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Original Research Article

Exploring the interrelation among sarcopenia, obesity and nutrition in older adults

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ABSTRACT

Background: The purpose of the study was to explore the interrelation among sarcopenia, obesity, and nutrition in adults aged 60 and older, focusing on how these conditions interact, the role of nutrition in their progression. It further seeks to examine the influence of physical activity and dietary patterns on these conditions to identify potential preventive strategies.
Methods: A cross-sectional study was conducted from January to May 2025 on 172 older adults to examine the interrelation among sarcopenia, obesity, nutrition, physical activity, and Alzheimer's disease. Sarcopenia, obesity, and Alzheimer's were assessed using the SARC-F, BMI, and AQ questionnaire respectively, while dietary intake was analyzed via 24-hour recall and FFQ, and physical activity was measured using the RAPA tool.
Results: Among 172 older adults, a significant association was found between BMI and sarcopenia, with all overweight and obese participants being sarcopenic. Physical activity levels were significantly linked to both BMI and sarcopenia, with the majority of inactive individuals being overweight and also sarcopenic. No significant association was observed between sarcopenia and Alzheimer's. Regression analysis indicated protein intake positively predicted cognitive scores, while calcium and iron had negative associations. Overall, participants had low energy, calcium, and iron intake, with dietary patterns dominated by rice intake and limited consumption of nutrient-dense foods.
Conclusions: The study highlights that maintaining a healthy BMI, engaging in regular physical activity, and ensuring adequate protein intake are key to reducing the risk of sarcopenic obesity and cognitive decline.

Keywords: Alzheimer's disease, Older adults, Sarcopenia

INTRODUCTION

Sarcopenia and obesity are two major public health challenges that commonly coexist in older adults as sarcopenic obesity. Sarcopenia involves the gradual loss of muscle mass and strength, while obesity, particularly visceral obesity, increases fat accumulation and systemic inflammation. Together, they contribute to reduced mobility, increased risk of chronic illnesses like diabetes and cardiovascular disease, and diminished quality of life. Nutrition plays a critical role in the prevention and management of both sarcopenia and obesity. Inadequate protein intake, micronutrient imbalances, and excessive calorie consumption contribute to the progression of these conditions.[1] Conversely, dietary strategies emphasizing optimal protein intake, sufficient calorie control, and physical activity have been shown to mitigate their impacts. Emerging research highlights a strong interplay between sarcopenia, obesity, physical activity, and nutritional status, which collectively influence cognitive health and the development of neurodegenerative conditions such as Alzheimer's disease.[2] Physical inactivity and poor dietary habits contribute not only to muscle atrophy and fat accumulation but also to chronic systemic inflammation and oxidative stress, both of which are implicated in the pathogenesis of Alzheimer's disease. Additionally, obesity is linked to insulin resistance and vascular dysfunction, which may impair cerebral perfusion and accelerate cognitive decline.[3]

Given the aging global population and the increasing burden of dementia, understanding the multifactorial relationships among sarcopenia, obesity, physical activity, and nutrition is essential for developing integrated strategies to prevent or delay the onset of Alzheimer's disease. This interconnected framework offers a promising avenue for public health interventions aimed at promoting healthy aging and preserving cognitive and physical independence in older adults.[4]

This study was undertaken to assess sarcopenia status among older adults within the age group of 60 and older. This study aims to explore the interrelation among sarcopenia, obesity, and nutrition in older adults.[5] Sarcopenia and obesity are prevalent conditions in the elderly, both of which can significantly impact health outcomes and quality of life. This research analyzed how these conditions interact with each other and how nutritional status influences their development and progression. By investigating these relationships, the study aims to provide insights into potential interventions and strategies for improving health in older adults.[6]

METHODS

This cross-sectional study was conducted over five months (January to May 2025) among 172 older adults (68 males, 104 females) from three old age homes and a nearby community in Baranagar, West Bengal. A non-probability convenience sampling technique was used to recruit participants who fulfilled the inclusion criteria during the study period. Inclusion criteria included individuals aged 60 and above who were willing to participate. Sarcopenia was assessed using the SARC-F questionnaire, with scores ≥4 indicating risk.[7] Obesity was evaluated using BMI based on WHO Asian classification, with weight and height measured to calculate BMI (kg/m²).[3,8] Nutritional status was assessed through a 24-hour dietary recall and Food Frequency Questionnaire (FFQ), with nutrient intakes compared to RDA 2024 values. Physical activity levels were measured using the RAPA tool, which captures aerobic, strength, and flexibility activities.[9] Cognitive health, specifically Alzheimer's risk, was evaluated using the Alzheimer's Questionnaire (AQ), a 21-item informant-based screening tool assessing memory, orientation, functional ability, visuospatial skills, and language.[10,11]

Statistical analysis

The data was entered in Microsoft Excel and presented in the form of pie chart and bar diagram. Appropriate statistical methods were used for proper analysis of the collected data. The data was distributed using tables.

Statistical analysis was performed using the Statistical Package for Social Sciences (version 16.0, SPSS) software. Mean, Standard Deviation were calculated for age, height, weight, BMI, sarcopenia, physical activity, Alzheimer disease, energy, macronutrients, micronutrients. Percentage were calculated for BMI, sarcopenia, physical activity, Alzheimer disease status and different food groups of FFQ.

Sarcopenia, physical activity and Alzheimer disease questionnaire was assessed by using chi-square correlation to assess the association between BMI with sarcopenia status, physical activity with sarcopenia and BMI status, Alzheimer disease with sarcopenia and BMI status. Multiple regression analysis was used to assess the regression of Alzheimer disease score with 24 hrs total nutrient intake. Compare the mean value of energy, macronutrients and micronutrients with RDA requirements.

RESULTS

The study included 172 older adults with a mean age of 70.7 years. The average BMI was 24.8, and the mean SARC-F score was 4.5, indicating a considerable prevalence of sarcopenia (60.5%). According to BMI classification, 36.6% were of normal weight, 33.7% overweight, 19.2% obese, and 10.5% underweight. A statistically significant association was found between BMI and sarcopenia status (p=0.00) with all overweight and obese individuals being sarcopenic, while most normal and underweight individuals were non-sarcopenic.

According PA status 36.6%are lower active, 1.7% are moderate active and 61.6% are never active. The relationship between participants' BMI categories and their physical activity (PA) status show that, among those who are lower active, the majority have a normal BMI (39 individuals), followed by overweight (5), obese (5), and underweight (14). In contrast, among those who are never active, most participants fall into the overweight category (52), followed by obese (28), normal (23), and underweight (3). Only a small number of participants are moderate active (1 normal, 0 obese, 1 overweight, 1 underweight). The chi-square test result indicates a P value of 0.00, which is statistically significant. This suggests that there is a significant association between BMI status and physical activity status in this sample, meaning BMI and physical activity are related in a way that is unlikely due to chance. The relationship between physical activity (PA) levels and sarcopenia status (SARCF), show a significant association (P value = 0.00) indicating that sarcopenia status is strongly related to PA level. Among participants who were lower active, 53 had no sarcopenia and 10 had sarcopenia, out of a total of 63 individuals. In the moderate active group, 2 had no sarcopenia and 1 had sarcopenia, totalling 3 participants. Strikingly, among those who were never active, 13 had no sarcopenia whereas 93 had sarcopenia, out of 106 individuals. These findings suggest that individuals with lower or no physical activity are significantly more likely to have sarcopenia compared to those who are active. The strong statistical significance highlights the potential protective role of physical activity against sarcopenia.

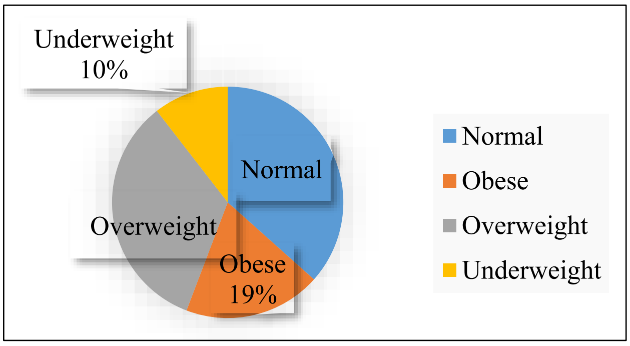

Figure 1: Category of participants according BMI status.

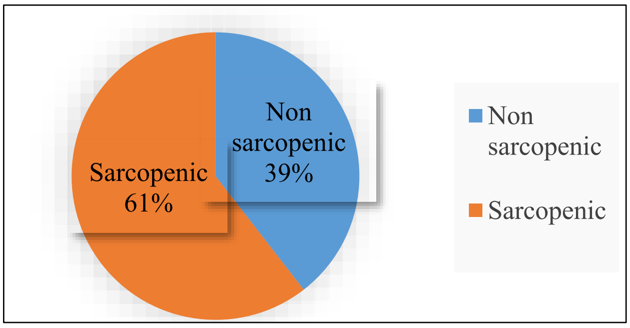

Figure 2: Category of participants according sarcopenia status.

According AQ status 1.2% are dementia, 9.9% are mild cognitive impairement, and 89.0% are normal. The association between BMI status and Alzheimer's status (AQ status) among 172 participants show that the BMI categories include normal, obese, overweight, and underweight, and their distribution is shown across AQ status groups: dementia, mild cognitive impairment (MILD. C.I), and normal. The majority of participants with normal BMI (61 out of 63) were classified as having normal cognitive status, with only 2 showing mild cognitive impairment and none with dementia. Similarly, among the obese and overweight groups, most participants (31 out of 33 for obese; 55 out of 58 for overweight) were classified as cognitively normal, with only a few having mild cognitive impairment and no cases of dementia. In contrast, the underweight group showed a notable pattern: out of 18 underweight participants, 6 were cognitively normal, 10 had mild cognitive impairment, and 2 had dementia. The p-value reported is 0.00 indicating a statistically significant association between BMI status and Alzheimer's status. This suggests that BMI status is significantly linked to cognitive health, with underweight individuals appearing to have a higher prevalence of cognitive impairment and dementia compared to those with normal, overweight, or obese BMI. Relationship between sarcopenia status (as assessed by SARCF) and Alzheimer's status (as classified into dementia, mild cognitive impairment [MILD C.I], and normal) in 172 participants show that among the 68 non-sarcopenic individuals, 2 had dementia, 8 had mild cognitive impairment, and 58 were normal. In contrast, among the 104 sarcopenic individuals, none had dementia, 9 had mild cognitive impairment, and 95 were normal. The chi-square test yielded a p value of 0.16 which is not statistically significant. This suggests that there is no significant association between sarcopenia status and Alzheimer status in this sample, indicating that sarcopenia does not appear to be linked with the presence or severity of cognitive impairment or dementia in this group.

The results of a multiple regression analysis examining the association between 24-hour total nutrient intake and AQ (Alzheimer's Questionnaire) final score among 172 participants. The dependent variable in this analysis is the AQ final score, while the independent variables include energy, carbohydrate, protein, fat, calcium, and iron intake. The multiple correlation coefficient (R) is 0.544, indicating a moderate positive relationship between the set of predictor variables and the AQ final score. The coefficient of determination (R^2) is 0.296, meaning that approximately 29.6% of the variance in AQ final score is explained by the combined effect of these nutrient intakes. Furthermore, the ANOVA p-value is 0.00, suggesting that the overall regression model is statistically significant, and the predictors collectively have a meaningful association with the AQ score.

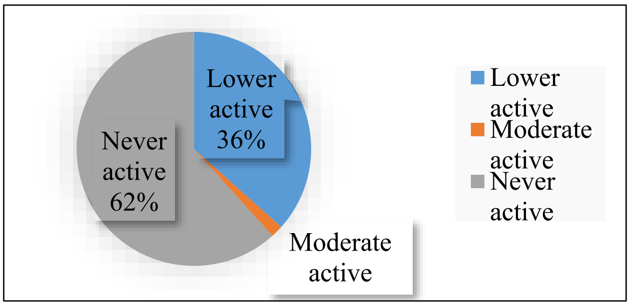

Figure 3: Category of participants according PA status.

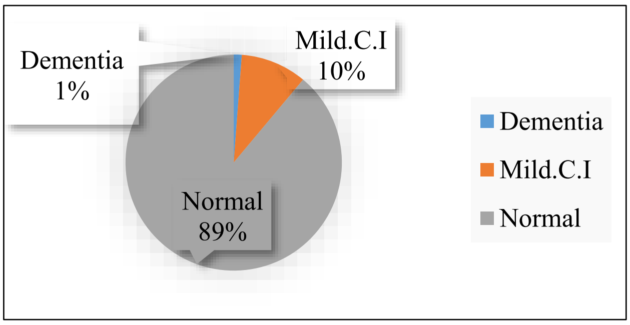

Figure 4: Category of participants according AQ status.

The regression coefficients for predictors in a multiple regression analysis, showing the significance (p value) of each nutrient in relation to the dependent variable. The constant term is significant (p=0.000), indicating that the model has a meaningful baseline value. Among the predictors, protein shows a significant positive association (p=0.004), meaning higher protein intake is significantly linked with an increase in the dependent variable. Both calcium and iron are significant negative predictors (p=0.000 for both), suggesting that higher intake of these nutrients is significantly associated with a decrease in the dependent variable. In contrast, energy (p=0.795), carbohydrate (p=0.994), and fat (p=0.760) do not show significant relationships, indicating that their contributions to the model are not statistically meaningful in this analysis.

The analysis of participants' dietary intake revealed imbalances in macronutrient and micronutrient consumption when compared to recommended standards. While protein and carbohydrate intake appeared sufficient or even higher than recommended, energy and fat intake were notably lower, indicating an overall inadequate caloric supply. This imbalance suggests that while participants are meeting their protein needs, their diets may lack sufficient energy and healthy fats, which are essential for maintaining overall metabolic and physiological function.

Micronutrient intake also reflected nutritional deficiencies, particularly in calcium and iron, with average consumption levels falling short of the recommended dietary allowances. Food frequency data indicated a strong preference for staple items such as rice, tea, and other carbohydrate-rich foods, with moderate inclusion of common protein sources and vegetables. In contrast, several nutrient-dense or less familiar foods—such as oats, tofu, and certain dairy products—were rarely consumed, reflecting cultural habits, availability, or personal preferences. These patterns point to a need for targeted nutrition education and dietary planning in the population studied. These dietary trends underscore the importance of culturally sensitive interventions that promote nutrient-dense, locally acceptable food options. Addressing these gaps through tailored nutrition strategies could help improve overall health and reduce the risk of diet-related conditions in older adult.

Table 1: Association between body mass index and sarcopenia status (n=172).

SARCF status					
	Category	**No**	**Yes**	**Total**	**P value**
BMI status	Normal	53	10	63	0.00 (significant)
	Obese	0	33	33	
	Overweight	0	58	58	
	Underweight	15	3	18	

Table 2: Association between body mass index and physical activity status (n=172).

PA status	BMI status					P value
	Normal	**Obese**	**Over.W**	**Under.W**	**Total**	
Lower active	39	5	5	14	63	0.00 (significant)
Moderate active	1	0	1	1	3	
Never active	23	28	52	3	106	

Table 3: Association between sarcopenia and physical activity status (n=172).

SARCF status					P value
	Category	**No**	**Yes**	**Total**	
PA status	Lower active	53	10	63	0.00 (significant)
	Moderate active	2	1	3	
	Never active	13	93	106	

Table 4: Association between BMI and Alzheimer status (n=172).

PA status	AQ status				P value
	Dementia	**Mild. C.I**	**Normal**	**Total**	
0	2	61	63	0	0.00 (significant)
0	2	31	33	0	
0	3	55	58	0	
2	10	6	18	2	

Table 5: Association between sarcopenia and Alzheimer status (n=172).

SARCF status	AQ status				P value
	Dementia	**Mild. C.I**	**Normal**	**Total**	
Non sarcopenic	2	8	58	68	0.16 (significant)
Sarcopenic	0	9	95	104	

Table 6: Multiple regression analysis between 24 hrs total intake with AQ score (n=172).

Dependent variable	AQ final score
Independent variables	Energy, Carbohydrate, Protein, Fat, Calcium, Iron
R (multiple correlation)	0.544
R square (coefficient of determination)	0.296 (29.6% of variance of AQ final score is explained by the predictors)
ANOVA (p value)	0.00 (significant regression model overall)

DISCUSSION

BMI and sarcopenia: a dual burden

A significant association between BMI status and sarcopenia was observed (p=0.00), revealing a 100% prevalence of sarcopenia among overweight and obese individuals. This reflects the presence of sarcopenic obesity, where excess fat mass coexists with muscle loss, potentially masking muscle decline while imitations. Conversely, underweight individuals showed a lower prevalence of sarcopenia, though a small proportion were affected indicating risk for frailty-induced sarcopenia. Participants with normal BMI exhibited the lowest sarcopenia rates, suggesting a possible protective role of maintaining a healthy body weight.[6,11]

BMI and physical activity

The relationship between BMI and physical activity status was statistically significant (p=0.00), showing that most never-active participants were either overweight or obese. This indicates a possible bidirectional link: inactivity may promote weight gain, while excess weight may hinder mobility and reduce engagement in physical activity. Participants with lower activity levels tended to have normal BMI, implying that even light activity may help prevent excessive weight gain in older adults.[12-14]

Physical activity and sarcopenia

Physical activity level was also significantly associated with sarcopenia status (p=0.00). Among those who were never active, a disproportionately high number (93 of 106) had sarcopenia. This confirms the protective role of physical activity in maintaining muscle mass and delaying or preventing sarcopenia in aging populations.

BMI and cognitive status

A significant association was found between BMI and Alzheimer's Questionnaire (AQ) scores (p=0.00), with normal, overweight, and obese individuals more likely to be cognitively normal. Underweight individuals showed the highest prevalence of mild cognitive impairment and dementia, indicating that low BMI may be a risk factor for cognitive decline. These findings suggest that extremely low body weight in older adults might reflect poor nutritional status and increased vulnerability to neurodegeneration.[15,16]

Sarcopenia and cognitive status

The analysis found no significant association between sarcopenia and AQ status (p=0.16). Despite a higher number of sarcopenic participants, cognitive impairment and dementia were more frequent in the non-sarcopenic group, indicating that muscle loss may not be directly linked to cognitive decline in this sample.[16]

Nutrient intake and cognitive function

Multiple regression analysis revealed that nutrient intake explains nearly 30% of the variance in AQ scores (R^2= 0.296, p=0.00). Among nutrients, protein showed a significant positive association with cognitive scores (p=0.004), supporting its role in brain and muscle health. Interestingly, calcium and iron showed significant negative associations (p=0.000), which may suggest potential overconsumption, interactions with other nutrients, or underlying health conditions influencing these effects. These associations highlight the importance of balanced nutrient intake and the need to explore confounding factors.[17]

Nutritional deficiencies and health implications

The population showed low intake of energy, fat, calcium, and iron, despite sufficient protein and carbohydrates. These inadequacies could compromise muscle function, metabolic health, and cognitive outcomes. Addressing these gaps through culturally appropriate dietary interventions, fortified foods, or supplementation is essential.[18]

CONCLUSION

This study highlights the interplay between sarcopenia, obesity, nutrition, and cognitive health in older adults. The findings underscore the dual burden of sarcopenic obesity and the protective roles of normal BMI, adequate protein intake, and physical activity. While BMI showed a link with cognitive status, sarcopenia alone was not associated with cognitive decline. These results emphasize the need for integrated interventions focusing on balanced nutrition and active lifestyles to support healthy aging and reduce functional and cognitive risks.

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Ethical approval: The study was approved by the Institutional Ethics Committee (NSHM-KOL/IEC/4/2024/PR33)

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