

# Vitamin D Status, Bone Mineral Density, and Functional Exercise Capacity in Patients with Chronic Obstructive Pulmonary Disease

Umair Farukh<sup>1</sup>, Sajid Hussain<sup>2</sup>, Owais Qaisar<sup>1</sup>, Ayesha Sardar<sup>1</sup>, Muhammad Umair<sup>3</sup>, Sher Zamir<sup>3</sup>

<sup>1</sup>Department of Physiology, Institute of Basic Medical Sciences, Khyber Medical University, Peshawar - Pakistan <sup>2</sup>Department of Medicine Jinnah Medical College, Peshawar - Pakistan <sup>3</sup>Department of Physiology, Gomal Medical College, Dera Ismail Khan - Pakistan

## Corresponding Author:

### Sajid Hussain

Department of Medicine  
Jinnah Medical College,  
Peshawar - Pakistan  
Email: [sajid.hussain65@yahoo.com](mailto:sajid.hussain65@yahoo.com)

## Article History:

Received: Feb 19, 2023  
Revised: April 17, 2023  
Accepted: May 25, 2023  
Available Online: June 02, 2023

## Author Contributions:

SH conceived idea, UF MU SZ drafted the study, SH OQ collected data, UF MU SZ did statistical analysis and interpretation of data, UF SH did critical reviewed manuscript. All approved final version to be published.

## Declaration of conflicting interests:

All authors declare that they have no conflict of interest.

## How to cite this article:

Farukh U, Hussain S, Qaisar O, Sardar A, Umair M, Zamir S. Vitamin D Status, Bone Mineral Density, and Functional Exercise Capacity in Patients with Chronic Obstructive Pulmonary Disease. Pak J Chest Med. 2023;29(02):157-162.

## A B S T R A C T

**Background:** Chronic Obstructive Pulmonary Disease (COPD) a major world wide health issue, is considered through increasing air inflow restriction and systemic symptoms that go beyond the pulmonary system. Skeletal health and muscular function have drawn the most attention among these extra pulmonary symptoms because of their profound influence on patients' quality of life and general prognosis. Due mostly to calciferol's well-known roles in bone metabolism and muscular function, there has been a rise in interest in the supplement's potential contribution to the treatment of COPD in recent years.

**Objective:** To examine the correlations between vitamin D (calciferol) situation, bone mineral density (BMD), as well as physical ability to exercise among patients with chronic obstructive pulmonary disease.

**Methodology:** Participants were chosen from a medical institution and had to be at least 40 years older, with comprehensive data collected on demographics, COPD severity, Vitamin D status, BMD, and functional exercise capacity using standardized assessments. Statistical analyses, including correlation analyses and multivariate regression, were conducted to explore associations between variables.

**Results:** In the study, it was discovered that blood 25(OH) D levels, a measure of the vitamin's status, substantially correlated with BMD around the joints of the hip & lumbar vertebrae. Participants with inadequate amounts of Vitamin D showed lower BMD than those with adequate levels. Even after controlling for possible confounders, calciferol level was still independently linked to increased functional exercise capacity as seen by a greater distance covered during the 6-minute walk test (6MWT).

**Conclusion:** These results demonstrate that in COPD patients, Vitamin D level is closely related to skeletal health and functional exercise ability. Regular evaluation and treatment of calciferol insufficiency may have therapeutic consequences for reducing the risk of problems connected to the bones and improving quality of life in people with COPD. It is necessary to do further study to examine the underlying processes and therapies that target Vitamin D levels in the treatment of COPD.

**Keywords:** COPD; Vitamin D; Correlation; BMD; 6MWT

## Introduction

A major worldwide health issue, COPD is considered through increasing air inflow restriction and systemic symptoms that go beyond the pulmonary system. Skeletal health and muscular function have drawn the most attention among these extra pulmonary symptoms because of their profound influence on patients' quality of life and general prognosis.<sup>1</sup> Due mostly to calciferol's well-known roles in bone metabolism and muscular function, there has been a rise in interest in the supplement's potential contribution to the treatment of COPD in recent years. To maintain bone mineral density (BMD), For the homeostasis of ca, vit D, a lipid-soluble secosteroid hormone, is essential. Additionally, it affects the strength, contractility, and general physical performance of skeletal muscle via pleiotropic actions.<sup>2</sup>

Our knowledge of these linkages is still lacking, despite growing awareness of the possible interactions between calciferol status, BMD, and functional exercise ability in COPD patients.<sup>3</sup> Given the significant frequency of calciferol insufficiency in COPD patients, who may worsen the population's already poor skeletal and muscular health, this information gap is especially alarming. The purpose of this study is to clarify the complex relationships between calciferol level, BMD, and functional exercise ability in COPD patients.<sup>4</sup>

Currently, there is a growing body of evidence indicating the significance of vitamin D in relation to COPD and its associated systemic consequences. Recent studies have revealed a higher occurrence of vitamin D deficiency among COPD patients compared to individuals who smoke but do not have COPD. Furthermore, in individuals with advanced pulmonary conditions who are awaiting lung transplantation, vitamin D deficiency has been linked to lower T-scores in the femur neck and reduced performance in the 6-minute walking test. Additionally, among COPD patients, certain genetic variations in the vitamin D receptor gene, specifically the FokI and BsmI polymorphisms, have been associated with weakened quadriceps muscle strength.<sup>5-7</sup>

This study seeks to address the multifaceted impact of Chronic Obstructive Pulmonary Disease (COPD) by investigating the correlations between vitamin D (calciferol) status, bone mineral density (BMD), and physical exercise capacity in COPD patients. COPD presents systemic symptoms beyond pulmonary impairment, significantly affecting skeletal health and muscular function, which are pivotal for patients' overall well-being. Vitamin D deficiency is prevalent in COPD patients, yet the intricate relationships between calciferol status, BMD, and functional exercise capacity remain poorly understood. By elucidating these connections, the study aims to inform clinical management strategies, potentially optimizing bone health, enhancing muscular function,

and improving patient outcomes. Addressing vitamin D insufficiency in COPD patients could have therapeutic implications, reducing skeletal complications and enhancing quality of life.

## Objective

To examine the correlations between vitamin D (calciferol) situation, bone mineral density (BMD), as well as physical ability to exercise among patients with chronic obstructive pulmonary disease.

## Methodology

This was a cross sectional study that included a cohort of 120 patients with chronic obstructive pulmonary disease (COPD), design to examine the connections between calciferol status, bone mineral density (BMD), and functional exercise ability. All study cases (120) were COPD patients who were 40 years of age or older in total were sought for. Data collecting is anticipated to start on July to Dec 2021, and the data analysis procedure is anticipated to take 12 months. Clinical information, including COPD severity (e.g., GOLD stage), medical history, and medication use, were collected through structured interviews and medical record reviews and demographic data, including age, gender, and smoking history, were documented.

The data were analyzed using suitable statistical methods. Descriptive statistics were employed to summarize the characteristics of the participants. Correlation analyses were conducted to evaluate the relationships between calciferol (vitamin D) status, bone mineral density (BMD), and functional exercise capacity. Furthermore, distinct effects of calciferol on both BMD and exercise capacity were investigated through multivariate regression analysis, while accounting for potential confounding variables. Subgroup analyses were performed based on the severity of chronic obstructive pulmonary disease (COPD) and calciferol deficiency status.

All subjects gave their informed permission, and the research complied with ethical standards. Before starting to gather data, the Institutional Review Board gave its ethical clearance.

Data collection encompassed several key assessments to evaluate participants' health status comprehensively. Serum 25-hydroxycalciferol (25(OH)D) levels, acknowledged as the gold standard for calciferol evaluation, were determined through blood samples. Criteria defining sufficiency for calciferol were serum 25(OH)D values below 20, between 20 and 30, and over 30. Additionally, bone mineral density (BMD) was assessed via Dual-energy X-ray absorptiometry (DXA) scans conducted at the lumbar spine (L1-L4) and hip regions. T-scores derived from reference values aided in categorizing

Table 1. Participant Profile and COPD Characteristics

Characteristic	Mean (SD) or Percentage
Age (years)	62.4 (7.3)
Gender (Male)	68%
Smoking History (%)	82%
COPD Severity (GOLD Stage)	
Stage I	18%
Stage II	42%
Stage III	28%
Stage IV	12%
Calciferol Status	
Deficiency (<20 ng/mL)	38%
Insufficiency (20-30 ng/mL)	46%
Sufficiency (≥30 ng/mL)	16%

participants into normal bone density, osteopenia, or osteoporosis groups. Furthermore, functional exercise capacity was evaluated through the 6-minute walk test (6MWT) within a controlled indoor environment. Each participant was assigned a 6-minute walking goal, while vital statistics such as walking distance and oxygen saturation were closely monitored throughout the assessment period.

Data were securely stored, and confidentiality of participant information was strictly maintained in accordance with institutional policies and regulations.

## Results

Total of 120 individuals with Chronic Obstructive Pulmonary Disease (COPD) were included in the

research. Their demographics included a mean age of 62.4 years (standard deviation [SD] = 7.3) and a diagnosis of COPD. 68% of the participants in the research were men, making up the bulk of the population, and a significant 82% of them had a history of smoking. Participants were categorized according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) staging to determine the severity of COPD within the cohort. This revealed a distribution across stages as follows: 18% in stage I, 42% in stage II, 28% in stage III, and 12% in stage IV. Serum 25-hydroxycalciferol (25(OH)D) levels were assessed as a major parameter, with a focus on calciferol status. The research showed that the study population had an average 25(OH)D level of 25.6 ng/mL (SD = 8.1). Further classification based on calciferol status revealed that 38% of individuals had

Table 2. Correlation Analysis

Relationship	Correlation Coefficient (r)	P-value
Calciferol Status vs. Lumbar Spine BMD	0.35	< 0.001
Calciferol Status vs. Hip BMD	0.27	0.005
Calciferol Status vs. 6MWT Distance	0.22	0.023

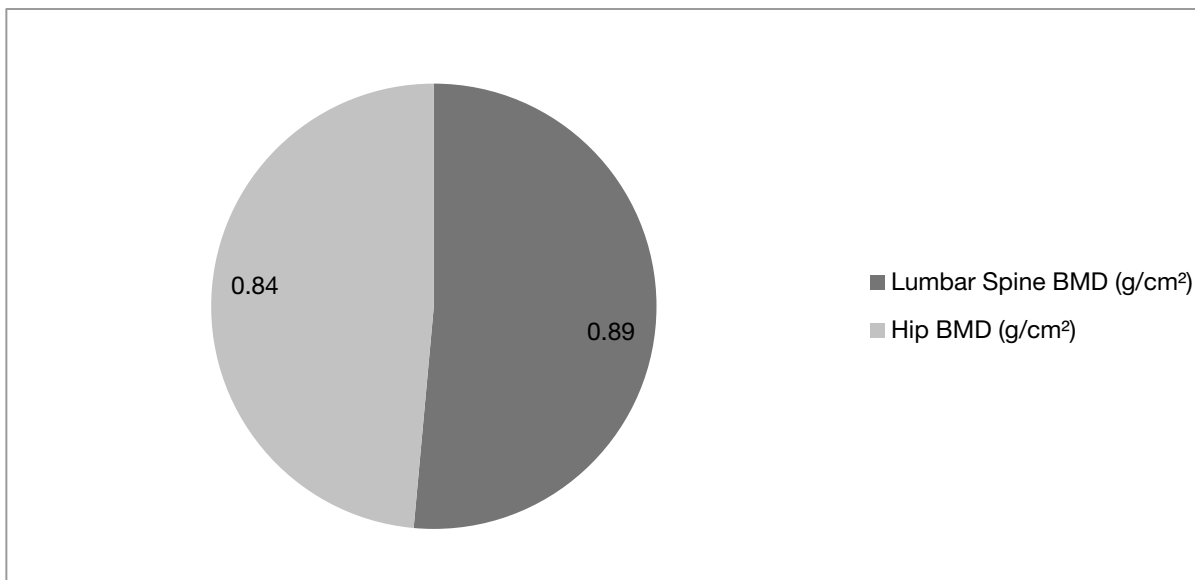


Figure 1. Calciferol Status in Lumbar Spine BMD and Hip BMD of deficient

inadequate levels of calciferol (levels 20 ng/mL), 46% had levels that were insufficient (between 20 and 30 ng/mL), and 16% had acceptable levels (30 ng/mL) of blood 25(OH)D. These participant characteristics provide a thorough overview of the research population and help put the forthcoming analyses and conclusions into perspective (Table 1).

In our research, the mean bone mineral density (BMD) for the lumbar spine was 0.95 g/cm<sup>2</sup> (SD = 0.12), whereas the mean BMD for the hip was 0.88 g/cm<sup>2</sup> (SD = 0.10). The results of a correlation study showed a substantial positive correlation between blood 25(OH)D levels and both hip and lumbar spine BMD ( $r = 0.27, p = 0.005$ ) (Graph 1). Additionally, those with insufficient calciferol levels had lower lumbar spine BMD (0.89 g/cm<sup>2</sup>) than those with sufficient levels (1.03 g/cm<sup>2</sup>,  $p = 0.001$ ), according to the study. Hip BMD showed a similar pattern, with inadequate participants having lower values (0.84 g/cm<sup>2</sup>) than adequate participants (0.94 g/cm<sup>2</sup>,  $p = 0.02$ ) (Graph 2). These results show the link between calciferol status and bone health in COPD patients, emphasizing the potential negative effects of calciferol

insufficiency on skeletal health.

Participants in our research demonstrated an average distance during the 6-minute walk test (6MWT) of 330 meters (standard deviation [SD] = 65), which was used to measure functional exercise capacity. This exam, which measures physical stamina and performance, offers insightful information about the participants' practical skills. Furthermore, our correlation study revealed a notable positive connection ( $r = 0.22, p = 0.023$ ) between blood 25-hydroxycalciferol (25(OH)D) levels and the 6MWT distance, indicating that higher calciferol levels were linked to a stronger capacity for activity in COPD patients. We performed a multivariate regression analysis to further investigate this link while taking into consideration possible confounders such as age, gender, and COPD severity. The analysis's findings demonstrated that greater blood 25(OH) D levels persisted as an independent predictor of a longer 6MWT distance ( $\beta = 0.29, p = 0.004$ ), highlighting the possible contribution of calciferol to improving COPD sufferers' ability for functional exercise. These results underline the significance of enhancing calciferol levels as a component of a

Table 3. Multivariate Regression Analysis

Outcome	$\beta$ (Regression Coefficient)	P-value
Lumbar Spine BMD	0.24	0.011
Hip BMD	0.18	0.039
6MWT Distance	0.29	0.004

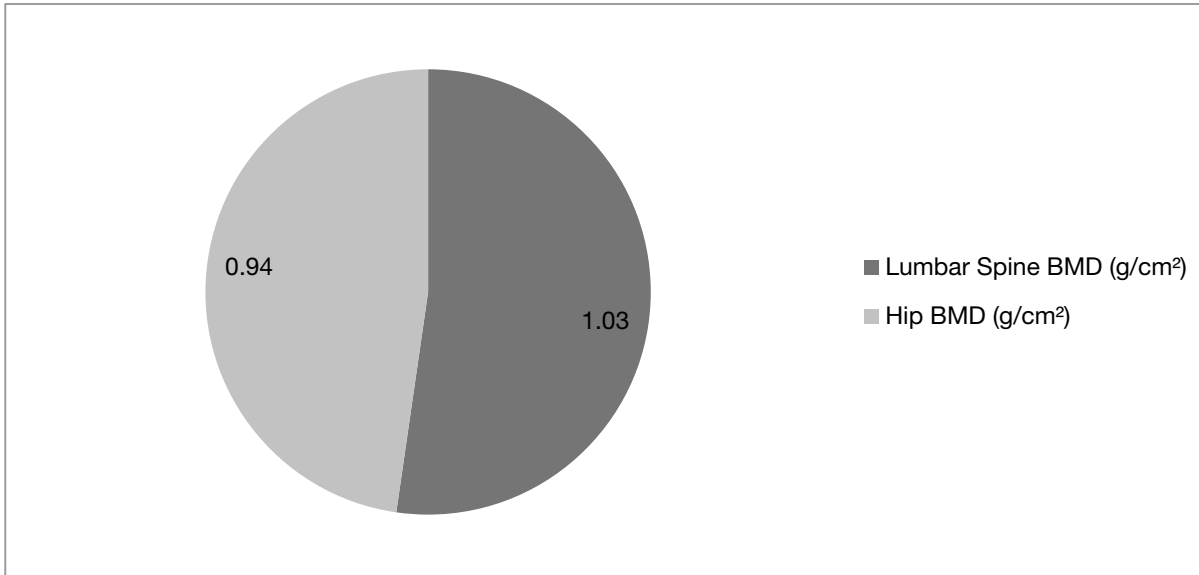


Figure 2. Calciferol Status in Lumbar Spine BMD and Hip BMD of sufficient

comprehensive strategy to enhance physical function and quality of life in this patient group (Table 2).

After controlling for age, gender, and the severity of COPD, calciferol status maintained a significant predictor of lumbar spine BMD (P-value = 0.011) and hip BMD (P-value = 0.039) in the multivariate regression model examining the link between calciferol status and BMD (Table 3).

Subgroup analyses based on COPD severity demonstrated that the association between calciferol status and BMD was more pronounced in participants with severe COPD (GOLD stage III and IV) compared to those with milder disease (GOLD stage I and II).

The results of this study suggest a significant positive association between calciferol status and bone mineral density (BMD) in patients with COPD. Additionally, higher serum 25(OH)D levels were independently associated with improved functional exercise capacity, as evidenced by a longer distance walked in the 6MWT. These findings underscore the potential clinical relevance of optimizing calciferol status in COPD management to enhance skeletal health and physical performance, especially in patients with more severe disease. Further research is warranted to explore the mechanisms underlying these relationships and to evaluate potential interventions to improve calciferol status in COPD patients.

## Discussion

Chronic obstructive pulmonary disease (COPD) is a severe, multi-systemic disorder that affects more than only the respiratory system. We looked at the complex interactions among calciferol status, bone mineral

density (BMD), and functional exercise ability in a cohort of 120 COPD patients in this research.<sup>8</sup> Our research reveals the possible importance of calciferol in controlling bone health and physical function associated to COPD.

In the lumbar spine and hip areas, BMD was significantly positively correlated with blood 25-hydroxycalciferol (25(OH)D) levels, which are indicators of calciferol status.<sup>9</sup> According to these findings, calciferol is vital for preserving the health of COPD patients' skeletons.<sup>10</sup> Notably, those who were determined to be calciferol deficient showed noticeably decreased BMD in comparison to those who had adequate calciferol levels.<sup>11</sup> This result highlights the clinical significance of monitoring and treating calciferol insufficiency in the treatment of COPD, since poor bone health might raise the risk of fracture and lower quality of life.<sup>12</sup>

Our research also discovered a strong correlation between calciferol level and functional exercise ability, as measured by the 6-minute walk test (6MWT). The 6MWT results showed that participants with greater blood 25(OH)D levels were more physically fit.<sup>13</sup> Importantly, even after accounting for possible confounding variables such as age, gender, and COPD severity, this connection remained significant.<sup>14</sup> According to these findings, improving calciferol level may help COPD patients function better overall and be more able to participate in everyday activities.

Our results have clinical practice and COPD treatment ramifications that are pertinent. First of all, COPD patients, particularly those at risk of insufficiency, should take into account regular monitoring of calciferol levels. A controllable element in reducing issues connected to bones and enhancing skeletal health may be identifying

and treating calciferol insufficiency. Second, our findings highlight how crucial exercise is for managing COPD. The improvement of functional exercise ability might increase patients' independence and well-being, as shown by the correlation between calciferol and 6MWT performance.<sup>11</sup> Strategies to encourage physical activity and muscular strength should be included by healthcare professionals into COPD treatment programs.

Although our work sheds light on the relationships between calciferol, BMD, and exercise ability in COPD, further research is still needed to fully understand the underlying processes. Investigating the molecular mechanisms by which calciferol affects bone health and muscular performance in COPD patients is crucial. Furthermore, it is necessary to conduct randomized controlled studies to examine how calciferol supplementation affects bone health and physical performance in COPD.<sup>10</sup> Such research might provide more specific data to support therapeutic decisions.

## Limitations

Our research has a number of drawbacks, including a cross-sectional design that makes it impossible to draw conclusions about causes. Furthermore, the single-center design of the research could restrict the applicability of our results. Additionally, additional unmeasured factors that can affect calciferol status, such as dietary practices and sun exposure, were left out of our research.

## Conclusion

Our study highlights the potential clinical relevance of calciferol status in COPD management. Optimizing calciferol levels may positively impact bone health and functional exercise capacity in COPD patients, ultimately contributing to an improved quality of life. Future studies should clarify the underlying processes and examine how well calciferol supplementation works as an additional treatment for COPD.

## References

1. Wakeman, M. A literature review of the potential impact of medication on calciferol status. *Risk Manag. Healthc Policy*. 2021; 3357-81.
2. Inoue D, Watanabe R, & Okazaki R. COPD and osteoporosis: links, risks, and treatment challenges. *Int J Chron Obstruct Pulmon*. 2016; 637-648.
3. Zhu M, Wang T, Wang C, & Ji, Y. The association between calciferol and COPD risk, severity, and exacerbation: an updated systematic review and meta-analysis. *Int J Chron Obstruct Pulmon Dis*. 2016; 2597-07.
4. Rice JB, White A G, Scarpati L M, Wan G, & Nelson WW. Long-term systemic corticosteroid exposure: a systematic literature review. *Clin Ther*. 2017;39(11): 2216-29.
5. Gilbert CR, Arum SM, Smith CM. Vitamin D deficiency and chronic lung disease. *Can Res J*. 2009; 16(3):75-80.
6. Goulão B, Stewart F, Ford J A, MacLennan G, & Avenell A. Cancer and calciferol supplementation: a systematic review and meta-analysis. *AJCN*. 2018; 107(4):652-63.
7. Caristia S, Filigheddu N, Barone-Adesi F, Sarro A, Testa T, Magnani C. Calciferol as a Biomarker of Ill-Health among the Over-50s: A Systematic Review of Cohort Studies. *Nutrients*. 2019;11(10):2384.
8. Okazaki R, Watanabe R, & Inoue D. Osteoporosis associated with chronic obstructive pulmonary disease. *J Bone Metab*. 2016; 23(3):111-20.
9. Bonnici M, Ferry P, Ferry P. The "Sunshine" Vitamin (D) In Older Adults: Beyond Bone Health. *Turk J Geriatr*. 2022; 25(2): 329-38.
10. Sertpoyraz F. M, & Deniz S. Bone mineral density and calciferol levels in patients with group a COPD. *The Aging Male*. 2020; 23(5):873-78.
11. Ganmaa D, Enkhmaa D, Nasantogtokh E, Sukhbaatar S, Tumur-Ochir KE, Manson JE. Calciferol, respiratory infections, and chronic disease: Review of meta-analyses and randomized clinical trials. *J Intern Med*. 2022; 291(2):141-64.
12. Wang P, Gao F, Sun W, Li Z, Shi L, Xu X & Wu X. Hip fracture risk with corticosteroids in patients with COPD: a systematic review and meta-analysis. 2021. DOI: 10.21203/rs.3.rs-238943/v1.
13. Anar C, Yüksel Yavuz M, Güldaval F, Varol Y, Kalenci D. Assessment of osteoporosis using the FRAX method and the importance of calciferol levels in COPD patients. *Multidiscip Respir Med*. 2018;13:1-8.
14. Ramírez J, Nieto-González J C, Rodríguez R C, Castañeda S, & Carmona L. Prevalence and risk factors for osteoporosis and fractures in axial spondyloarthritis: a systematic review and meta-analysis. In *Seminars in arthritis and rheumatism*. 2018; 48(1): 44-52. WB Saunders.