Correlation Between Vitamin D Levels and Charlson Comorbidity Index with Sarcopenia in Geriatric Patients

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KEYWORDS
Geriatrics, Vitamin D, Charlson Comorbidity Index, Sarcopenia.

ABSTRACT
Introduction: Elderly individuals are particularly susceptible to malnutrition due to the physiological changes associated with aging, one of which is often vitamin D deficiency. Several studies have indicated a potential association between vitamin D concentrations and sarcopenia; however, the results remain inconsistent. Furthermore, there is limited knowledge regarding the impact of comorbid diseases on this relationship. Methods: This was an analytical observational study with a cross-sectional design, aimed at determining the relationship between vitamin D levels and the Charlson Comorbidity Index with sarcopenia in geriatric patients. The research subjects were geriatric patients receiving outpatient care at the geriatric clinic of Ulin Hospital Banjarmasin, who met the inclusion criteria and were selected using a consecutive sampling technique. Measurements of sarcopenia components, Charlson Comorbidity Index scores, and vitamin D levels were performed. The degree of sarcopenia was then calculated, tabulated, and analyzed using correlation tests. Results: A total of 77 subjects participated in the study. There was no significant association between vitamin D levels and the incidence of sarcopenia. Similarly, no significant relationship was found between the Charlson Comorbidity Index and sarcopenia. Conclusion: Vitamin D levels are not associated with the incidence of sarcopenia in geriatric patients. Similarly, the Charlson Comorbidity Index score is not associated with the incidence of sarcopenia in this population.

1. Introduction

Aging is a natural process, and old age is a normal and inevitable biological phenomenon. It cannot be reversed, only prevented or delayed (Amin, 2022). The global elderly population is rapidly increasing, both today and in the years to come. According to the 1998 Law, the elderly are defined as individuals who have reached the age of 60 years or older.

Indonesia has the fifth-largest elderly population in the world, with 18.1 million elderly people in 2010, projected to double to 36 million by 2025. The life expectancy of the Indonesian population was 67.8 years during the 2000-2005 period, and it is projected to reach 73.6 years by 2020-2025. The proportion of elderly individuals has increased from 6% between 1950 and 1990 to 8% today, and it is expected to rise to 13% by 2025 and 25% by 2050 (Setiati, 2017).

Elderly individuals are particularly susceptible to malnutrition due to physiological changes associated with aging and challenges in accessing nutritious foods. A prevalent issue among older adults is vitamin D deficiency (Irawati et al., 2020), which is associated with decreased physical performance and an increased risk of falls and fractures (Azzam et al., 2020).

Vitamin D deficiency leads to increased muscle protein breakdown through the ubiquitin-proteasomal (UPP) pathway and autophagy, as well as the upregulation of the adenosine monophosphate-activated protein kinase (AMPK) renin-angiotensin system (Uchitomi et al., 2020). Low vitamin D levels impair mitochondrial function and increase muscle adiposity, leading to mitochondrial dysfunction, decreased adenosine triphosphate (ATP) production, increased reactive oxygen species (ROS) production, oxidative damage, muscle atrophy, and impaired muscle function (Latham et al., 2020; Latham et al., 2021).

Several studies have demonstrated an association between vitamin D concentrations and geriatric conditions such as osteoporosis, sarcopenia, and functional impairments like falls, loss of muscle strength, and slow

walking speed. Vitamin D supplementation in vitamin D-deficient individuals improves hip muscle strength and helps prevent falls in elderly people over 65, suggesting a strong relationship between vitamin D levels and muscle and motor function (Mizuno et al., 2022).

The prevalence of sarcopenia is reported to be as high as 29% among the elderly in community healthcare settings, and it ranges from 11% to 50% in individuals aged 80 years and older (Cho et al., 2022). Observational studies and mechanistic experiments suggest a biological link between low vitamin D levels and the age-related decline in muscle mass and quality, indicating that vitamin D supplementation may be an effective way to prevent and treat sarcopenia, frailty, and its clinical complications. Several randomized clinical trials have been conducted to investigate the effect of oral vitamin D supplementation on sarcopenia prevention and treatment in elderly patients, but the results remain controversial (Francesca Remelli, Aurora Vitali, 2019).

Several studies have explored the relationship between individual comorbidities and vitamin D deficiency, but the results are still conflicting. Azzam et al. (2020) reported that low vitamin D levels have no significant correlation with timed-up-and-go test scores (a measure of sarcopenia), and there is no strong evidence linking vitamin D deficiency to physical activity in elderly patients.

Little is known about the impact of comorbidities on vitamin D levels. The Charlson Comorbidity Index (CCI) is the most widely used method for assessing a patient's overall comorbidity burden in clinical research. A higher CCI score indicates a greater comorbidity burden and is associated with increased mortality, longer hospital stays, and higher readmission rates in the geriatric population. The risk of falls and disability is significantly higher in the elderly when two or more chronic diseases co-occur, compared to those without comorbidities.

While the CCI is commonly used as a comorbidity assessment tool, its potential to assess sarcopenia risk remains uncertain and requires further research (Gong et al., 2019).

Based on existing information and literature, this study aims to explore the relationship between vitamin D levels, the Charlson Comorbidity Index (CCI), and sarcopenia in geriatric patients. Specifically, the study seeks to determine the incidence of sarcopenia, assess vitamin D levels, and evaluate the CCI in this population. Furthermore, it will analyze how vitamin D levels and the CCI relate to sarcopenia.

The findings are expected to provide valuable insights into the factors influencing sarcopenia in the elderly, making a significant contribution to geriatric care, particularly in managing patients with sarcopenia. By understanding the relationships between vitamin D levels, CCI, and sarcopenia, healthcare providers can adopt targeted approaches for treatment. This may help identify patients at higher risk for sarcopenia based on their CCI scores and vitamin D levels, enabling earlier interventions such as vitamin D supplementation or effective management of comorbidities.

Moreover, this study may lead to the development of holistic treatment protocols for geriatric patients, addressing not only age and nutritional factors but also the impact of comorbidities. Ultimately, these findings could improve the quality of life for elderly patients with sarcopenia and help reduce the risk of complications such as falls, fractures, and disability.

2. Research Methods

This study employed an analytical observational design with a cross-sectional approach, aiming to analyze the relationship between vitamin D levels and Charlson Comorbidity Index (CCI) scores as independent variables, and sarcopenia as the dependent variable in geriatric patients at Ulin Banjarmasin Hospital. This design was chosen because it allows researchers to observe the relationships between variables at a specific point in time without intervention.

The study was conducted at Ulin Banjarmasin Hospital from June to July 2024, targeting geriatric patients who sought treatment at the hospital's geriatric polyclinic between February and April 2024. The sample was selected using a consecutive sampling technique, where participants were chosen based on predefined inclusion and exclusion criteria. The sample size, calculated using a correlational research formula, consisted of 77 participants.

Inclusion criteria for the study were patients over the age of 60 who regularly attended the geriatric polyclinic. Exclusion criteria included incomplete medical records, unwillingness to participate, and an inability to stand. Vitamin D levels were measured by assessing serum 25-hydroxyvitamin (OH) D in the accredited laboratory of

Ulin Banjarmasin Hospital, while CCI scores were calculated using a standardized method. Sarcopenia was diagnosed following the Asian Working Group for Sarcopenia (AWGS) guidelines, with physical performance, muscle strength, and muscle mass assessed using standardized tools.

Several key variables were assessed among geriatric patients. Vitamin D levels were measured as serum 25-hydroxyvitamin (OH) D, using classifications from The Endocrine Society. These levels were recorded in ng/ml and categorized as follows: deficiency if serum levels were less than 20 ng/ml, insufficiency if levels ranged from 21 to 29 ng/ml, and optimal or normal levels if serum 25-hydroxyvitamin D was 30 ng/ml or greater. The Charlson Comorbidity Index (CCI) was used as an assessment tool to predict long-term mortality, combining 19 separate health conditions on a scale of 1 to 6 points, with a minimum score of 0 and a maximum score of 37. The severity of comorbidities was divided into two groups: 1-4 points indicating mild to moderate conditions and greater than 5 points indicating severe conditions. Sarcopenia, defined as the loss of muscle mass, low muscle strength, and decreased physical performance. This was measured according to standards from the Asian Working Group for Sarcopenia (AWGS). Physical performance was evaluated using the 5-time chair stand test, with a time greater than 12 seconds indicating poor performance. Muscle strength was assessed using the Jamar® Handgrip dynamometer, with low muscle strength defined as less than 22.4 kg for men and less than 14.3 kg for women. The Skeletal Muscle Mass Index (SMI) was determined using Bio Impedance Analysis (BIA) with the Multi Frequency Tanita® RD 545, categorized according to AWGS standards. The skeletal muscle mass (SMM) was calculated as the percentage of SMM multiplied by body weight, and the SMI was obtained by dividing SMM by height in square meters, with low SMI defined as less than 7.0 kg/m² for men and less than 5.7 kg/m² for women. A diagnosis of sarcopenia was made if there was a decrease in muscle mass and either muscle strength or physical performance. Additionally, the study collected data on gender, categorized into male and female based on medical records, and age, which was divided into two categories: 60 to 74 years (young elderly) and older than 74 years (old elderly).

The collected data will be analyzed using the chi-square statistical test to determine the relationship between the independent and dependent variables, with a significance level set at $p < 0.05$. If a significant relationship is found, logistic regression analysis will be conducted to assess the strength of the association between variables. All descriptive data will be presented in frequency and percentage distribution tables.

3. Results And Discussion

Subject Characteristics

The subject characteristics assessed in this study were age, gender, muscle strength, physical performance, BIA, CCI Score, and Vitamin D Level.

Table 1. Descriptive data from research results.

No.	Characteristics	Male	Female	Total
1.	Age			
	Frequency:			
	60 - 74 years	14 (20%)	55 (80%)	69
	>74 years old	1 (12.5%)	7 (87.5%)	8
2	Vitamin D			
	Frequency:			
	25-hydroxyvitamin (OH) D serum level ≤ 20 ng/ml (Deficiency)	6 (10.9%)	49 (89.1%)	55
	25-hydroxyvitamin (OH)D serum level 21-29 ng/ml (Insufficiency)	9 (40.9%)	13 (59.1%)	22
3	Charlson Comorbodity Index (CCI)			
	Frequency:			
	1-4 (mild-moderate)	8 (15.7%)	43 (84.3%)	51
	>5 (severe)	7 (26.9%)	19 (73.1%)	26
4	Sarcopenia Status			
	Frequency:			
	Normal	6 (13%)	40 (87%)	46
	Sarcopenia	9 (29%)	22 (71%)	31

Based on the data from Table 1, most patients were female, with 62 out of 77 total samples. The majority of patients fell into the "young elderly" category (60-74 years), accounting for 69 individuals (89.6%). Vitamin D levels in the patients were generally below normal, with 55 people (71.4%) experiencing deficiency, and 22 people (28.6%) classified as having vitamin D insufficiency (table 2). No individuals in the study sample had

normal or optimal vitamin D levels. The Charlson Comorbidity Index (CCI) scores were mostly in the mild to moderate range, with 51 people (66.2%). Sarcopenia was found in 31 individuals (40.2%).

Table 2. Vitamin D levels, Charlson Comorbidity Index score, and sarcopenia in geriatric patients

No.	Variables	Normal	Sarcopenia
1	Vitamin D		
	25-hydroxyvitamin (OH)D ≤ 20 ng/ml (Deficiency)	35	20
	25-hydroxyvitamin (OH)D 21-29 ng/ml (Insufficiency)	11	11
	Total	46	31
2	Charlson Comorbidity Index (CCI)		
	1-4 (mild-moderate)	31	20
	>5 (severe)	15	11
	Total	46	31

Relationship between vitamin D levels, Charlson Comorbidity Index score, and sarcopenia in geriatric patients.

The relationship between vitamin D levels, Charlson Comorbidity Index scores, and sarcopenia in geriatric patients was analyzed using Statistical Package for the Social Sciences (SPSS) software, version 27.0. The test results are presented in Table 4. The bivariate regression analysis, based on the p-value, showed that vitamin D deficiency was not significantly associated with the incidence of sarcopenia (p=0.270). Similarly, Charlson Comorbidity Index scores were not significantly associated with sarcopenia (p=0.794). Since the relationships for both independent variables were not significant, further regression analysis was not conducted.

Table 3. Correlation analysis between vitamin D levels, Charlson Comorbidity Index score, and sarcopenia in geriatric patients

No.	Variables	Sarcopenia
1	Vitamin D	p=0,270
2	Charlson Comorbidity Index (CCI)	p=0.794

Notes: *= significant relationship

Discussion

In this study, 77 participants were found to have vitamin D levels below normal, with 55 individuals (68.7%) classified as having vitamin D deficiency and 22 individuals (27.5%) categorized as having vitamin D insufficiency. Notably, there were no samples with normal vitamin D levels in this study. Vitamin D deficiency remains a significant global health issue, particularly among the elderly. Studies indicate a prevalence of 40-100% among older populations in America and Europe. In rural Taiwan, vitamin D deficiency has been reported at 44%, while certain regions of China showed 55.9% of individuals with levels below 20 ng/ml and 38.7% in the 20-30 ng/ml range. Other areas in China reported 69.2% with vitamin D levels below 20 ng/ml and 24.4% in the 20-30 ng/ml range. Similarly, Thailand reported a prevalence of vitamin D deficiency of 46.7% (Meshkin et al., 2024).

Despite living in the tropics, where sunlight exposure is abundant year-round, vitamin D deficiency is frequently observed in Indonesia. Previous research involving 504 women of childbearing age in Indonesia and Malaysia indicated a prevalence of vitamin D deficiency of 63% in both countries (Melviana et al., 2020). This study found no significant relationship between vitamin D levels and sarcopenia, leading to the rejection of Hypothesis 1, which posited that vitamin D levels are related to the incidence of sarcopenia in geriatric patients.

These results align with research by Azzam et al. (2020), which stated that low vitamin D levels do not significantly correlate with timed up-and-go test scores, a component of sarcopenia. There is insufficient evidence linking vitamin D deficiency with physical activity in elderly patients. Although vitamin D deficiency is prevalent among older adults, other factors—such as age-related muscle changes, malnutrition, lack of physical activity, comorbidities, and inflammation—may exert a more significant influence on muscle strength and physical performance than vitamin D levels (Azzam et al., 2014; Azzam et al., 2020).

Contrastingly, some studies suggest a significant relationship between low serum vitamin D levels and the risk of decreased muscle mass and physical performance in older adults. For instance, research by Conzade et al. (2019) concluded that low serum vitamin D levels are an early risk factor for muscle mass loss and decreased physical performance in old age (Bachry et al., 2021).

Various studies have demonstrated that blood levels of vitamin D are independently associated with loss of muscle mass and decreased muscle strength in elderly individuals. This indicates that older adults experiencing vitamin D deficiency are particularly susceptible to developing sarcopenia. An observational study conducted in 2017 found that very low vitamin D levels correlated with an increased loss of muscle strength (Khan et al., 2023).

Vitamin D has garnered increasing attention due to its role beyond bone metabolism. Numerous studies have reported associations between suboptimal vitamin D levels and various comorbidities, including prostate, colon, pancreatic, ovarian, stomach, and breast cancers; cardiovascular diseases such as hypertension, myocardial infarction, and congestive heart failure; diabetes mellitus; infectious diseases including HIV; autoimmune diseases such as rheumatoid arthritis, Crohn's disease, and multiple sclerosis; stroke; chronic obstructive pulmonary disease; and mental health issues (Moo et al., 2020).

The role of vitamin D in muscle function was first identified with the discovery of the vitamin D receptor (VDR), initially found in intestinal cells and later in many other body cells, including skeletal muscle cells. Vitamin D's action in muscle is mediated by its active form binding to the VDR, which enhances muscle fiber size. However, the quantity of VDR in muscle tissue decreases with age, leading to a poor functional response to vitamin D and subsequent reductions in muscle mass and strength. A study reported smaller muscle fibers in mice with fewer VDRs, which also exhibited a faster loss of muscle mass. This highlights the central role of VDR in muscle fibers (Novira et al., 2022). A review study by Garcia et al. (2019) concluded that vitamin D is related to muscle fiber metabolism expressed by VDR, and serum vitamin D levels are directly linked to age, gender, and pathological factors affecting declines in muscle mass, function, and strength in the elderly (Bachry et al., 2021).

Women exhibited a higher incidence of vitamin D deficiency in this study, with 49 individuals (77%) affected, compared to 6 men (35%). Previous research by Siddiqee et al. (2021) also found that females are more likely to experience vitamin D deficiency than males (Siddiqee et al., 2021). In South Asia, vitamin D deficiency prevalence was reported at 76% for women compared to 51% for men. This disparity may be attributed to cultural factors, as women in this region often spend less time outdoors, limiting their exposure to direct sunlight. Additionally, cultural dress practices, such as wearing the burqa (full body covering), hijab (Muslim clothing that covers the upper body), and traditional attire, further restrict sunlight exposure. These clothing practices are prevalent in many areas of India, Pakistan, and Bangladesh (Siddiqee et al., 2021) and are similarly observed in Indonesia.

The Charlson Comorbidity Index (CCI) score in this study was found not to be significantly associated with the incidence of sarcopenia; therefore, Hypothesis 2, which posited that the Charlson Comorbidity Index score is associated with the incidence of sarcopenia in geriatric patients, was rejected. The results of this study do not align with research from Gong et al. (2019), Wenjing et al. (2024), and Xia et al. However, they are consistent with the study by Moo et al. (2020), which also found no association between CCI scores and vitamin D levels in geriatric patients.

The incidence of comorbidity and the coexistence of two or more diseases increase with age among the elderly. Those with comorbidities tend to have higher morbidity and mortality rates and a lower quality of life. Various diseases are commonly observed in elderly individuals with comorbidities (Gong et al., 2019). Research by Pacifico et al. (2022) indicated a higher prevalence of sarcopenia among individuals diagnosed with cardiovascular disease (CVD), dementia, diabetes mellitus (DM), and multimorbidity, which is defined as the coexistence of two or more diseases. When multiple diseases occur concurrently, nutrient demands increase, particularly affecting muscle mass. This can lead to higher Charlson Comorbidity Index (CCI) scores and reduced muscle mass in the elderly. These findings suggest that the CCI score could be useful in assessing sarcopenia risk in older adults

Prevention and treatment of sarcopenia may involve universally accepted oral calorie and protein supplementation; however, the role of vitamin D supplementation in deficiency states remains controversial. Several experimental and epidemiological studies support the hypothesis that vitamin D supplementation could be effective in preventing and treating sarcopenia in older adults. Nevertheless, the high heterogeneity of observational studies and conflicting results from randomized controlled trials (RCTs) render the exact role of vitamin D supplementation in preventing and treating sarcopenia uncertain, necessitating further research. Additional intervention studies are required to clarify the effects of vitamin D supplementation on skeletal muscle and determine the optimal serum levels needed to maintain good physical function in older age.

Meanwhile, given the high prevalence of vitamin D deficiency among elderly individuals and its fundamental biological effects beyond skeletal muscle, oral supplementation is recommended for all elderly patients diagnosed with sarcopenia and vitamin D deficiency. Furthermore, patients at risk of or suffering from sarcopenia should be encouraged to engage in regular physical activity and increase their intake of protein and/or essential amino acids (Francesca Remelli, Aurora Vitali, 2019).

The high incidence of vitamin D deficiency observed in this study presents a pressing issue that requires intervention. This elevated prevalence of vitamin D deficiency may be attributed to the numerous comorbidities found in patients (Siddiqee et al., 2021). As vitamin D deficiency impacts skeletal muscle metabolism, it is advisable to evaluate vitamin D levels in patients with sarcopenia. Given that vitamin D has numerous essential biological functions beyond its role in skeletal muscle, supplementation is still recommended. Oral supplementation should be administered to every elderly individual with vitamin D deficiency (Novira et al., 2022).

Women who wear heavy clothing and those who spend more time indoors should be advised to regularly check their serum vitamin D levels and take necessary supplements. For individuals who do not receive sufficient sun exposure, it is recommended that adults consume 800-1,000 IU of vitamin D daily. Several organizations have provided recommendations for daily vitamin D supplementation: The Endocrine Society suggests at least 600 IU/day for adults aged 19-70 and at least 800 IU/day for those over 70; some individuals may require 1,500-2,000 IU/day to achieve vitamin D levels exceeding 30 ng/mL. The American Association of Clinical Endocrinologists and the American College of Endocrinology recommend daily supplementation with vitamin D3 at doses of 1,000 to 2,000 IU to maintain optimal serum 25(OH)D levels. Higher doses may be necessary in certain conditions and for specific populations, including individuals with obesity, malabsorption issues, and specific ethnic backgrounds. Transplant patients and elderly individuals may also require higher doses (Sizar O, Khare S, Goyal A, 2022).

This study has several limitations, primarily due to its cross-sectional design, which captures data at a single point in time. Consequently, it cannot evaluate the long-term effects of vitamin D deficiency, CCI, and sarcopenia.

4. Conclusions and Suggestions

Based on the results of this study, it can be concluded that there is no relationship between vitamin D deficiency and sarcopenia in geriatric patients. Additionally, no significant association was found between the Charlson Comorbidity Index (CCI) score and sarcopenia in this population.

For future research, studies should adopt a cohort design with larger sample sizes and include interventions such as vitamin D supplementation. Longitudinal follow-ups could help assess changes in patients' conditions over time. Furthermore, future studies should consider additional factors influencing sarcopenia development, such as nutritional status, physical activity levels, and other comorbidities, which were not addressed in the current study.

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