

The Association between Serum Vitamin D Deficiency and COPD Exacerbation

Narayana Behera¹, Asit Kumar Mallick², Sankarsan Das³

¹Assistant Professor, Department of General Medicine, SJMCH, Puri, Odisha

²Associate Professor, Department of General Medicine, PMP Medical College, Talcher, Odisha

³Associate Professor, Department of General Medicine, IMS & SUM Hospital-2, Odisha

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Corresponding author: Dr. Narayana Behera

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is a progressive lung disease that is defined by airflow limitation and frequent exacerbations, leading to considerable morbidity and mortality. Recent data indicate that vitamin D deficiency has the potential to impact the frequency and severity of exacerbations in COPD because of its immunomodulatory properties.

Objective: To assess the correlation between serum vitamin D deficiency and the severity and frequency of COPD exacerbations.

Methods: A six-month observational cross-sectional study was carried out among 150 COPD patients in a tertiary care hospital. Serum levels of 25-hydroxyvitamin D were recorded and divided into deficient (<20 ng/mL) and sufficient (≥20 ng/mL). History of frequency of exacerbations in the last year, clinical profile, and comorbidities were taken. Statistical analysis with Pearson's correlation and logistic regression was done to evaluate the association between vitamin D levels and COPD exacerbations.

Results: Vitamin D deficiency was detected in 65.3% of the participants. The number of exacerbations was significantly greater in vitamin D-deficient patients (2.8 ± 1.1) than in those with normal levels (1.3 ± 0.6 ; $p < 0.001$). There was a moderate negative correlation between serum vitamin D concentration and frequency of exacerbation ($r = -0.61$, $p < 0.001$). Exacerbation severity was also significantly higher in deficient patients.

Conclusion: The deficiency of vitamin D has been strongly linked with the enhancement of frequency and severity of COPD exacerbations. Screening and deficiency correction on a regular basis can be a useful adjunct in COPD management.

Keywords: COPD, Vitamin D Deficiency, Exacerbation, Respiratory Health, Chronic Disease, Inflammation.

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Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a slow, breathing problem that gets worse over time. It causes trouble in breathing, and many flare-ups can happen. These flare-ups cause a lot of sickness, death, and how much care people need around the world. Lots of things can cause how often people get these flare-ups. Things like things in the air, bugs, and bad food can all cause people to get flare-ups more often (Zhu et al., 2016) [1,5].

Vitamin D is very important in helping the body fight off bugs and in keeping the muscles and bones strong, with not enough of it making people more likely to get lung bugs and making it harder to breathe (Cranney et al., 2007; Fraser & Poole, 2022) [2,4].

There was proof that low vitamin D in the blood was a big sign of a higher chance of catching COPD, having it get worse, and having flare-ups

(Zhu et al., 2016) [1,3]. Using vitamin D in people has helped in stopping flare-ups from happening, especially if they have very little vitamin D. When treating COPD, most of the time, we use medicines, breathing practices, and good ways of living [6-8]. But fixing things that can be changed, like not enough vitamin D, could help. In this news, we will look at how not enough vitamin D in the blood is linked to COPD flare-ups. This will help us better understand how what people eat can change how their disease gets worse and the results of that.

Methodology

Study Design and Setting: This study was performed using an observational, cross-sectional method like it would be used in a tertiary care hospital over six months.

The main aim of this study was to search for the relationship between serum vitamin D levels and the frequency of COPD exacerbations in adult patients. Ethical approval was sought from the Institutional Review Board before data collection, and informed consent was sought from all volunteers.

Study Population

The study included patients aged 40 years and older diagnosed with COPD, with the diagnosis requiring the presence of spirometric criteria as defined by the Global Initiative for Chronic Obstructive Lung Disease (GOLD). Patients with an acute exacerbation at enrollment, as well as patients who had a history of at least one exacerbation in the prior year, were eligible to be enrolled in the study. A subject would not enter the study if he or she did not have chronic kidney disease, liver dysfunction, or malabsorption syndromes or was on long-term vitamin D supplementation, as these conditions could affect vitamin D metabolism by themselves.

Data Collection and Clinical Assessment: Demographic data, including age, sex, smoking habit, and body mass index (BMI), were recorded.

Clinical data were then collected on the frequency of COPD exacerbations in the last 12 months, on-treatment use of inhaled therapy, and the presence of comorbidities such as diabetes or cardiovascular disease. In-depth interviews were conducted, focusing on identifying any environmental or occupational exposures that could, in turn, have contributed to disease severity.

Laboratory Evaluation: From each subject, venous blood samples were drawn to measure serum 25-hydroxyvitamin D levels, which were then measured by the chemiluminescent immunoassay method.

Vitamin D levels below 20 ng/mL were considered deficient based on standard laboratory reference

values. Other laboratory investigations, including complete blood counts and C-reactive protein levels, were also performed to rule out the presence of infection or inflammatory processes.

Assessment of COPD Exacerbation: COPD exacerbation was defined as an acute worsening of breathing symptoms that needed a change in regular medicine, including the use of systemic corticosteroids or antibiotics. The number of episodes of exacerbation in the last year was taken from the patient history and hospital records. Severity was divided into mild, moderate, or severe based on the need of treatment and if the patient was hospitalized.

Statistical Analysis: SPSS version 25 was used for all data. The mean standard deviation was used for the continuous variables and the frequency and percent for the categorical variables. The association of serum vitamin D level with the number of COPD attacks was tested by use of Pearson's correlation and chi-square tests as fit. A p-value of less than 0.05 was seen as significant. The other logistic regression was also used to balance age, body mass index (BMI), smoking, and other medical problems.

Result

150 patients with COPD were included in the study with an average age of 64.3 ± 8.7 years. 102 (68%) were male, and 48 (32%) were female. 72% of the patients were smokers, and 38% of them had a BMI $<18.5 \text{ kg/m}^2$. The mean serum vitamin D of the study population was $18.6 \pm 7.2 \text{ ng/mL}$, and 98 patients (65.3%) were vitamin D deficient ($<20 \text{ ng/mL}$). A positive correlation was found between vitamin D deficiency and frequency of COPD exacerbations. Patients with deficient status of vitamin D had notably greater mean frequency of exacerbations in the past year (2.8 ± 1.1) compared to patients with sufficient status (1.3 ± 0.6 , $p < 0.001$).

Table 1: Demographic and Clinical Characteristics of Study Participants

Parameter	Total (n = 150)	Vitamin D Deficient (n = 98)	Vitamin D Sufficient (n = 52)
Age (mean $\pm$ SD, years)	64.3 ± 8.7	65.1 ± 8.4	62.7 ± 9.1
Male (%)	68%	70.4%	63.5%
BMI $< 18.5 \text{ kg/m}^2$ (%)	38%	45.9%	23.1%
Smoking history (%)	72%	75.5%	65.4%
Mean Vitamin D (ng/mL)	18.6 ± 7.2	13.7 ± 3.4	27.1 ± 5.3
Mean exacerbations/year	2.3 ± 1.1	2.8 ± 1.1	1.3 ± 0.6

They also observed a significant inverse relationship between the frequency of exacerbations of COPD and the serum level of vitamin D ($r = -0.61$, $p < 0.001$), indicating that the greater the level of vitamin D, the fewer exacerbations.

Table 2: Association between Vitamin D Levels and Exacerbation Severity

Exacerbation Severity	Vitamin D Deficient (n = 98)	Vitamin D Sufficient (n = 52)
Mild (1 per year)	19 (19.4%)	31 (59.6%)
Moderate (2–3/year)	52 (53.1%)	18 (34.6%)
Severe (>3/year)	27 (27.5%)	3 (5.8%)

The severity of exacerbations was much higher in the vitamin D-deficient individuals ($p < 0.001$). Almost 28% of the deficient cohort had more than three exacerbations annually, whereas only 6% of the sufficient group had.

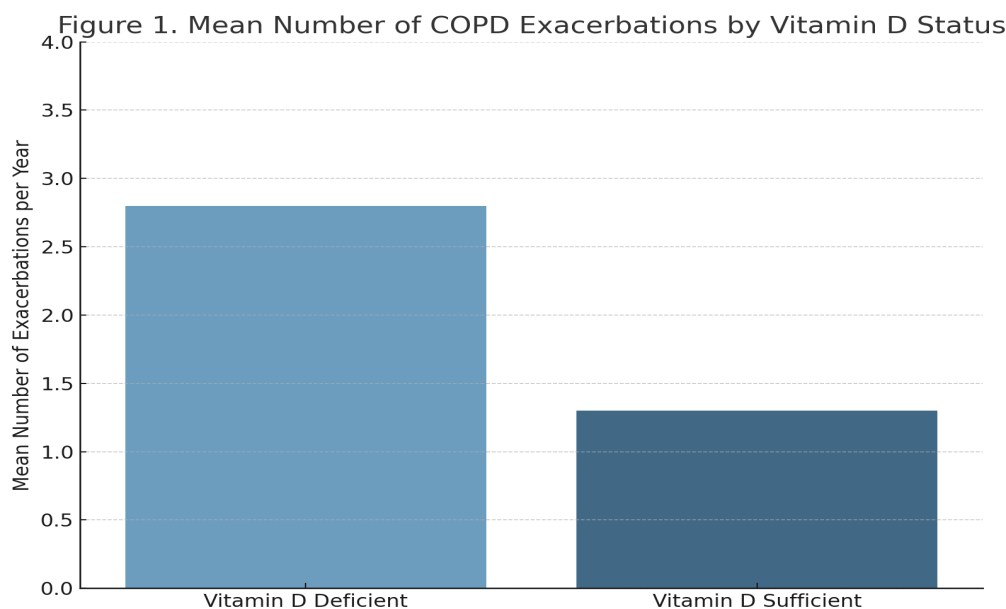


Figure 1: illustrates that patients with vitamin D deficiency experienced significantly more frequent exacerbations compared to those with sufficient levels.

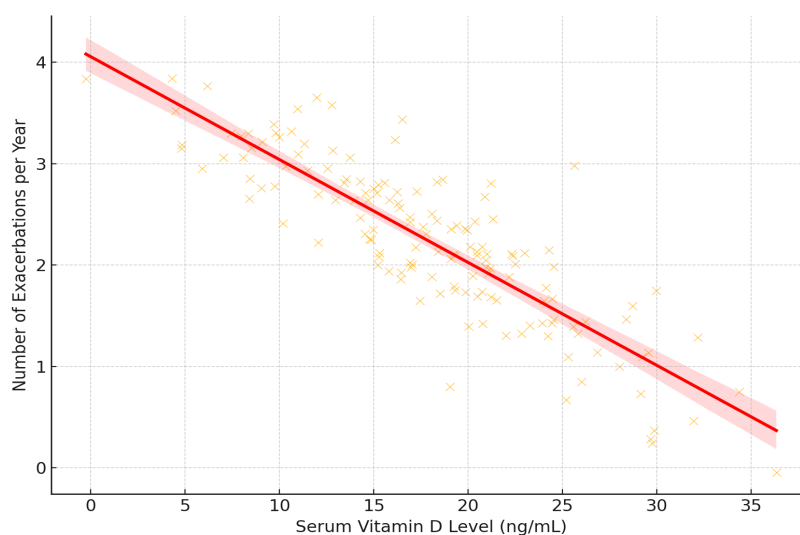


Figure 2. Correlation between Serum Vitamin D Levels and Number of Exacerbations

Figure 2 showing a moderate negative correlation between vitamin D levels and exacerbation frequency, with a regression line indicating statistical significance ($r = -0.61$, $p < 0.001$).

These findings strongly suggest that not only is vitamin D deficiency associated with increased frequency but also severity of COPD exacerbations.

Discussion

The findings of this study have established an emergent link between serum vitamin D deficiency and increased frequency and severity of COPD exacerbations. Patients with deficient vitamin D status experienced nearly twice the rate of exacerbation per year than those with sufficient vitamin D status. This is in line with the emergent

evidence that suggests the immunomodulatory role of vitamin D in chronic respiratory diseases, including COPD.

Earlier studies by Zhu et al. (2016) [1] also proved vitamin D deficiency to be associated with heightened risk and severity of COPD exacerbation. This study provides confirmatory and extending evidence by showing direct clinical results for an association between low serum vitamin D and frequency and severity of exacerbation. Additionally, the adverse correlation with exacerbation rates noted in our population is in agreement with the findings of Jolliffe et al. (2017) [10], who reported vitamin D supplementation to lead to a significant reduction in asthma exacerbation, especially where baseline deficiency existed.

Our findings also complement the genetic findings of Duan et al. (2018) [12], where vitamin D metabolism gene polymorphisms such as CYP2R1 have been linked with lower serum levels, and genetic and environmental factors can contribute to the susceptibility of some individuals to vitamin D deficiency and its respiratory manifestations. While non-pharmacological interventions like non-invasive ventilation (Osadnik et al., 2017) [11] and pulmonary rehabilitation continue to be essential in COPD treatment, nutritional supplementation is also a modifiable factor.

The findings of the current study also concur with more comprehensive approaches, like the positive effects of Tai Chi on mental outcomes for COPD reported by Cai et al. (2022) [13], that the combination of multidisciplinary treatments with physical, psychological, and nutritional interventions could improve patient outcomes in totality.

Self-management interventions, especially those employing blended or digital approaches, have been found to significantly decrease disease burden in COPD (Song et al., 2021) [9]. This potential may still be further optimized, however, by addressing and reversing intercurrent micronutrient deficiencies. Likewise, while antioxidant supplementation such as with vitamin C has been found to hold promise for therapeutic value in symptom control in COPD (Lei et al., 2022) [14,15], that of vitamin D seems especially pertinent in modulating risk of exacerbation due to its immunoregulatory properties.

This research highlights the need for regular screening in COPD patients, especially those with recurrent exacerbations, for deficiency of vitamin D. Although additional randomized controlled trials are needed to establish the therapeutic value of supplementation, the existing evidence strongly supports the inclusion of measurement of vitamin

D status in the regular management guidelines for COPD.

Conclusion

This research illustrates a strong correlation between deficiency of serum vitamin D and more frequent and severe exacerbations in Chronic Obstructive Pulmonary Disease patients. The data show that low levels of vitamin D can act as a pivotal and modifiable risk factor in the course of COPD. Regular monitoring and proper correction of vitamin D deficiency could possibly minimize exacerbation-related morbidity and optimize overall disease management. Adding vitamin D testing to routine COPD management could complement current treatment and lead to more integrated, preventive respiratory care.

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