

Relationship between vitamin D levels and muscle strength in hospitalised elderly patients

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Abstract

Background: Vitamin D deficiency is highly prevalent among hospitalized elderly individuals and has been associated with impaired muscle function, sarcopenia, frailty, falls, and prolonged hospitalization. Muscle weakness in elderly patients significantly contributes to morbidity, disability, and poor quality of life. This study aimed to evaluate the relationship between serum vitamin D levels and muscle strength among hospitalized elderly patients.

Methods: A hospital-based cross-sectional observational study was conducted among 200 hospitalized elderly patients aged ≥ 65 years. Serum 25-hydroxyvitamin D [25(OH)D] levels were measured using chemiluminescent immunoassay. Muscle strength was assessed using handgrip strength measured by a digital dynamometer. Patients were categorized into vitamin D-deficient (<20 ng/mL), insufficient (20–30 ng/mL), and sufficient (>30 ng/mL) groups. Statistical analysis was performed using SPSS software version 25. Pearson correlation and multivariate regression analyses were applied.

Results: Vitamin D deficiency was observed in 61% of participants. Mean handgrip strength was significantly lower in vitamin D-deficient patients compared to sufficient patients (16.8 ± 4.5 kg vs. 24.6 ± 5.2 kg, $P < 0.001$). Serum vitamin D levels demonstrated a significant positive correlation with muscle strength ($r = 0.64$, $P < 0.001$). Multivariate analysis showed vitamin D level as an independent predictor of muscle strength after adjustment for age, sex, BMI, and comorbidities.

Conclusion: Low vitamin D levels are significantly associated with reduced muscle strength in hospitalized elderly patients and may improve rehabilitation outcomes.

Keywords Vitamin D, muscle strength, elderly, hospitalization, sarcopenia, handgrip strength

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Introduction

Vitamin D is a fat-soluble ketosteroid hormone that plays a vital role in calcium and phosphorus homeostasis, bone metabolism, and maintenance of musculoskeletal health. In recent years, increasing evidence has highlighted the extra skeletal functions of vitamin D, particularly its influence on muscle strength and physical performance. Vitamin D receptors are widely distributed in skeletal muscle tissue, and activation of these receptors contributes to muscle protein synthesis, muscle cell growth, and neuromuscular coordination. Deficiency of vitamin D has therefore been associated with muscle weakness, impaired balance, reduced functional capacity, and an increased risk of falls and fractures, especially among the elderly population [1,2]. Vitamin D plays a crucial role in calcium homeostasis, bone metabolism, neuromuscular coordination, and skeletal muscle function. Aging is associated with decreased cutaneous synthesis of vitamin D, reduced dietary intake, impaired intestinal absorption, and limited sunlight exposure, making elderly individuals particularly vulnerable to vitamin D deficiency. Hospitalized elderly patients are at even greater risk due to immobility, chronic illnesses, malnutrition, and prolonged indoor stay [3]. Aging is accompanied by progressive loss of muscle mass and strength, commonly referred to as sarcopenia, which significantly affects quality of life and independence in older adults. Hospitalized elderly patients are particularly

vulnerable due to reduced mobility, comorbid illnesses, inadequate nutritional intake, and limited exposure to sunlight. These factors predispose them to vitamin D deficiency and subsequent decline in muscle function. Several epidemiological studies have reported a high prevalence of hypovitaminosis D among elderly individuals worldwide, including in tropical countries such as India, where adequate sunlight exposure is expected [4]. Several studies have suggested that vitamin D receptors are expressed in skeletal muscle tissue and influence muscle protein synthesis, mitochondrial function, and muscle contraction [5].

Visser *et al.* demonstrated that low serum 25-hydroxyvitamin D [25(OH)D] concentrations were associated with poorer muscle strength and physical performance in older adults [6]. Similarly, Bischoff-Ferrari *et al.* [6] reported that vitamin D supplementation improved lower extremity strength and reduced the risk of falls in elderly individuals with vitamin D deficiency. However, some studies have shown inconsistent findings, and the exact relationship between serum vitamin D levels and muscle strength remains uncertain, particularly among hospitalized elderly patients in the Indian population [6].

Muscle strength is an important determinant of functional independence and overall prognosis in elderly hospitalized patients. Handgrip strength is considered a reliable marker of overall muscle function and nutritional status. Previous investigations have demonstrated that reduced handgrip

strength is associated with increased hospitalization duration, disability, and mortality [7].

Given the growing burden of geriatric morbidity and the high prevalence of vitamin D deficiency, understanding the association between vitamin D status and muscle strength has important clinical implications [8]. Early detection and correction of vitamin D deficiency may help improve muscle function, reduce disability, and enhance quality of life in elderly individuals. Hence, the present study was undertaken to evaluate the relationship between serum vitamin D levels and muscle strength among hospitalized elderly patients.

Materials and Methods

A hospital-based cross-sectional observational study was conducted in the Department of General Medicine, HIMS, Sitapur, a tertiary care teaching hospital over a period of 12 months. A total of 200 hospitalized patients aged ≥ 65 years, admitted for more than 48 hours, and willing to participate were included in the study. Participants were further categorized according to their vitamin D status as follows: deficient (<20 ng/mL), insufficient (20–30 ng/mL), and sufficient (>30 ng/mL). Patients with a history of neuromuscular disorders, severe osteoarthritis affecting grip strength, stroke with residual paralysis, chronic corticosteroid therapy, terminal illness, or malignancy were

excluded from the study. Ethical approval was obtained from the Institutional Ethics Committee. Detailed demographic and clinical information, including age, sex, body mass index (BMI), comorbidities, and vitamin D deficiency status, was recorded for all participants.

A 3 mL venous blood sample was collected aseptically from each participant. The samples were centrifuged at 3000 rpm for 15 minutes to separate the serum. Serum 25-hydroxyvitamin D [25(OH)D] levels were then measured using a chemiluminescent immunoassay method.

Assessment of Muscle Strength

Handgrip strength was assessed using a calibrated digital hand dynamometer. Three measurements were recorded from the dominant hand, and the mean value was used for statistical analysis.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics. Continuous variables were presented as mean $\pm$ standard deviation (SD), while categorical variables were expressed as percentages. Pearson's correlation coefficient was used to evaluate associations between variables. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Baseline Characteristics of Study Participants

Variables	Mean $\pm$ SD / n (%)
Age (years)	72.4 $\pm$ 6.8
Male	112 (56%)
Female	88 (44%)
BMI (kg/m ²)	23.1 $\pm$ 4.2
Diabetes Mellitus	94 (47%)
Hypertension	116 (58%)
Vitamin D deficiency	122 (61%)

Table 2: Vitamin D Levels and Handgrip Strength

Vitamin D Status	Number of Patients (N=200)	Handgrip Strength (kg)
Deficient (<20 ng/mL)	122 (56%)	16.8 $\pm$ 4.5
Insufficient (20–30 ng/mL)	48 (48%)	20.9 $\pm$ 4.8
Sufficient (>30 ng/mL)	30 (15%)	24.6 $\pm$ 5.2
P < 0.001		

Table 3: Correlation Between Vitamin D and Muscle Strength

Parameter	Correlation Coefficient (r)	P-value
Serum Vitamin D vs Handgrip Strength	0.64	<0.001

Discussion

The present study demonstrated a significant positive association between serum vitamin D levels and muscle strength among hospitalized elderly patients. Patients with vitamin D deficiency exhibited significantly lower handgrip strength compared with those having sufficient vitamin D

levels. These findings indicate that vitamin D deficiency may contribute substantially to reduced muscle performance and functional decline in elderly hospitalized individuals [9]. Vitamin D deficiency was highly prevalent in our study population, affecting 61% of patients. Similar findings were reported in studies evaluating frail hospitalized elderly patients, where vitamin D deficiency was observed as a common clinical problem [10].

Our study demonstrated a significant positive correlation between serum vitamin D levels and handgrip strength ($r = 0.64$, $P < 0.001$), indicating that higher vitamin D levels are associated with better muscle strength among elderly hospitalized patients. These findings support the growing body of evidence suggesting that vitamin D has a crucial role in maintaining skeletal muscle function through its effects on muscle protein synthesis, muscle fiber differentiation, neuromuscular coordination, and muscle contraction. Vitamin D receptors present in skeletal muscle tissue are believed to mediate these physiological effects, thereby influencing muscle performance and strength [11].

The findings of the present study are in agreement with the

observations of Visser *et al.*, who reported that lower serum 25-hydroxyvitamin D [25(OH)D] levels were significantly associated with reduced muscle strength and poorer physical performance in older adults. Similarly, Bischoff-Ferrari *et al.* [12] demonstrated that vitamin D supplementation improved muscle function and reduced the risk of falls in elderly individuals with vitamin D deficiency. Ceglia *et al.* [13] also highlighted the important role of vitamin D in skeletal muscle metabolism and regeneration, suggesting that deficiency may contribute to muscle weakness and functional decline. Furthermore, studies conducted by Janssen *et al.* [14] and Houston *et al.* [15] have shown that inadequate vitamin D status is associated with decreased handgrip strength, impaired mobility, and increased frailty among geriatric populations. These observations support the biological plausibility of our findings and reinforce the importance of maintaining adequate vitamin D levels for optimal muscle health. The strong positive correlation observed in the present study may be attributed to the high prevalence of vitamin D deficiency among hospitalized elderly patients, who are often exposed to multiple risk factors such as reduced sunlight exposure, poor nutritional intake, chronic illnesses, and physical inactivity.

Thus, the present study adds to the existing evidence that serum vitamin D levels are significantly associated with muscle strength and suggests that assessment and correction of vitamin D deficiency may help improve functional status and reduce morbidity in elderly individuals.

Conclusion

- The study showed that low vitamin D levels are associated with reduced muscle strength in hospitalized elderly patients.
- Early detection and correction of vitamin D deficiency may help improve mobility, reduce frailty and dependence, and enhance quality of life among the elderly population
- Based on the findings of the present study, we suggest that tertiary care hospitals should consider routine assessment of serum vitamin D levels and muscle strength in hospitalized geriatric patients.
- Adequate sunlight exposure, balanced nutrition, and vitamin D-rich foods should be encouraged.

Limitations and Future Recommendation:

- The present study is a single-center study with a relatively small sample size; the generalizability of the results may be limited.
- In addition, the cross-sectional design of the study restricts the ability to establish a causal relationship between serum vitamin D levels and muscle strength. Important factors influencing vitamin D status and muscle function, such as dietary vitamin D intake and sunlight exposure, were not assessed. Furthermore, long-term follow-up of the participants was not performed, which limited the evaluation of the sustained effects of vitamin D status on muscle strength

and clinical outcomes.

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