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RESEARCH

Association of Dietary Patterns and Sarcopenia in the Ageing Population in Polonnaruwa District, Sri Lanka: A Cross-Sectional Study

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ABSTRACT

Sarcopenia involves age-related muscle loss, posing a significant concern for older people. This study investigates the relationship between dietary patterns and sarcopenia prevalence among the ageing population in the Polonnaruwa district, Sri Lanka. A cross-sectional study was conducted with 150 randomly selected individuals aged 65 and above. Assessments included nutritional status using the Mini Nutritional Assessment-Short form, dysphagia risk with the EAT-10 tool, and physical activity using the International Physical Activity Questionnaire-Short Form. Sarcopenia was diagnosed using the Asian Working Group for Sarcopenia-2019 (AWGS) criteria, including the SARC-Calf questionnaire, handgrip strength, Skeletal Muscle Mass Index (SMI), and gait speed. Statistical analyses, including logistic regression for the outcome variable (prevalence of sarcopenia) using continuous predictors (age and BMI), and Chi-square tests for categorical predictors (nutritional status and gender), were performed with a significance threshold of 0.05. The average age of participants was 70.7 years. The prevalence of sarcopenia was 49.6%, affecting 44.6% of males and 52.9% of females. The odds of sarcopenia increased with age (OR: 1.0654, $p>0.05$) and decreased with higher BMI (OR: 0.7542, $p<0.05$). Significant associations were observed between sarcopenia and legume consumption, nutritional status, and physical activity levels ($p<0.05$), while no significant associations were found between sarcopenia and gender, dysphagia, smoking, drinking water, vegetarianism, meat, dairy, and alcohol consumption ($p>0.05$). These findings highlight that adequate nutrition, increased physical activity, and legume consumption may protect against and delay the onset of sarcopenia, suggesting targeted interventions for aging people in Polonnaruwa.

INTRODUCTION

Sarcopenia, a term coined by Rosenberg in 1989, represents a multifaceted aspect of the aging process, characterized by the progressive loss of skeletal muscle mass and function (Cesari, Calvani, & Marzetti, 2020). Derived from the Greek words "sarx" meaning flesh and "penia" meaning loss, sarcopenia encapsulates the age-related decline in muscle tissue, which has significant implications for overall health and functional ability in older adults (Langer, *et al.*, 2019; Lewandowicz, Sławiński, Kądalska, & Targowski, 2020).

Adequate protein intake is crucial for the maintenance of muscle mass and function in older adults. Research highlights the importance of dietary protein in mitigating the effects of sarcopenia. For instance, Coelho-Junior *et al.* (2022) conducted a systematic review and meta-analysis emphasizing the critical role of protein intake in preserving muscle mass and strength in older populations. The consensus is that higher protein consumption can attenuate muscle loss and enhance physical performance in sarcopenic individuals. Wiedmer *et al.* (2021) and Coelho-Junior *et al.* (2022) emphasize the indispensable role of physical activity, particularly resistance training, in maintaining muscle health and mitigating the deleterious effects of sarcopenia.

Sarcopenia is a growing concern among older adults in Sri Lanka (Rathnayake, Alwis, Lenora, & Lekamwasam, 2019). This age-related condition, characterized by the loss of muscle mass and strength, has gained attention in recent years due to its impact on the health and quality of life of the elderly population. Preliminary research findings suggest that dietary patterns and physical activity levels play significant roles in its prevalence (Granic, Sayer , & Robinson, 2019). With dietary protein intake often falling below recommended levels and a substantial portion of older adults engaging in low levels of physical activity, there is an urgent need for further investigation into the prevalence, risk factors, and no potential interventions to mitigate sarcopenia in this demographic (Beasley, *et al.,* 2018). Understanding the specific challenges and contributing factors related to sarcopenia in Sri Lankan older adults is essential for developing effective strategies to improve their overall health and well-being.

This study aims to explore the associations between dietary patterns and sarcopenia in the elderly population of Polonnaruwa District, Sri Lanka. By analyzing the nutritional intake and dietary habits of this demographic, the research seeks to understand the impact of nutrition on the prevalence of sarcopenia. The goal is to provide insights into dietary modifications that could help prevent or delay sarcopenia in the ageing population.

MATTERIALS AND METHODS

Study Design and Sample Size

The current study is a community-based cross-sectional analysis conducted in the Polonnaruwa District, Sri Lanka, from March 2024 to June 2024. The study was approved by the Ethical Review Committee of the Faculty of Allied Sciences at the University of Peradeniya, with the committee's reference number AHS/ERC/2023/124. The method of sampling was simple random sampling, with participants aged 65 and above selected from electoral registers. Recruitment predominantly occurred in the community through home visits, community centers, and religious centers.

Sarcopenia affects approximately 10%–16% of the elderly population worldwide (Yuan & Larsson, 2023), though prevalence data specific to Sri Lanka are limited. For this study, we estimated a sarcopenia prevalence of 10% to determine the necessary sample size for investigating the association between dietary patterns and sarcopenia in the elderly population of the Polonnaruwa district, Sri Lanka. Considering a 95% confidence level, a 5% margin of error, a design effect of 1, and a 10% non-response rate, the required sample size is approximately 154. This sample size ensures adequate power to

detect the association in our target population.
The inclusion criteria for participants in this study were individuals aged 65 years and older, permanent residents within the community, possessing the capacity to understand and respond to the questionnaire, and expressing willingness to provide informed consent for participation. Exclusion criteria encompassed individuals with cognitive impairment, lower extremity amputation, those who are bedridden, those unable to walk or demonstrate grip strength, and individuals with a history of long-term chronic diseases.

Data collection
Data were gathered through interviewer-administered questionnaires covering various aspects. Sociodemographic details, chronic conditions, Lifestyle behaviors and dietary patterns will also be assessed. Face-to-face personal interviews will be conducted with each participant using a validated questionnaire.

Anthropometric measurements
All physical examinations were performed according to standardized procedures. Height and body weight were measured using a stadiometer and a digital weighing scale, respectively. Body Mass Index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters. Waist Circumference (WC) and Calf Circumference (CC) were measured with a non-stretchable measuring tape.

Nutritional status
To identify malnutrition risk in geriatric individuals across various settings, the Mini Nutritional Assessment (MNA-SF), a six-item questionnaire, was utilized. It assesses factors such as food intake, weight loss, psychological stress over the past three months, and BMI. Scores range from 0-7, indicating malnourishment, 8-11, suggesting risk of malnutrition, and 12-14, reflecting normal nutritional status.

Dysphagia evaluation
Dysphagia risk was determined using the validated Eating Assessment Tool (EAT-10), a 10-item self-directed questionnaire. Each question rates the severity of swallowing problems from zero (no issue) to four (severe problem). A score of three or more indicates abnormality, with higher scores indicating more severe dysphagia.

Physical activity
Physical activity was assessed using the IPAQ-SF, evaluating walking, moderate, and vigorous activities by frequency and duration. Total physical activity volume was calculated in MET. minutes. Subjects were classified into three categories: inactive, moderately active (Engage in ≥3 days of vigorous activity (≥20 min/day) or ≥5 days of moderate activity/walking (≥30 min/day), totaling ≥600 MET-min/week.), and HEPA (high activity levels, either vigorous activity >3 days/week with ≥1500 MET-min/week, or any combination of activities >5 days/week with ≥3000 MET-minutes/week).

Sarcopenia assessment
The AWGS-2019 criteria assess sarcopenia through anthropometric measures and muscle strength, categorizing it as possible, confirmed, or severe. Possible sarcopenia is indicated by low muscle strength or performance, confirmed by low muscle mass and strength or performance. The SARC-CalF questionnaire screens for possible cases, while handgrip strength, Skeletal Muscle Mass Index (SMI), and gait speed confirm diagnosis. Severe sarcopenia includes low muscle mass, strength, and performance.

Statistical analysis
The prevalence of sarcopenia was calculated by dividing the number of participants diagnosed with sarcopenia by the total number of participants, and the result was expressed as a percentage. Normality of the continuous variables (age and BMI) was assessed using the Shapiro-Wilk test. The association between sarcopenia and categorical variables (gender, smoking, alcohol consumption, nutritional status, physical Activity level, dietary patterns) was examined using Pearson's Chi-square test. Logistic regression was conducted to examine the association between sarcopenia (outcome variable) and

continuous predictors (age and BMI). The threshold of significance was 0.05.

RESULTS

Among the 143 participants, 39.9% (n = 57) were male, and 60.1% (n = 86) were female (Figure 1), all over 65 years old, with a mean age of 70.6 years. Possible sarcopenia (n = 74) was screened using the Sarc-Calf screening tool. The prevalence of sarcopenia among these participants was 49.0%, with 43.9% of males and 52.3% of females affected.

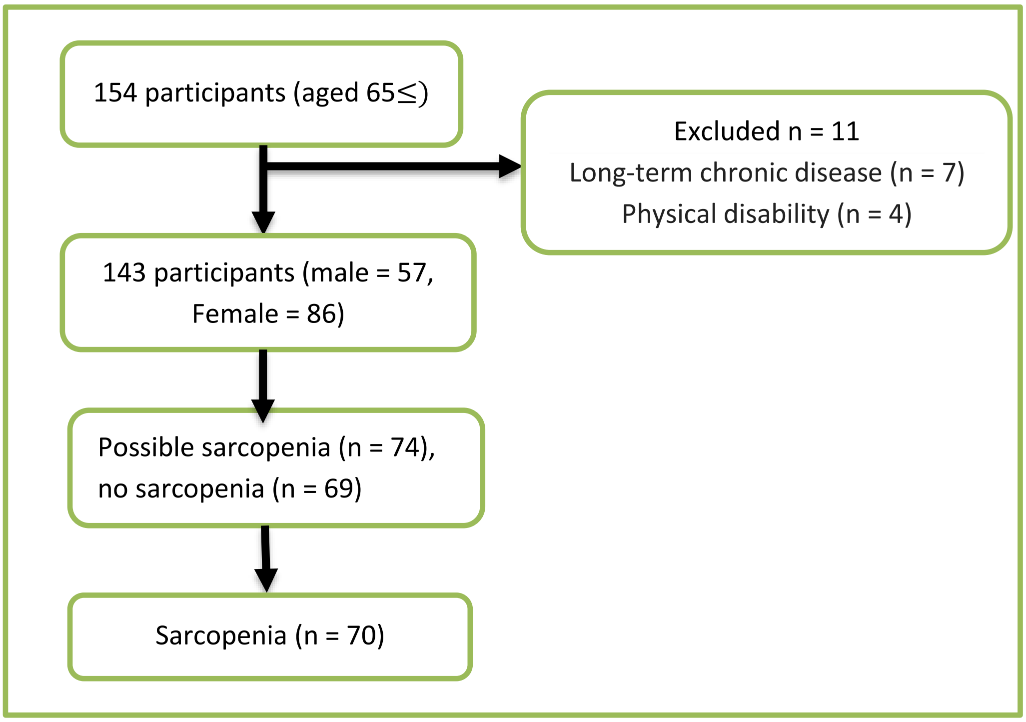

Figure 1: Flow diagram for study participants

The Shapiro-Wilk test results indicated that the continuous variables BMI ($p < 0.05$) and age ($p < 0.05$) are not normally distributed. The results from the logistic regression analysis indicate that age is not statistically significant at the 0.05 level but is marginally significant. The positive coefficient suggests that as age increases, the odds of sarcopenia might increase. The odds ratio of 1.071 indicates that with each additional year of age, the odds of sarcopenia increase by approximately 7.1%. However, the confidence interval (0.998 to 1.157) includes 1, suggesting that this result is not conclusive (Table 1). BMI is statistically significant ($p < 0.05$). The odds ratio of 0.775 suggests that for each unit increase in BMI, the odds of sarcopenia decrease by approximately 24.5%. The confidence interval (0.662 to 0.839) is entirely below 1, reinforcing the significance of this finding. These results suggest that BMI has a significant protective effect against sarcopenia.

The chi-square test results provide insight into the association between sarcopenia and various associated risk factors. Dietary habits (legume consumption), nutritional status (MNA), and physical activity (IPAQ)

Table 1: Logistic regression analysis result of BMI and Age

Variable	Std. Error	Z-Value	P-Value	Odd Ratio	CI Lower	CI Upper
Age	0.038	1.84	0.0656	1.071	0.998	1.157
BMI	0.058	-4.86	0.000001	0.775	0.669	0.839

Table 2: Association between sarcopenia and Risk factors

Variable	Total N=143(n%)	Sarcopenia		P-value(Chi-square test)
		Normal	Sarcopenia	
Gender				
Male	57(39.9%)	32(22.4%)	25(17.5%)	0.4118
Female	86(60.1%)	41(28.7%)	45(31.4%)	
Smoking				
Yes	18(12.6%)	10(7.0%)	8(5.6%)	0.8753
No	125(87.4%)	63(44.0%)	62(43.4%)	
Alcohol				
Yes	18(9.2%)	11(7.7%)	7(4.9%)	0.5085
No	125(90.8%)	62(43.4%)	63(44.1%)	
Vegetarianism				
Yes	8(5.6%)	2(1.4%)	6(4.2%)	0.2489
No	135(94.4%)	71(49.7%)	64(44.8%)	
Meat, fish or egg				
Once a day or more	91(63.6%)	51(35.6%)	40(28.0%)	
Few times a week	29(20.3%)	14(9.8%)	15(10.5%)	0.1797
Rarely or not at all	23(16.1%)	8(5.6%)	15(10.5%)	
Legumes				
Once a day or more	44(30.8%)	15(8.4%)	29(20.3%)	
Few times a week	83(58.0%)	49(34.5%)	34(23.8%)	0.02528
Rarely or not at all	16(11.2%)	9(6.3%)	7(4.9%)	
Milk				
Once a day or more	90(62.9%)	47(32.9%)	43(30.1%)	
Few times a week	8(5.6%)	4(2.8%)	4(2.8%)	0.9337
Rarely or not at all	45(31.5%)	22(15.4%)	23(16.1%)	
Yogurt				
Daily or more	27(18.9%)	11(7.7%)	16(11.2 %)	
Few times in week	16(11.2%)	9(6.3%)	7(4.9%)	0.4786
Rarely or not at all	100(69.9%)	53(37.1%)	47(32.8%)	
Water				
More than 1.5 l per day	132(92.3%)	68(47.6%)	64(44.4%)	0.9423
Less than 1.5 l per day	11(7.7%)	5(3.5%)	6(4.2%)	
Dysphagia				
Yes	32(22.4%)	14(9.8%)	18(12.6%)	0.4612
No	111(77.6%)	59(41.2%)	52(36.4%)	
MNA				
Normal	70(49.0%)	50(35.0%)	20(14.0 %)	
At risk	33(23.1%)	11(7.7%)	22(15.4%)	0.00001
Malnourished	40(28.0%)	12(8.4%)	18(19.6%)	
IPAQ				
Active	26(18.2%)	19(13.3%)	7(4.9%)	
Moderate	57(39.9%)	37(25.9%)	20(14.0%)	0.00002
Low	60(42.0%)	17(11.9%)	43(30.1%)	

associations were found between sarcopenia and other factors, including gender, smoking, alcohol consumption, vegetarianism, meat consumption, milk consumption, yogurt consumption, water consumption, and dysphagia ($p > 0.05$) (Table 2).

Table 3: Multinomial analysis for association between sarcopenia with nutritional status and physical activity level

Categories	P-value	Odd. Ratio(OR)	Confidence Interval(CI)
Nutritional Status(MNA-SF)			
Malnourished	0.0141	2.33	1.19-4.59
At risk	0.7604	0.86	0.32-2.31
Normal	0.00005	0.17	0.07- 0.40
Physical Activity Level (IPAQ)			
Low	0.0012	2.53	1.44-4.44
Moderate	0.0001	0.21	0.10-0.47
Active	0.0003	0.15	0.05-0.41
Legume consumption			
Rarely or not at all	0.6180	07778	0.29- 2.09
Few times a week	0.8360	0.8221	0.30-2.63
Once a day or more	0.1265	2.4857	0.77-7.99

DISCUSSION

The prevalence of sarcopenia globally ranges from 9.9% to 40.4%, depending on the definition used (Mayhew, *et al.,* 2019). This variation is influenced by several factors, including ethnic diversity, social demographics, lifestyle choices, nutritional status, levels of physical activity, prevalence of chronic diseases, healthcare access, and educational attainment (Liu, *et al.,* 2020; Xin, Sun, Lu, & Shan, 2021). These factors collectively contribute to the differences in sarcopenia prevalence observed across various populations and regions. Our study reveals that the prevalence of sarcopenia among older adults (≥65 years) in the Polonnaruwa district is notably high at 49.0%. This aligns with global trends that indicate a substantial burden of sarcopenia in aging populations. Although our study did not reveal a statistically significant difference in sarcopenia prevalence between genders, it is noteworthy that females exhibited a higher prevalence rate (52.3%) compared to males (43.9%). This gender disparity, though not statistically significant, may reflect differences in muscle mass and hormonal influences. Estrogen is significant for the musculoskeletal system, particularly in women. Postmenopausal women experience a decrease in estrogen levels, which contributes to the loss of muscle mass and strength. This hormonal shift is a key factor in the increased prevalence of sarcopenia among older women (Gupta & Kumar, 2022).

Our logistic regression analysis identified a significant association between sarcopenia and Body Mass Index (BMI), with a $P < 0.05$. BMI appears to have a protective effect against sarcopenia, with higher BMI values correlating with a lower risk of developing the condition (Odds Ratio = 0.775, CI: 0.669-0.839) (Table 1). This inverse relationship underscores the complex role of body composition in sarcopenia pathophysiology. While higher BMI may imply greater muscle mass, which can counteract the effects of sarcopenia, it is also important to distinguish between lean mass and fat mass in future research. Several other studies also reported the protective effect of BMI against sarcopenia (Tan You Mei, *et al.*, 2024).

Advancing age stands as the primary risk factor for sarcopenia (Hwang & Park, 2022). Muscle loss typically initiates in the fourth decade of life and escalates post the age of sixty (Smith, *et al.,* 2021). Age-related hormonal alterations, mitochondrial dysfunction, increased production of reactive oxygen species, systemic upregulation of pro-inflammatory markers, and shifts in muscle regeneration mechanisms collectively contribute to this phenomenon (Coen, Musci, Hinkley, & Miller, 2018; Bian, *et al.*, 2020; Lewandowicz, Sławiński, Kądalska, & Targowski, 2020). Our analysis also indicated that sarcopenia increases with aging, with a marginally significant P-value of 0.066 and an Odds Ratio of 1.071 (CI: 0.998-1.157) (Table 1). This finding suggests that as age progresses, the risk of sarcopenia slightly increases, which is consistent with the understanding that aging is a primary risk factor for muscle degeneration.

Lifestyle habits such as smoking and alcohol consumption did not show a significant association with sarcopenia in our study. Lack of regular physical activity, including resistance training and aerobic exercise, is a significant risk factor for sarcopenia (Chen, Zhang, Wang, Hong, & Fang, 2017). Physical inactivity can accelerate muscle loss and weaken muscle function (Volpi, Nazemi, & Fujita , 2004; Distefano & Goodpaster, 2018). Michal Steffl *et al.* (2017) conducted a systematic review and meta-analysis that confirmed the beneficial influence of physical activity in general for the prevention of sarcopenia. Our study also found that the level of physical activity, measured by the International Physical Activity Questionnaire (IPAQ), showed a significant association with sarcopenia ($p<0.05$). Individuals with low physical activity levels (OR: 2.53, CI: 1.44-4.44) have higher odds of developing sarcopenia. Both moderate (OR: 0.21, CI: 0.10-0.47) and active (OR: 0.15, CI: 0.05-0.41) physical activity levels are significantly associated with lower odds of developing sarcopenia (Table 3), with high physical activity providing the greatest protective effect. These findings underscore the significant protective effect of higher physical activity levels against sarcopenia, emphasizing the importance of promoting physical activity to reduce the risk of sarcopenia in the population.

Regarding dietary patterns, the majority of our study participants were non-vegetarian (95.0%), and statistical results showed no significant association between overall dietary patterns and sarcopenia. However, specific food consumption patterns revealed that while meat, fish, dairy intake, and water consumption had no significant association, legume consumption was significantly ($p < 0.05$) associated with a reduced risk of sarcopenia. 95% of study participants drank more than 1.5 liters of water per day, which did not appear to influence sarcopenia prevalence.

Malnutrition and sarcopenia are closely related, as malnutrition leads to decreased muscle mass and body cell mass (Calcaterra, *et al.*, 2024). Our study revealed a significant association between nutritional status and sarcopenia ($P < 0.05$). Individuals classified as malnourished (OR: 2.33, CI: 1.19-4.59) have 2.33 times higher odds of developing sarcopenia compared to those with normal nutritional status (Table 3). This finding indicates a strong relationship between malnutrition and increased risk of sarcopenia. Conversely, individuals with normal nutritional status have a significantly lower risk of sarcopenia, with an OR:0.17 (CI: 0.07-0.40), indicating approximately 83% lower odds of developing the condition. This significant protective effect underscores the importance of maintaining adequate nutrition to prevent the onset of sarcopenia.

The results of this study emphasize the critical role of nutrition in mitigating the risk of sarcopenia. Specifically, maintaining a normal nutritional status appears to be strongly protective against sarcopenia, while being malnourished or at risk of malnutrition does not show a statistically significant association with increased risk in this analysis. These findings suggest that nutritional interventions aiming to ensure adequate intake of essential nutrients might be effective in preventing sarcopenia, particularly in populations at higher risk.

CONCLUSIONS

Sarcopenia is highly prevalent among the elderly living in Polonnaruwa, affecting 49.0% of this population (43.9% of males and 52.3% of females). This study highlights the significant protective effect of maintaining normal nutritional status against sarcopenia. The results suggest that higher levels of physical activity (moderate and active) are significantly associated with lower odds of sarcopenia. Additionally, dietary habits, specifically legume consumption, were significantly associated with sarcopenia. No significant associations were found between sarcopenia and other factors such as gender, smoking, alcohol consumption, dietary pattern (vegetarian or non-vegetarian), meat consumption, dairy consumption, yogurt consumption, water consumption, and dysphagia.

Future research should aim to further explore the nuanced relationships between varying degrees of nutritional status and sarcopenia. Larger sample sizes and longitudinal studies could provide more definitive insights into causality and help identify specific nutritional factors that are most influential in reducing the risk of sarcopenia. Additionally, examining the role of specific dietary components and their direct impact on muscle health could provide targeted strategies for prevention and management.

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