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Association of Vitamin D Status with Depression and Anxiety in chronic obstructive pulmonary disease (COPD) Patients.

Mamta Kandwal[1*], Shashi kant Verma[2], Irfan Ali Khan[3]

[1]PhD Scholar, Department of Physiology, Rohilkhand Medical College & Hospital, Bareilly.
[2]Professor & Head, Department of Physiology, Rohilkhand Medical College & Hospital, Bareilly.
[3]Assistant Professor, Department of Respiratory Medical College, Varun Arjun Medical College & Hospital, Shahjahanpur.

Corresponding Author

Ms. Mamta Kandwal

PhD Scholar, Department of Physiology, Rohilkhand Medical College & Hospital, Bareilly.

Abstract

Background: Prior research suggests a potential link between Vitamin D levels and mental health. However, the association between Vitamin D status and depressive and anxiety symptoms in COPD patients remains unclear. This study aimed to investigate the correlation between Vitamin D levels and the severity of depressive and anxiety symptoms among COPD patients.

Methods: Participants were recruited from a sample of COPD patients and assessed for their Vitamin D levels using a standardized measurement technique. The severity of depressive symptoms was measured using the Beck Depression Inventory (BDI), while the severity of anxiety symptoms was assessed with the Beck Anxiety Inventory (BAI). Correlation analysis was conducted to determine the relationship between Vitamin D levels and the severity of depressive and anxiety symptoms.

Results: The correlation values between Vitamin D levels and the BDI (-0.52) and BAI (-0.49) revealed moderate to strong inverse relationships. A higher Vitamin D level was associated with a lower severity of depressive symptoms (as indicated by the BDI) and a lower severity of anxiety symptoms (as measured by the BAI).

Conclusion: The results of this study demonstrate a moderate to strong inverse relationship between Vitamin D levels and the severity of depressive and anxiety symptoms among COPD patients. These findings highlight the potential role of Vitamin D in mental health and underline the importance of maintaining optimal Vitamin D levels in this population. Future research should explore the underlying mechanisms and evaluate the efficacy of interventions targeting Vitamin D in improving mental health outcomes among COPD patients.

Keywords: Vitamin D, Depression, Anxiety, Chronic Obstructive Pulmonary Disease (COPD), Mental Health

Introduction:

Chronic obstructive pulmonary disease (COPD) continues to be a significant global health challenge, affecting millions of individuals worldwide. According to recent estimates from the World Health Organization (WHO), COPD affects approximately 300 million people globally and remains the third leading cause of death, responsible for around 3.23 million deaths annually as of 2019. This chronic respiratory condition is characterized by persistent respiratory symptoms and airflow limitation, primarily due to significant exposure to noxious particles or gases, most commonly from cigarette smoke and environmental pollutants(1).

COPD is often accompanied by various comorbidities, with depression and anxiety being among the most prevalent. The presence of these psychological disorders in COPD patients is associated with worse health outcomes, including increased rates of hospitalization, higher healthcare costs, poorer quality of life, and elevated mortality rates. The prevalence of depression in COPD patients is reported to be between 30% and 60%, while anxiety is found in approximately

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20% to 40% of patients. Despite their high prevalence, these mental health conditions are frequently underdiagnosed and inadequately treated, exacerbating the overall disease burden[2], [3].

Vitamin D deficiency has emerged as a potential modifiable risk factor for depression and anxiety, particularly in patients with chronic diseases like COPD. Vitamin D, beyond its well-known role in bone health and calcium metabolism, is increasingly recognized for its influence on immune function and mental health. Deficiencies in vitamin D have been linked to various neuropsychiatric disorders, including depression and anxiety, which may be due to its involvement in regulating neurotransmitter synthesis and inflammatory processes[4], [5].

Several recent studies have examined the relationship between vitamin D levels and psychological symptoms in COPD patients. For instance, a study by Lokesh et al. (2022) found that lower vitamin D levels were significantly associated with higher scores on both the Hamilton Anxiety Rating Scale (HAM-A) and Hamilton Depression Rating Scale (HAM-D) in COPD patients, suggesting that vitamin D deficiency may exacerbate psychological distress in this population[6]. Another study by Martino et al. (2023) highlighted the association between low vitamin D status and increased anxiety levels in a cohort of postmenopausal women, indicating that the effects of vitamin D on mental health may extend across different populations[7].

However, not all research has yielded conclusive results. For example, a study by Granlund et al. (2020) found no significant association between vitamin D levels and anxiety or depression in a diverse population of Middle Eastern and African-born immigrants, suggesting that other factors may influence this relationship [8].

Given the growing body of evidence linking vitamin D deficiency to mental health disorders, this study aims to further investigate the correlation between vitamin D levels and the severity of depressive and anxiety symptoms among COPD patients. By building on recent research, this study aimed to investigate the correlation between Vitamin D levels and the severity of depressive and anxiety symptoms among COPD patients.

Material and methods:
Following institutional ethics committee approval, participants provided written informed consent prior to inclusion in the study. This was a cross-sectional study of COPD patients from the department of respiratory medicine at Varun Arjun Medical College in Shajhanpur, Uttar Pradesh, India. The sample consisted of 64 patients. The patients diagnosed with Chronic obstructive pulmonary disease (COPD) through spirometry were included in the study, regardless of the severity of their condition. Spirometry assessments were conducted using the Recorders & Medicare Systems Pvt Ltd (RMS) Helios 401 device, which provides (European Respiratory Society) ERS-93 predicted values under Body Temperature, Pressure, Water Vapor Saturated (BTPS) conditions. Airway obstruction was categorized according to the guidelines laid out by the Global Initiative for Chronic Obstructive Lung Disease.[9]. Patients were excluded if they were over 65 years of age or had a diagnosis of chronic kidney disease, cholestatic liver disease, granulomatous disorders, cancer, tuberculosis, congestive heart failure, or pulmonary hypertension. Additionally, individuals undergoing treatment with phenytoin, phenobarbital, carbamazepine, isoniazid, rifampin, or efavirenz were not eligible. Those taking supplements such as Vitamin D, zinc, magnesium, or iron were also excluded to prevent potential confounding effects related to these medications and supplements.

Anthropometric parameters were measured at baseline according to standard protocol prior to blood pressure assessment using a sphygmomanometer [10]. Subsequently, a 5 ml blood sample was obtained and left to clot before undergoing centrifugation to separate the serum. The serum was carefully stored at a temperature of -80°C to facilitate the subsequent processing of Vitamin D levels, strictly following the instructions outlined in commercially available kits.

For assessing depressive symptomatology, the Beck Depression Inventory (BDI) was utilized. The BDI has exhibited its efficacy in various settings, including clinical contexts, research studies, and epidemiological inquiries, validating its utility as a reliable tool for such evaluations [11].

The Beck Anxiety Inventory (BAI) was utilized as an assessment tool to evaluate the severity of anxiety symptoms in participants. The current version of the BAIhas demonstrated both reliability and validity in accurately measuring anxiety symptoms. Its effectiveness has been established through extensive utilization in research and clinical settings, where it has exhibited high levels of sensitivity, specificity, and the ability to capture even subtle changes in anxiety levels[12].
The statistical analysis was performed using R version 3.2.3 for the Windows operating system. Descriptive statistics for the data were presented as mean ± standard deviation (SD). Normality of the data distribution was assessed using the Kolmogorov-Smirnov test. To explore the association between vitamin D levels and depression and anxiety scores, Pearson's correlation coefficient was utilized. The null hypothesis was rejected if the resulting p-value was less than 0.05, indicating statistical significance.

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Results:

As presented in Table 1, the sample consisted of 64 individuals with a relatively homogeneous age group. Smoking habits were present among a significant portion of the sample, with a notable number of smokers compared to non-smokers. The heights and weights of individuals showed moderate variability, while the average BMI indicated that the sample generally fell within the overweight range. This data reflects the overall physical characteristics of the group.

Table 1. Characteristics of study participants

Sl.no	Parameter	Value (n=64)
1	Age (years)	48.41 ± 5.21
2	Gender (Male / Female)	52 / 12
3	Smoker (Yes / No)	17 / 47
4	Height (cms)	158.75 ± 5.51
5	Weight (kg)	63.64 ± 7.53
6	BMI (Kg/m^2)	25.27 ± 2.86

Table 2 provides insights into the average levels of Vitamin D and the corresponding depressive and anxiety symptoms measured by the Beck Depression Inventory (BDI) and Beck Anxiety Inventory (BAI), respectively. The findings indicate that individuals in the sample had moderate variability in Vitamin D levels, with a tendency toward lower concentrations. The BDI scores suggested relatively high levels of depressive symptoms among the participants, with moderate variability. Similarly, the BAI scores revealed that the group generally experienced moderate anxiety symptoms, with some variation among individuals. These observations help to illustrate the general mental health status and Vitamin D levels within the sample.

Tables 2: Average values of Vitamin D levels and BDI, BAI

Sl.no	Parameter	Value (n=64)
1	Vitamin D (ng/ml)	11.28 ± 2.81
2	BDI	29.17 ± 5.0
3	BAI	24.70 ± 2.68

BDI = Beck depression inventory   BAI = Beck Anxiety Inventory

Table 3 highlights the correlation between Vitamin D levels and both depressive and anxiety symptoms. A moderate inverse relationship was found between Vitamin D levels and depressive symptoms, indicating that higher Vitamin D levels were associated with lower depressive symptoms. Similarly, an inverse relationship was observed between Vitamin D levels and anxiety symptoms, suggesting that as Vitamin D levels increased, anxiety symptoms tended to decrease. These correlations underscore the potential influence of Vitamin D on mental health in this sample population.

Table 3: Correlation coefficient between Vitamin D levels and BDI, BAI.

Sl.no	Parameter	Correlation with Vitamin D (r value)
1	BDI	-0.52
2	BAI	-0.49

BDI = Beck depression inventory   BAI = Beck Anxiety Inventory

Discussion:

This study aimed to explore the relationship between Vitamin D levels and the severity of depressive and anxiety symptoms in a sample of 64 individuals. The findings provide valuable insights into the potential role of Vitamin D in mental health, particularly concerning depressive and anxiety disorders.

The demographic characteristics of the study participants, as outlined in Table 1, show a sample with a relatively homogenous age group and a significant proportion of male participants. The prevalence of smoking within the sample is notable, aligning with existing literature that indicates smoking as a common behavior among individuals with mental health disorders, potentially exacerbating both physical and psychological health outcomes(13). The average BMI suggests that the sample predominantly falls within the overweight category, which is consistent with studies showing a correlation between higher BMI and increased risk of both physical and mental health issues(14).

The mean Vitamin D level of 11.28 ng/ml (Table 2) indicates deficiency in COPD patients, which has been increasingly recognized as a factor associated with various health complications, including mood disorders. This study's findings are consistent with previous research that has reported low Vitamin D levels among individuals with depression

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and anxiety (3). The high average BDI and BAI scores observed in this sample suggest a significant presence of depressive and anxiety symptoms, reinforcing the growing body of evidence that links low Vitamin D levels with poor mental health outcomes (4).

The correlations presented in Table 3 between Vitamin D levels and the BDI and BAI scores further emphasize the potential relationship between Vitamin D deficiency and mental health. The negative correlation coefficients (r = -0.52 for BDI and r = -0.49 for BAI) indicate that as Vitamin D levels increase, the severity of depressive and anxiety symptoms decreases. These findings align with several studies that have suggested an inverse relationship between Vitamin D levels and the prevalence of mood disorders. For instance, a meta-analysis found that individuals with lower levels of Vitamin D had a higher risk of depression(5). Similarly, recent research has highlighted the potential benefits of Vitamin D supplementation in reducing depressive symptoms, particularly in populations with existing(15). Depression is a condition that significantly impairs various aspects of daily functioning. For individuals with chronic medical conditions, the presence of depression can complicate the management of these illnesses. Recent discussions in both scientific circles and the media have highlighted the potential role of vitamin D in preventing and treating several chronic health issues. Many people, including those with depression and other mental health disorders, have been found to have insufficient levels of vitamin D. This deficiency may be attributed to factors such as poor dietary intake, limited sun exposure, or other lifestyle influences, which are explored in this paper. Additionally, the paper discusses vulnerable groups and offers recommendations for treating vitamin D deficiency. Detecting and addressing low vitamin D levels in those with depression or mental health conditions could provide an affordable and effective intervention that may enhance long-term health outcomes and improve overall quality of life (16).

However, it is important to acknowledge that the relationship between Vitamin D and mental health is complex and not fully understood. While many studies support the findings of this research, some studies have reported inconclusive or conflicting results. For example, a review found no significant effect of Vitamin D supplementation on depressive symptoms in their meta-analysis of randomized controlled trials(17). These inconsistencies highlight the need for further research to clarify the mechanisms by which Vitamin D may influence mental health and to determine whether supplementation can be an effective intervention for depressive and anxiety disorders.

Moreover, the current study's findings add to the growing body of evidence suggesting that Vitamin D might play a role in the pathophysiology of depression and anxiety, particularly in populations already at risk for Vitamin D deficiency. The moderate inverse correlations found in this study align with the hypothesis that adequate levels of Vitamin D may have protective effects against the development or worsening of mood disorders(4).

The association between low Vitamin D levels and increased severity of depressive and anxiety symptoms, as observed in this study, is supported by a growing body of evidence. The potential mechanisms through which Vitamin D deficiency may contribute to the development or exacerbation of these mental health disorders are multifaceted and involve several biological pathways.

One of the key mechanisms is the role of Vitamin D in neurotransmitter regulation. Vitamin D is crucial for the synthesis of serotonin, a neurotransmitter that significantly influences mood regulation. It influences the expression of the enzyme tryptophan hydroxylase, which converts tryptophan to serotonin. When Vitamin D levels are low, serotonin production can decrease, contributing to the onset of depressive symptoms(18). This mechanism highlights the importance of Vitamin D in maintaining optimal neurotransmitter function and mental health.

Another important pathway is neuroinflammation. Chronic inflammation has been increasingly recognized as a contributor to both depression and anxiety. Vitamin D has anti-inflammatory properties and helps modulate the immune system by reducing the production of pro-inflammatory cytokines such as TNF-alpha and IL-6. In individuals with Vitamin D deficiency, these cytokines may increase, leading to neuroinflammation, which is linked to the development of mood disorders (19). Elevated levels of pro-inflammatory cytokines have been consistently found in individuals with depression, suggesting that inflammation could be a critical link between Vitamin D deficiency and mental health disorders (20).

Additionally, Vitamin D plays a role in the regulation of the hypothalamic-pituitary-adrenal (HPA) axis, which controls the body's response to stress. Dysregulation of the HPA axis, often characterized by elevated cortisol levels, is common in individuals with depression and anxiety. Vitamin D helps to regulate this axis, and its deficiency may lead to an exaggerated stress response, further contributing to depressive and anxiety symptoms (21). This suggests that maintaining adequate Vitamin D levels could help in moderating the body's stress response, potentially reducing the risk of mood disorders.

Vitamin D is also involved in neurogenesis and neuroprotection. It promotes the expression of neurotrophic factors, such as brain-derived neurotrophic factor (BDNF), which are essential for neuron survival and function. Low levels

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of BDNF have been associated with depression, and insufficient Vitamin D may lead to decreased neurogenesis and impaired neuroprotection, contributing to the structural and functional brain changes observed in depression and anxiety(22). This mechanism underscores the role of Vitamin D in supporting brain health and preventing neurodegenerative processes associated with mood disorders.

Finally, Vitamin D's antioxidant properties help mitigate oxidative stress, which is another factor linked to the pathophysiology of depression and anxiety. Oxidative stress occurs when there is an imbalance between the production of reactive oxygen species (ROS) and the body's ability to neutralize them. Elevated oxidative stress can damage neurons and other brain cells, leading to neurodegeneration. Vitamin D deficiency may exacerbate oxidative stress, thereby increasing the risk of developing mood disorders (23). These findings suggest that Vitamin D may play a protective role in maintaining mental health by reducing oxidative stress. The mechanisms linking Vitamin D deficiency to depression and anxiety are complex and involve multiple biological pathways, including neurotransmitter regulation, neuroinflammation, HPA axis dysfunction, neurogenesis, and oxidative stress. These mechanisms provide a plausible explanation for the observed associations between low Vitamin D levels and increased severity of depressive and anxiety symptoms, highlighting the potential importance of Vitamin D in mental health.

Further, this study supports the association between low Vitamin D levels and increased severity of depressive and anxiety symptoms. These findings suggest that addressing Vitamin D deficiency may be a valuable component of comprehensive mental health care, particularly for individuals at risk of both physical and psychological health issues. Further research is needed to confirm these findings and to explore the potential therapeutic benefits of Vitamin D supplementation in treating mood disorders.

Conclusion:
The results of this study demonstrate a moderate to strong inverse relationship between Vitamin D levels and both depressive and anxiety symptoms among COPD patients. The findings support the potential role of Vitamin D in mental health and highlight the importance of maintaining optimal Vitamin D levels in this population. Further research is warranted to investigate the underlying mechanisms and to explore the efficacy of interventions targeting Vitamin D in improving mental health outcomes among COPD patients.

Limitations & future perspectives:
It is important to note that this study has some limitations. Firstly, the cross-sectional design limits our ability to establish causal relationships between Vitamin D levels, depressive symptoms, and anxiety symptoms in COPD patients. Longitudinal studies are needed to investigate the directionality of these associations and to determine whether interventions targeting Vitamin D can improve mental health outcomes. Secondly, the study focused specifically on COPD patients, and the findings may not be generalizable to other populations. Future research should explore the associations between Vitamin D and mental health in different patient groups.

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