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The Relationship Between Protein Intake and Muscle Mass and Strength in the Elderly

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ABSTRACT

Protein is essential for building muscle mass and functional capacity. Aging results in decreased muscle mass and, consequently, functional capacity. This process is a physiological condition of the body resulting from an imbalance between anabolism and catabolism in muscle cells. This can be prevented through adequate protein intake and physical activity. Assessment of muscle mass and strength was conducted to determine the physical strength of elderly people in relation to meeting daily protein intake requirements. This study aimed to determine the relationship between protein intake and changes in muscle mass and strength in elderly people. This study used an observational cross-sectional design. Data were collected from elderly people in Tulungagung Regency, East Java, through interviews regarding protein intake, muscle mass measurements, and functional capacity during July and August 2024. Sixty-five individuals were recruited. The results showed a relationship between protein intake and muscle mass ($p<0.05$; $r=0.7$), while right and left functional capacity did not show a significant relationship ($p>0.05$). The conclusion of this study is that protein intake has a strong relationship with increased muscle mass. However, no differences were found in muscle strength due to various factors influencing the assessment.hand grip strength.

Introduction

The number of elderly people is increasing almost worldwide, even in developing countries. This is due to technological advances, improved healthcare, and socioeconomic improvements, resulting in increased life expectancy. In 2010, the number of elderly people worldwide reached approximately 524 million and is expected to double by 2050.[1]In developed countries like Japan, the elderly population aged 60 and over has reached 30% of the total population. However, developing countries are also experiencing an increase, with approximately two-thirds of the world's elderly population living in low- and middle-income countries.[2]In Indonesia, the prevalence of elderly people has reached 10.7% in 2020 and will continue to increase to 19.9% in 2045. This increase will trigger health problems and risks of morbidity, thus becoming a health burden on society.[3]

The aging process is a normal physiological change and decline in the body. However, as we age, the risk of health problems such as cardiovascular disease, diabetes, respiratory disease, and cancer increases.[4]In addition, psychological factors such as depression, anxiety and stress will also have an impact on the health of the elderly.[5]Health problems experienced by the elderly can lead to impaired nutritional intake, leading to malnutrition. Decreased muscle mass and functional capacity are indicators of malnutrition in the elderly, often referred to as sarcopenia.[6] Various studies have shown the negative impacts on the health of older adults with sarcopenia. These include physical and immune decline, a risk of falls, an increased risk of complications, a reduced quality of life, and even death.[7]The overall prevalence of sarcopenia is approximately

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86.5% in adults. The development of sarcopenia is associated with anorexia, physical inactivity, metabolic disorders, and inadequate protein intake.[8]

Nutrition is a risk factor for sarcopenia that can be modified or corrected early. Consuming the recommended protein intake*Recommended Dietary Allowance* (RDA) is approximately 0.8 grams/kg/day to maintain muscle mass and physical function in the elderly.[9]Muscles in older age require more amino acids to stimulate*muscle protein synthesis*(MPS) in response to hyperaminoacidemia or often called anabolic resistance.[10] However, protein requirements will increase when used to stimulate MPS, so the recommendation given to increase muscle mass and strength is around 1 – 1.5 grams/kg/day.[11]Various food sources that contain high levels of protein are found in animal products such as meat, milk, eggs and fish, while plant products are found in nuts.[12]

Providing adequate protein intake in older adults is essential to prevent loss of muscle mass and strength. This is related to physical activity and independence in daily life. Maintaining a healthy daily routine can improve quality of life and life expectancy.[13]Therefore, this study aims to determine the relationship between daily protein intake in the elderly and muscle mass and functional capacity..

Methodology

This study was an observational study with a cross-sectional design to determine the relationship between protein intake and muscle mass and functional capacity. The study respondents were elderly patients at the Beji Boyolangu Community Health Center, Tulungagung Regency, East Java. The data collection process was carried out from June to August 2024. Data collection used a purposive sampling technique with inclusion criteria: patients aged 60 years and above, no motor or sensory disorders in the upper extremities, and no diseases that cause dietary restrictions. This study sample was obtained as many as 65 people.

Protein intake data collection was carried out using*food frequency Questionnaire*(FFQ) with semi-quantitative assessment to determine daily protein intake. Muscle mass assessment was carried out using*bio impedance analysis*(BIA) and functional capacity is carried out using measurements*hand grip strength*(HGS) on the right and left hands. The data will be analyzed using a correlation test to show the relationship between the two variables.

Results and Discussion

This study shows the characteristics of respondents including gender, age, still working, body mass index, and comorbidities (diabetes, hypertension, dyslipidemia and arthritis). Based on table 1, the gender in this study was mostly female, around 57 people (87.7%). In the age group, it shows young elderly (60-69 years) of 41 people (63%), middle elderly (70-79 years) of 22 people (33.8%) and old elderly (≥ 80 years) of 2 people (3.2%). Regarding employment, most of the study respondents were no longer working, amounting to 47 people (72.3%). Respondents based on body mass index were grouped into*underweight*3 people (4.6%), normal 18 people (27.7%),*overweight*11 people (16.9%), grade 1 obesity in 26 people (40%), and grade 2 obesity in 7 people (10.8%). The characteristics of comorbidities in this study were hypertension in 32 people (49.2%), diabetes mellitus in 14 people (21.5%), dyslipidemia in 23 people (35.4%), and arthritis in 5 people (7.7%).

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Table 1. Distribution of Respondent Characteristics

Characteristics		Frequency (n)	Prevalence (%)
Gender	Man	8	12,3
	Woman	57	87,7
Age	Young Elderly (60-69 years)	41	63,0
	Middle Elderly (70-79 years)	22	33,8
	Older Adults (≥ 80 years)	2	3,2
Work	Work	18	27,7
	Doesn't work	47	72,3
Body Mass Index	Underweight (<18,5)	3	4,6
	Normal (18,5 – 22,9)	18	27,7
	Overweight (23 – 24,9)	11	16,9
	Grade 1 Obesity (25 – 29.9)	26	40,0
	Grade 2 Obesity (≥30)	7	10,8
Hypertension	Of	32	49,2
	No	33	50,8
Diabetes mellitus	Of	14	21,5
	No	51	78,5
Dyslipidemia	Of	23	35,4
	No	42	64,6
Arthritis	Of	5	7,7
	No	60	92,3

The majority of respondents were female, as several studies have shown a higher life expectancy for women than for men. This is influenced by biological factors such as the hormone estrogen, which is linked to immunity, lifestyle, and greater health awareness compared to men.[14] The aging process also affects body composition, such as fat-free mass and fat mass, which decrease. As we age, fat distribution shifts toward the visceral area, increasing the risk of accumulation in the liver.[15]In addition, decreased metabolism and energy expenditure in the body resulting from reduced physical activity will result in increased fat mass.[16]Therefore, respondents in this study were more likely to be overweight or obese. In the elderly group, comorbidities increase due to various physiological and psychological factors.[17]Physiological factors are usually caused by a decrease in food intake and body function, thus increasing the risk of malnutrition which affects the patient's immunity and quality of life, while psychological factors are related to anxiety or depression.[18] Respondent This study found that the elderly had fewer comorbidities compared to healthy elderly. This is because the study was conducted in an outpatient health center, where elderly patients were able to carry out activities and did not experience dietary issues.

Table 2. Mean of Research Group Variables

Group	Maximum	Minimum	Mean ± SD	Normality Test
Protein Intake	69,9	11,3	32,9 ± 11,5	0,056
Muscle Mass	36,0	12,8	23.2 ± 3,9	0,200
Right HGS	30,3	7,2	16,2 ± 5,1	0,000
HGS Skin	29,6	6,7	15,4 ± 5,2	0,200

Based on table 2, the average for each group includes protein intake (32.9 ± 11.5), muscle mass (23.2 ± 3.9), Right HGS (16.2 ± 5.1), and Left HGS (15.4 ± 5.2). In addition, a normality test was carried out, which showed that the protein intake, muscle mass, and left HGS groups were normally distributed.

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Protein intake is essential for the elderly to maintain muscle mass by providing essential amino acids and stimulating protein synthesis. The elderly are at greater risk of protein deficiency, which can lead to insufficient muscle mass and strength maintenance. Adequate protein intake in the elderly has positive health benefits, such as reducing the risk of complications, increasing bone mineral density, and preventing sarcopenia.[19] Several studies recommend protein intake of up to 1.5 grams/kg/day to prevent muscle loss, and can even be increased to 2 grams/kg/day in severe illness or severe malnutrition.[20]Taking kidney function into account when providing protein intake is also necessary, especially in the elderly, many of whom experience decreased kidney function, either physiologically or due to chronic disease. The decrease in protein intake in chronic kidney disease can range from 0.8 to 1.0 grams/kg/day, depending on the patient's condition. This also contributes to the problem of decreased muscle mass in the elderly.[21] The study showed that elderly patients had low protein intake, which was only nearly 33 grams/day.

Aging is also often associated with a gradual physiological decline in skeletal muscle mass and strength. The risk of falls, dependence or reduced independence, and premature death are among the impacts of decreased muscle mass. Appropriate interventions should be provided to older adults to prevent further muscle loss. Physical activity can improve aerobic metabolism and insulin sensitivity. Muscle plays a crucial role in physical activity. One commonly used measure of muscle mass is*bio impedance analysis*(BIA). The elderly are said to be experiencing sarcopenia or malnutrition if the analysis results range between 6.75–7.40 kg/m2 in men and 5.07–5.80 kg/m2 in women.[22]The results of the muscle mass assessment in this study were still within normal limits due to various factors such as respondents still being able to carry out physical activities, not experiencing food intake disorders and having a history of working with heavy activities (most of them previously worked as farmers).

Functional capacity reflects muscle strength and is associated with early detection of physical and mental function in older adults during daily life. Furthermore, it can be an early indicator of future health problems such as metabolic syndrome, cardiovascular disease, arthritis, and stroke. Decreased muscle strength is influenced by various factors, including insufficient protein intake, physical activity, and psychological disorders in older adults.[23] Muscle strength measurements can be done using*handgrip strength* (HGS). Based on *The Asian Working Group for Sarcopenia*(AWGS) 2014 defines low muscle mass when the assessment*handgrip strength*<28 kg for men and <18 kg for women.[24] The results of the HGS assessment in this study showed that most of them experienced a decrease in muscle strength which could be caused by age, physical activity and intake patterns.

Table 3. Results of Correlation Test Between Groups and Protein Intake

Group	Homogeneity Test	P-Value	Correlation
Muscle Mass	0,273	0,000	0,70
Right HGS	0,279	0,852	-
HGS Skin	0,000	0,980	-

Based on table 3, the results of the homogeneity test in the research group showed that muscle mass and right HGS were homogeneous. Furthermore, a Pearson test was conducted between protein intake and

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muscle mass (p=0.000; r=0.70), while no correlation was found between protein intake and right HGS and left HGS because there was no significant difference.

Skeletal muscle protein is dynamic and subject to change. After absorption, protein is converted into easily catabolized amino acids, which play a role in gluconeogenesis, the synthesis of immune components, plasma proteins, peptide hormones, and intracellular and extracellular enzymes. Decreased protein intake will result in protein imbalances in muscles and throughout the body, triggering protein breakdown and disrupting bone and calcium homeostasis, enzyme production and activity, and hormone synthesis.[25]Long-term protein deficiency will affect tissue physiology and cause muscle wasting. In the elderly, this condition increases the risk of morbidity and mortality, especially in hospitalized patients.[26]The research results show a fairly strong relationship between protein intake and muscle mass, but this is also influenced by the physical activity carried out by the respondents.[27]

Muscle strength assessment using the HGS (Hypertension Gap) not only reflects upper body strength but also lower and mid-body strength. HGS scores will be higher if the exercise focuses on the upper extremities and involves handgrip movement. In older adults, the impact of exercise on HGS is determined by various factors, such as duration, intensity, and training method. Additionally, age, sociodemographic factors, protein intake, and comorbidities also influence HGS assessment.[28]Several studies have shown that protein intake can reduce the loss of muscle strength and function, but not significantly. A study of Korean adults found no association between protein intake and low HGS scores. Conversely, one study showed that those with low protein intake were 1.5 times more likely to experience muscle strength decline compared to those with adequate protein intake. Several factors are thought to contribute to these differences in results, such as the type of protein consumed (quality and source), digestibility or gastrointestinal conditions that affect absorption, and previous physical activity history.[29] This also affects the research results which show no significant difference in protein intake due to the various factors that influence the HGS assessment.

Conclusion

Protein intake in the elderly can increase protein synthesis, thus preventing muscle loss. In muscle strength assessments, protein intake did not directly affect grip strength, as various factors can influence right and left hand grip strength.

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