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Nutritional Status and Anthropometric Indicators as Determinants of Mobility Function among Community-Dwelling Older Adults at Risk of Frailty

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ABSTRACT

Introduction: *Frailty is a geriatric condition characterized by a progressive decline in physiological reserves and functional capacity, particularly mobility. Nutritional status and anthropometric indicators play a crucial role in maintaining mobility among older adults; however, integrated evidence focusing on community-dwelling older adults at risk of frailty remains limited. This study aimed to examine the association between nutritional status, mid-upper arm circumference (MUAC), and mobility function among community-dwelling older adults at risk of frailty.* ***Methods:*** *An observational analytic study with a cross-sectional design was conducted among 176 older adults aged ≥60 years who were identified as being at risk of frailty and recruited using consecutive sampling. Nutritional status was assessed using the Mini Nutritional Assessment–Short Form (MNA-SF), MUAC was measured as an anthropometric indicator, and mobility function was evaluated using the Timed Up and Go (TUG) test. Data were analyzed using Chi-square tests and odds ratios (ORs) with 95% confidence intervals.* ***Results:*** *More than half of the participants were classified as at risk of chronic energy deficiency based on MUAC (56.25%), and 52.83% were categorized as malnourished or at risk of malnutrition. Impaired mobility was observed in 69.80% of participants. Significant associations were identified between nutritional status and mobility function ($p < 0.001$) as well as between MUAC and mobility function ($p < 0.001$), with very strong associations.* ***Conclusions*** *Early nutritional and anthropometric screening is essential to prevent functional decline and frailty progression among community-dwelling older adults.*

Introduction

The increase in life expectancy has driven a significant demographic transition, marked by a growing proportion of older adults both globally and nationally. According to Jane Osareme, Ogugua et al., (2024) The World Health Organization projects a substantial rise in the global older population. By the mid-2030s, the number of adults aged over 80 years is estimated to reach 265 million and is expected to double by 2050, reaching nearly 2 billion worldwide**.** By 2070, the global older population is projected to reach 2.23 billion (Nations, 2023)This rapid demographic transition, particularly in low- and middle-income countries, heightens the urgency to strengthen prevention-oriented geriatric care and community-based screening to maintain functional independence in later life(Putri et al., 2024).

The proportion of older adults increased by nearly 4%, reaching 12% in 2024. By 2045, the number of older adults in Indonesia is projected to reach 65.82 million, accounting for 20.31% of the total population (Statistics of Older Population, 2024). This rapid growth is accompanied by an increased burden of chronic health conditions and declining functional capacity, which has direct implications for families and healthcare systems. (Pusdatin, 2022).For district such as Jember in East Java, the growing older has important implication for primary health service (e.g

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Posyandu Lansia and Puskesmas) because functional decline, falls, and disability can substantially increase care needs at the household and community levels.

Frailty is one of the most prevalent conditions among older adults. Hikmah, (2022) reported that approximately 7% of adults aged 65 years' experience frailty, with prevalence increasing to 30% among those aged 80 years. The incidence of frailty among women aged 65 years reaches 28%. Frailty is a multidimensional syndrome involving complex interactions between age-related biological changes, nutritional status, muscle function, and functional capacity (Arif et al., 2025). Older adults with frailty are at higher risk of falls, disability, recurrent hospitalization, and mortality.(Santoso et al., 2025). However, the pre-frailty stage represents a critical window for early detection and preventive intervention.

Frailty is a clinical syndrome characterized by decreased physiological reserve and increased vulnerability to stressors, often manifested by weakness, slowed gait, exhaustion, and reduced physical activity (Dogan Varan, 2020). In community settings, frailty prevention remains challenging because early changes in nutritional intake, muscle mass, and mobility may be subtle, while routine screening is not consistently implemented. Simple, low-cost indicators that can be applied by community health workers are therefore essential to identify older adults at risk and initiate timely preventive interventions.

A typical pathway begins with age-related changes in appetite, digestion, and metabolism that reduce energy and protein intake (Guede-Rojas et al., 2020). Over time, inadequate intake contributes to malnutrition and loss of peripheral muscle mass (sarcopenia), which in turn diminishes strength and balance. These changes are reflected in poorer mobility performance—commonly measured using the Timed Up and Go (TUG) test—and ultimately increase fall risk and functional dependence (Dai et al., 2023).

Mobility function is a key indicator of functional capacity and an essential component of frailty assessment. Functional capacity refers to an individual's ability to change position and perform physical activities (Nugraha et al., 2024). Mobility includes basic activities such as standing from a seated position, walking, and maintaining balance. Declining mobility not only increases fall risk but also contributes to limitations in daily activities and loss of independence. Functional assessment tools such as gait speed, chair stand test, and the Timed Up and Go test are widely used as objective indicators of physical function and predictors of health outcomes in older adults (Chau et al., (2025).

Nutritional status is a major determinant of mobility function in older adults (Moon et al., 2023). Aging is often accompanied by reduced energy and protein intake, metabolic changes, and impaired nutrient absorption, leading to malnutrition or risk of malnutrition. Malnutrition contributes to decreased muscle mass and strength, known as sarcopenia, which is closely associated with physical performance decline (Ren et al., 2024). Poor nutritional status has been consistently associated with reduced lower extremity strength, slower gait speed, and increased frailty risk.

In addition to nutritional status, anthropometric indicators are important parameters for assessing body composition and physical function in older adults. Measurements such as body mass index, mid-upper arm circumference, and calf circumference are simple indicators reflecting muscle mass reserves (Kim et al., 2024). Calf circumference and mid-upper arm circumference have been shown to correlate strongly with muscle strength, balance, and mobility performance (Ceolin et al., 2024). Their simplicity, low cost, and feasibility make them highly suitable for frailty screening in primary care and community settings.

Despite growing evidence on the relationships between nutritional status, anthropometry, and mobility function, most previous studies have examined these variables separately.

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Integrated analyses focusing on community-dwelling older adults at risk of frailty, particularly in Indonesia, remain limited. Community-based research is crucial for capturing real-life conditions and informing contextually appropriate preventive and promotive strategies. Therefore, this study aimed to analyze nutritional status and anthropometric indicators as determinants of mobility function among community-dwelling older adults at risk of frailty.

From a prevention perspective, integrating brief nutritional screening (e.g., MNA-SF) and simple anthropometry (e.g., mid-upper arm circumference/MUAC) into routine community visits may facilitate early identification of older adults at risk of frailty-related functional decline. When risk is identified, multimodal approaches—including individualized nutrition counselling to improve protein-energy intake, progressive resistance and balance exercise, and medication review—have been recommended to mitigate frailty progression and improve physical function (Lo Buglio et al., 2024), However, evidence remains limited regarding how feasible community indicators such as MUAC and MNA-SF relate to mobility performance among older adults at risk of frailty in Indonesian community settings.

Despite the growing burden of frailty and functional decline, limited studies have examined practical nutritional and anthropometric indicators that can be applied in community screening to predict mobility limitations among older adults at risk of frailty. Therefore, this study aimed to (1) examine the association between nutritional status measured by the Mini Nutritional Assessment–Short Form (MNA-SF) and mobility function measured by the Timed Up and Go (TUG) test, and (2) examine the association between mid-upper arm circumference (MUAC) and TUG performance among community-dwelling older adults at risk of frailty in Jember Regency, Indonesia.

Methods

This study employed an observational analytic design with a cross-sectional approach. The target population consisted of community-dwelling older adults in Jember Regency who were at risk of frailty. During the study period, a total of 176 eligible older adults were identified across the selected communities and constituted the accessible population; all eligible individuals were approached and recruited using consecutive sampling, resulting in a final sample of 176 participants.

Inclusion criteria were: (1) age ≥60 years, (2) living in the community, (3) classified as at risk of frailty, (4) able to communicate verbally, and (5) willing to participate. Exclusion criteria included: (1) acute illness or severe disease affecting mobility, (2) severe cognitive impairment, and (3) inability to complete all measurements.

Nutritional status was assessed using the MNA-SF. Anthropometric measurements included mid-upper arm circumference and calf circumference (Setiati et al., 2025) . Mobility function was assessed using the Timed Up and Go test. Bivariate analysis was performed using Chi-square or Fisher's exact test, with significance set at $p < 0.05$. Odds ratios with 95% confidence intervals were calculated to determine the strength of associations.

Results

Data collection involved interviews and assessments of the study variables. Interviews conducted with 176 participants yielded the following demographic and clinical characteristics.

Tabel 1. General Characteristic of Partcipant (n=176)

Participaant Characteristics	Frequency	Percentage (%)
Age (years)		
60 – 74	43	24,4

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75 – 90	110	62,5
>90	23	13,1
Sex		
Male	60	34,1
Female	116	65,9
Visual Function		
Normal	39	22,2
Impaired	137	77,8
Hearing Function		
Normal	70	39,8
Impaaired	106	60,2
Living Arrangement		
Living Alone	9	5,1
Nuclear family	36	20,5
Extended family	131	74,4
Comorbidity		
Present	87	49,4
Absent	89	50,6
History of Fall		
Yes	99	56,3
No	77	43,8
Use of Walking Aid		
Yes	32	18,2
No	144	81,8

Berdasarkan data yang ditampilkan pada tabel 1 dapat kita ketahui bahwa mayoritas Most participants were aged 75–90 years (62.5%) and female (65.9%). A high proportion experienced visual (77.8%) and hearing impairment (60.2%). The majority lived with extended families (74.4%). More than half had a history of falls in the previous year (56.3%), although most did not use walking aids (81.8%).
Anthropometric measurements, nutritional status, and mobility function were assessed using MUAC, MNA-SF, and the TUG test. The results are presented below.

Tabel 2. Distribution of Mid-Upper Arm Circumference, Nutritional Status, and Mobility Function among Participants (n=176)

Variable	Frequency (N)	Percentage
Mid Upper Arm Circumference (MUAC)		
At risk of chronic energy deficiency	99	56,25
Normal	77	43,75
Nutritional Status		
Malnourished	3	1,70
At risk of malnutition	90	51,13
Normal	83	47,17
Mobility function		
Impaired mobility	107	69,80
Normal mobility	69	39,20

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Based on anthropometric assessment, 56.25% of participants were classified as at risk of chronic energy deficiency. According to MNA-SF, 52.83% were malnourished or at risk of malnutrition. Impaired mobility was observed in 69.80% of participants.

To examine the association between the independent and dependent variables, statistical analysis was performed using the Chi-square test. The results of the analysis are presented below.

Tabel 3. Cross Tabulation of Nutritional Status and Mobility Function of Participants (n=176)

		Mobility Function		Total
		Impaired Mobility	Nomal Mobility	
Nutritional Status	Malnuourished	3	0	3
	At risk of malnutrition	90	0	90
	Normal	14	69	83
Total		107	69	176
$\chi^2 = 127,169; p < 0,001$				

The cross-tabulation data presented in Table 3 show that all three participants classified as malnourished experienced impaired mobility. Similarly, all 90 participants who were at risk of malnutrition also demonstrated impaired mobility. In contrast, among the 83 participants with normal nutritional status, 83.13% exhibited normal mobility function. The Chi-square test revealed a Chi-square value of 127.169 with a p-value of less than 0.01, indicating a statistically significant association between nutritional status based on the MNA-SF and mobility function among older adults, with a very strong strength of association (Cramer's V = 0.850).

Tabel 4. Cross Taabulation of Mid Upper Arm Circumference aand Mobility Function of Participants (n=176)

		Mobility Function		Total
		Impaired Mobility	Normal Mobility	
MUAC	At risk of Chronid Energy Deficiency	99	0	99
	Normal	8	69	77
Total		107	69	176
$\chi^2 = 145,923; p < 0,001$				

Based on the cross-tabulation data in Table 4, all 99 participants classified as at risk of chronic energy deficiency according to MUAC experienced impaired mobility. In contrast, among the 77 participants with normal MUAC, 89.61% exhibited normal mobility function. The Chi-square test yielded $\chi^2 = 145.923$; $p < 0.001$, indicating a statistically significant association between MUAC and mobility function among older adults, with a very strong strength of association (Cramer's V = 0.911).
Furthermore, the risk of impaired mobility based on nutritional status and mid-upper arm circumference was estimated using odds ratios (ORs), as presented below.

Tabel 5. Odds Ratios for Impaired Mobility Function Based on Nutritional Status and Mid-Upper Arm Circumference (n=176)

Variable	OR	95%CI

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MUAC	1627,12	92,38 – 28658,21
Nutritional Status	896,31	52,56 – 15284, 12

In the bivariate association analysis using odds ratios (ORs) (Table 5), older adults with MUAC indicating risk of chronic energy deficiency had 1627.12 times higher odds of impaired mobility compared with those with normal MUAC (OR = 1627.12; 95% CI: 92.38–28658.21; $p < 0.001$). In addition, older adults who were malnourished or at risk of malnutrition had 896.31 times higher odds of impaired mobility compared with those with normal nutritional status (OR = 896.31; 95% CI: 52.56–15284.12; $p < 0.001$).

Discussion

The findings of this study indicate that 56.55% of participants were classified as at risk of chronic energy deficiency based on mid-upper arm circumference (MUAC), and 51.13% were at risk of malnutrition according to the Mini Nutritional Assessment–Short Form (MNA-SF). These results are consistent with Moon et al.,(2023), who reported that nutritional problems in older adults typically develop gradually and often remain at a risk stage before progressing to overt malnutrition. Among older and oldest-old individuals, reduced energy and protein intake is frequently observed due to age-related physiological changes in the gastrointestinal system, diminished appetite, and impaired metabolic regulation (Tseng et al., 2025).

The high proportion of participants with MUAC-based chronic energy deficiency risk reflects reduced peripheral muscle reserves. MUAC has been recognized as a sensitive anthropometric indicator for detecting sarcopenia and age-related changes in body composition among older adults, particularly in community settings (Ceolin et al., 2024). This is further supported by the study sample characteristics, in which most participants were aged ≥75 years and predominantly female—groups that generally have lower baseline muscle mass and are more vulnerable to accelerated muscle loss with aging (Otsuka et al., 2025).

Beyond biological factors, the high prevalence of visual and hearing impairments may also indirectly influence nutritional status. Sensory impairments can reduce independence in food selection, preparation, and consumption, and may limit social interaction during meals, ultimately contributing to decreased dietary intake (Ren et al., 2024). Notably, although most participants lived with extended family members, co-residence does not necessarily ensure adequate nutritional intake that matches older adults' specific needs.

This study also found that 69.80% of participants exhibited impaired mobility based on the Timed Up and Go (TUG) test. This finding suggests that mobility limitation is a common problem among community-dwelling older adults at risk of frailty. The TUG test has been widely used as an objective measure of mobility and as a predictor of functional decline, fall risk, and frailty in older adults (Chau et al., 2025).

The observed mobility impairment may be related to participants' advanced age as well as the high prevalence of falls within the past year. A history of falls can lead to activity restriction due to fear of falling, which may accelerate declines in muscle strength and balance (Santoso et al., 2025). Interestingly, although most participants did not use walking aids, the TUG test still identified impaired mobility, underscoring that mobility limitation can be subclinical and may only become apparent through objective functional assessment (Nugraha et al., 2024).

Bivariate analyses demonstrated highly significant associations between nutritional status and MUAC with mobility function, with very strong strengths of association. All participants who were malnourished/at risk of malnutrition and those with MUAC-based chronic energy deficiency risk experienced impaired mobility. These findings reinforce evidence that mobility decline in

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older adults is a functional manifestation of compromised nutritional status and reduced muscle reserves(Arif et al., 2025).

Biologically, inadequate nutritional intake contributes to loss of muscle mass and strength—particularly in the lower extremities, which are essential for walking, standing, and maintaining balance. MUAC reflects the long-term impact of nutritional status on peripheral muscle reserves, whereas MNA-SF captures multidimensional nutritional vulnerability, which together explain the substantially higher likelihood of mobility impairment among participants with poor nutritional and anthropometric profiles.

The very large odds ratios observed in this study indicate a strong association between the independent and dependent variables; however, these estimates should be interpreted cautiously due to zero cells in the cross-tabulations. This pattern suggests that the sample comprised older adults with high functional vulnerability, and therefore the observed associations may better reflect clinical strength of association rather than absolute risk estimates.

Overall, the findings suggest that poorer nutritional status (as screened by MNA-SF) and lower mid-upper arm circumference (MUAC) are strongly associated with impaired mobility (slower TUG performance) among community-dwelling older adults at risk of frailty. Because MUAC and MNA-SF are brief and low-cost, they are feasible to integrate into routine community services (e.g., Posyandu Lansia/Puskesmas) to support early identification and prevention. When risk is detected, timely multimodal strategies—such as improving protein-energy intake and implementing progressive resistance and balance exercise—may help preserve muscle mass and mobility and potentially slow frailty progression (Shi et al., 2025: Li et al., 2022). Future studies with prospective designs and larger samples are needed to confirm predictive value, refine cut-offs, and reduce the influence of sparse data in regression estimates.

Conclusion

Most community-dwelling older adults at risk of frailty experience chronic energy deficiency risk, nutritional risk, and impaired mobility. Nutritional status and mid-upper arm circumference are significantly associated with mobility function, indicating that nutritional reserves and muscle mass are key determinants of functional capacity. Early, integrated screening using simple nutritional, anthropometric, and mobility assessments is essential to prevent functional decline and frailty progression in community settings..

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Faculty of Health Sciences, Universitas Muhammadiyah Jember (Approval No. 0190/KEPK/FIKES/XII/2025). Written informed consent was obtained from all participants prior to data collection.

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