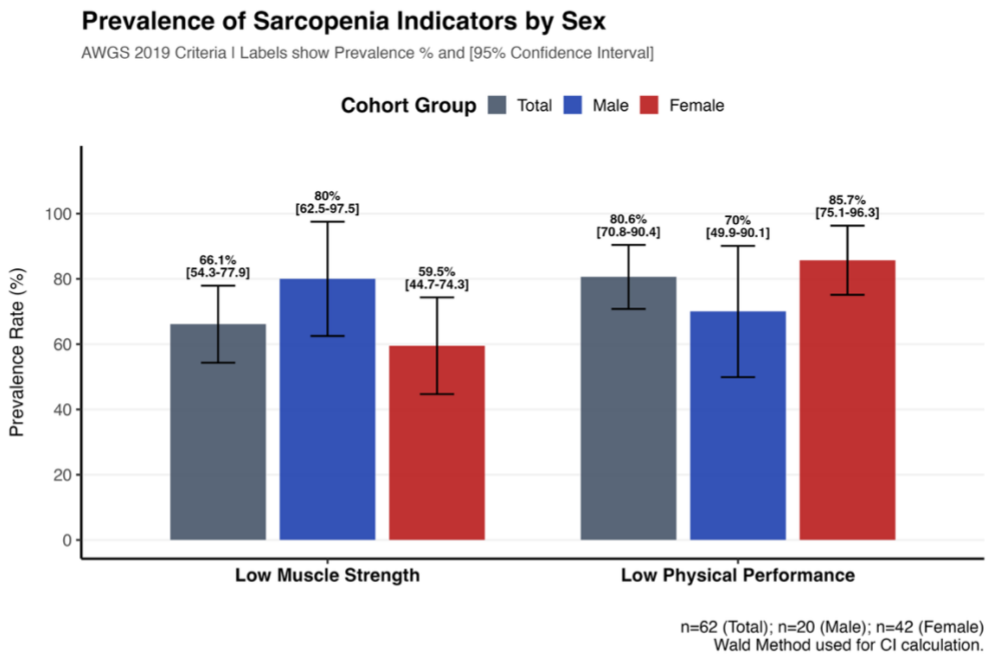

Figure 1. Prevalence Sarcopenia Indicators by Sex (Low Muscle Strength and Low Physical Performance)

In the adjusted model for low muscle strength, presented in Table 2A, age group and calf circumference emerged as significant independent predictors after adjusting for sex and BMI. Participants in the elderly age group (≥60 years) had over four times the odds of exhibiting low muscle strength compared to the pre-elderly group (AOR: 4.41; 95% CI: 1.23–17.6; p-value = 0.026). Furthermore, calf circumference was found to be a significant protective factor; for every 1 cm increase in calf circumference, the odds of having low muscle strength decreased by 23% (AOR: 0.77; 95% CI: 0.62–0.92; p-value = 0.008). BMI and sex were not significantly associated with muscle strength in the final adjusted model (p-value > 0.05)

In the second model (Table 2B) focusing on poor physical performance (slowness), calf circumference was the only significant predictor identified. After adjusting for age group, BMI, and sex, a larger calf circumference remained significantly associated with lower odds of physical slowness (AOR: 0.77; 95% CI: 0.57–0.96; p-value = 0.043). Age group (AOR: 0.94; p-value = 0.938), BMI (AOR: 1.22; p-value = 0.124), and sex (AOR: 3.32; p-value = 0.111) did not show statistically significant associations with physical performance.

Table 2A. Multivariable Logistic Regression Analysis for Low Muscle Strength

Variables	Crude OR (95% CI)	Adjusted OR (95% CI)
Age group (years)		
Pre-elderly (45 – 59)	1.0 (Ref.)	1.0 (Ref.)
Elderly (≥60)	**4.43 (1.48, 14.16) ***	**4.41 (1.23, 17.6) ***
Sex		
Male	1.0 (Ref.)	1.0 (Ref.)
Female	0.37 (0.09, 1.21)	0.39 (0.08, 1.61)
Calf Circumference (cm)	**0.8 (0.68, 0.91) ***	**0.77 (0.62, 0.92) ***
BMI (kg/m²)	0.91 (0.78, 1.05)	1.14 (0.92, 1.43)

Ref.: Reference value; OR: Odds Ratio; CI: Confidence Interval (*) p-value <0.05

Table 2B. Multivariable Logistic Regression Analysis for Poor Physical Performance

Variables	Crude OR (95% CI)	Adjusted OR (95% CI)
Age group (years)		
Pre-elderly (45 – 59)	1.0 (Ref.)	1.0 (Ref.)
Elderly (≥60)	1.17 (0.31, 4.18)	0.94 (0.19, 4.21)
Sex		
Male	1.0 (Ref.)	1.0 (Ref.)
Female	2.57 (0.7, 9.59)	3.32 (0.77, 15.55)
Calf Circumference (cm)	0.9 (0.79, 1.04)	**0.77 (0.57, 0.96) ***
BMI (kg/m²)	1.06 (0.9, 1.26)	1.22 (0.97, 1.61)

Ref.: Reference value; OR: Odds Ratio; CI: Confidence Interval; (*) p-value <0.05

Discussion

Our study results underscored a high prevalence of probable sarcopenia within the rural community of Kudukeras Village, rural Cirebon, Indonesia. We observed that 66.1% of participants exhibited low muscle strength and 80.6% demonstrated low physical performance. These figures were notably higher than those reported in some urban Indonesian settings,[27,28] suggesting rural populations may face unique challenges, such as nutritional deficiencies or the cumulative physical toll of manual labor, that accelerate functional decline.[29]

A primary and notable finding from this study is the demonstrated utility of calf circumference (CC) as a robust and readily accessible clinical indicator for assessing both muscle strength and physical performance. Our multivariable analysis indicated that a larger calf circumference conferred significant protection against both diminished muscle strength and slow physical performance. This observation is consistent with the established concept that CC serves as a reliable proxy for skeletal muscle mass, particularly within Asian populations where advanced diagnostic tools are often unavailable or less frequently utilized.[19,30–32] Furthermore, while CC demonstrated a protective effect across both outcomes, advanced age (60 years and older) emerged as a principal driver specifically for the decline in muscle strength, thereby confirming that the biological transition from the pre-elderly demographic to the elderly demographic significantly elevates an individual's risk of experiencing strength loss.

The Asian Working Group for Sarcopenia 2019 guidelines strongly support the utility of calf circumference as a screening tool, recommending its use for community-based screening programs when more advanced measurements such as bioelectrical impedance analysis or dual-energy X-ray absorptiometry are not feasible.[20–22,33] Prior research has empirically established that calf circumference exhibits a strong correlation with appendicular skeletal muscle mass and has predictive value for physical disability and mortality in older adult populations.[20,34,35] Within the specific context of Indonesia, existing studies underscored the critical importance of readily obtainable anthropometric measures due to the high costs and limited accessibility of sophisticated imaging technologies. Our finding that calf circumference remained a significant predictor of sarcopenia indicators, even after accounting for sex and BMI,[18,36] further reinforced its validity for application within the local primary care setting.[37] Moreover, our strategic inclusion of the pre-elderly age group, defined as individuals aged 45 to 59 years, offered a crucial perspective on the early onset of sarcopenia related functional decline[38]. Existing literature consistently indicated that muscle mass and strength begin to diminish notably after the fourth decade of life.[14,33] The current study's observation that individuals aged 60 years and older are approximately four times more prone to experiencing low muscle strength compared to their pre-elderly counterparts strongly suggests that the period between 45 and 60 years of age represents a critical window for the implementation of targeted interventions, such as resistance training programs and the optimization of protein intake, aimed at preserving long term functional independence.[8,32]

Despite the significant contributions of these findings, this investigation is subject to several limitations that warrant careful consideration. Our relatively modest sample size, totaling 62 participants, limited our ability to conduct sex stratified regression analyses, thus we included sex as a confounding variable rather than analyzing it as an independent group. Furthermore, as a cross-sectional study, our design permits the identification of associations between variables like calf circumference and muscle strength but, by its nature, cannot establish definitive causal relationships between these factors. Due to resource limitations present in the study setting, we could not measure muscle mass using gold standard methods such as dual-energy X-ray absorptiometry or bioelectrical impedance analysis, which confined our present findings to the identification of probable sarcopenia rather than a definitive diagnosis. Conducting the study in a specific rural village in Cirebon means the results may not fully represent urban populations or different ethnic groups within Indonesia. Finally, although we adjusted for sex, age, and BMI, we did not fully quantify other critical factors, including detailed nutritional intake, the presence of chronic comorbidities, and specific physical activity levels, potentially introducing unaddressed confounding. Future longitudinal researchers involving larger, diverse cohorts, and comprehensive nutritional assessments are imperative to develop and refine targeted intervention strategies aimed at preserving functional independence and enhancing the quality of life for the aging Indonesian rural population.

Conclusions

This study confirms a critical public health threat with the high prevalence of probable sarcopenia observed in rural Cirebon, where a substantial portion of both pre-elderly and elderly participants exhibited low muscle strength and particularly pervasive limitations in physical performance. Our findings strongly highlighted calf circumference as a powerful, low-cost, and practical clinical indicator for effectively identifying at-risk individuals across these groups, serving as a robust tool for assessing both muscle strength and physical performance. While calf circumference offered a broad protective value, advanced age was specifically identified as the primary driver for the decline in muscle strength. These collective findings underscored the significant burden of probable sarcopenia in rural Indonesian communities. To translate these insights into actionable public health initiatives and empower healthy aging, urgent, community-based strength training programs are needed to preserve functional independence. While larger longitudinal studies will further refine these associations, our findings provided an efficient, evidence-based starting point for immediate intervention in similar resource-limited rural settings.

Competing Interests

The authors declare that no commercial, financial, or other relationships exist that could be construed as a potential conflict of interest, nor any other conflicts that might bias the discussion and conclusion of this manuscript.

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Generative AI Declaration

In the development of this manuscript, the author(s) made use of Gemini 3.0 to support grammatical refinement and language polishing. All outputs were carefully reviewed, revised, and refined by the author(s), who take full responsibility for the accuracy, originality, and integrity of the final published version.

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