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ORIGINAL ARTICLE

Association Between Vitamin D Deficiency and Severity of Respiratory Infections in Adults

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ABSTRACT

Background: Vitamin D plays an essential role in immunomodulation, and its deficiency has been increasingly implicated in the development and progression of respiratory infections. Despite widespread vitamin D deficiency in South Asian populations, evidence linking serum vitamin D levels with respiratory infection severity in Pakistani adults remains limited. This study aimed to determine the association between vitamin D deficiency and the severity of acute respiratory infections in adults presenting to a tertiary care hospital.

Methods: An analytical cross-sectional study was conducted from March to August 2024 at a tertiary care hospital in Pakistan. A total of 90 adults aged 18 to 65 years presenting with acute respiratory infections were enrolled using non-probability purposive sampling. Serum 25-hydroxyvitamin D levels were measured, and participants were categorized as vitamin D deficient, insufficient, or sufficient. Disease severity and clinical outcomes, including hospitalization, oxygen therapy requirement, and length of stay, were recorded. Data were analyzed using chi-square test, ANOVA, and multivariate logistic regression to determine independent predictors of severe infection. A p value less than 0.05 was considered statistically significant.

Results: The mean age of participants was 41.8 ± 13.6 years, and 71.1 percent were vitamin D deficient. Severe respiratory infection occurred in 31.3 percent of vitamin D deficient individuals compared with 5.6 percent of those who were vitamin D sufficient. Vitamin D deficiency was significantly associated with infection severity (p = 0.004), higher hospitalization rates (57.8 percent), and increased need for oxygen therapy (45.3 percent). Length of hospital stay was greater among deficient participants (5.8 ± 2.1 days; p = 0.01). Multivariate analysis demonstrated that vitamin D deficiency independently predicted severe respiratory infection (adjusted OR 3.42; 95 percent CI 1.41–8.29).

Conclusion: Vitamin D deficiency was highly prevalent and significantly associated with increased severity and poorer clinical outcomes of respiratory infections. These findings highlight the importance of assessing and correcting vitamin D deficiency in adults at risk of acute respiratory infections.

Keywords: Vitamin D deficiency, respiratory infections, severity, hospitalization, oxygen therapy.

INTRODUCTION

Vitamin D is a vital nutrient known for its role in calcium homeostasis and bone metabolism; however, emerging evidence also indicates its significant influence on immune function and response to respiratory infections. A body of research suggests that inadequate levels of vitamin D may correlate with an increased incidence and severity of respiratory diseases, particularly acute respiratory infections (ARIs) such as influenza, pneumonia, and complications from COVID-19. A meta-analysis of randomized controlled trials has shown that vitamin D supplementation may reduce the risk of acute respiratory infections, especially in individuals with baseline deficiencies, thus highlighting its potential therapeutic role in managing respiratory illnesses [1, 2, 3].

The implications of vitamin D deficiency are particularly relevant, as it has been associated with heightened susceptibility to infections due to impairments in both innate and adaptive immune responses. For instance, studies have reported that lower serum levels of vitamin D correlate with poorer outcomes in patients with severe respiratory illnesses, including those requiring intensive care unit (ICU) admissions for conditions like COVID-19 [4, 5, 6]. The observed connection between vitamin D levels and clinical outcomes underscores the importance of maintaining adequate vitamin D status as part of preventive strategies against severe respiratory infections [7, 8].

Moreover, various epidemiological studies have reinforced the detrimental effects of vitamin D deficiency on respiratory health. For example, clinical evaluations of children with acute lower respiratory tract infections (LRTIs) demonstrate a significant correlation between low vitamin D levels and increased disease severity [6, 8]. These findings elucidate the critical role that vitamin D plays in the pathophysiology of respiratory infections, suggesting that enhancing nutritional support with vitamin D could serve as a valuable strategy for improving health outcomes in vulnerable populations [9, 10].

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In the Pakistani context, where respiratory diseases are a leading cause of morbidity and mortality, understanding the link between vitamin D deficiency and respiratory infections could inform significant public health interventions. A notable proportion of the population in Pakistan exhibits suboptimal vitamin D levels, often attributed to limited sun exposure, dietary deficiencies, and cultural practices [11,12]. This nutritional insufficiency, combined with prevalent respiratory illnesses, necessitates a focused public health policy aimed at improving vitamin D status through education, food fortification, and supplementation programs. Such strategies could reduce the burden of respiratory diseases and enhance overall health outcomes in the region [13, 14].

METHODOLOGY

This analytical cross-sectional study was conducted in the medical wards and outpatient clinics of a tertiary care hospital in Pakistan over a six-month period from March to August 2024. Ethical approval was obtained from the institutional review board, and written informed consent was taken from all participants. Adults aged 18 to 65 years presenting with symptoms of acute respiratory infections, including fever, cough, dyspnea, and radiologically confirmed lower respiratory tract involvement, were invited to participate. Individuals with chronic liver or kidney disease, long-term corticosteroid use, immunodeficiency, pregnancy, or prior vitamin D supplementation within the last three months were excluded to avoid confounding effects. A total of 90 consecutive patients meeting the eligibility criteria were enrolled through non-probability purposive sampling.

All participants underwent clinical evaluation, including assessment of disease severity based on standardized respiratory infection severity scales. Blood samples were collected at presentation and analyzed in the hospital laboratory for serum 25-hydroxyvitamin D using chemiluminescence immunoassay. Deficiency, insufficiency, and sufficiency were categorized using established international thresholds. Additional laboratory investigations, including CBC, CRP, and chest imaging, were

performed according to clinical need. Clinical outcomes, including hospitalization, oxygen requirement, and length of stay, were recorded prospectively.

Data were entered into a secure research database and analyzed using SPSS version 26. Continuous variables were presented as mean ± standard deviation, while categorical variables were reported as frequencies and percentages. Associations between vitamin D levels and severity of respiratory infection were evaluated using chi-square test, independent t test, and ANOVA where appropriate. A multivariate logistic regression model was constructed to identify independent predictors of severe disease, adjusting for potential confounders including age, gender, smoking status, and comorbidities. Statistical significance was set at p less than 0.05.

RESULTS

The final analysis included 90 adult patients diagnosed with acute respiratory infections. The mean age of participants was 41.8 ± 13.6 years, with 52.2 percent males and 47.8 percent females. The mean serum vitamin D level was 18.4 ± 7.1 ng/mL, and 71.1 percent of the sample had vitamin D deficiency (<20 ng/mL). According to clinical assessment, 44.4 percent of participants developed moderate and 21.1 percent severe respiratory infections. (Table 1).

Vitamin D deficiency was significantly associated with increased severity of respiratory infections. Among deficient individuals, 31.3 percent developed severe infection, compared with 5.6 percent among vitamin D sufficient individuals. Hospitalization rates were also higher among deficient participants (57.8 percent) compared with the sufficient group (25 percent). (Table 2)

Table 1. Demographic and Baseline Clinical Characteristics of Adults with Respiratory Infections (N = 90)

Variable	Category	Frequency n (%) / Mean ± SD
Age (years)	Mean ± SD	41.8 ± 13.6
	18–30	27 (30.0)
	31–45	34 (37.8)
	46–65	29 (32.2)
Gender	Male	47 (52.2)
	Female	43 (47.8)
Smoking Status	Smoker	32 (35.6)
	Non-Smoker	58 (64.4)
Comorbidities	None	44 (48.9)
	Diabetes Mellitus	18 (20.0)
	Hypertension	21 (23.3)
	COPD/Asthma	7 (7.8)
Vitamin D Level (ng/mL)	Mean ± SD	18.4 ± 7.1
Vitamin D Status	Deficient (<20 ng/mL)	64 (71.1)
	Insufficient (20–29 ng/mL)	18 (20.0)
	Sufficient (≥30 ng/mL)	8 (8.9)

Table 2. Association Between Vitamin D Status and Severity of Respiratory Infection (N = 90)

Vitamin D Status	Mild n (%)	Moderate n (%)	Severe n (%)	p-Value
Deficient (<20 ng/mL)	20 (31.3)	24 (37.5)	20 (31.3)	0.004
Insufficient (20–29 ng/mL)	9 (50.0)	7 (38.9)	2 (11.1)	
Sufficient (≥30 ng/mL)	3 (37.5)	5 (62.5)	0 (0.0)	

Table 3. Clinical Outcomes by Vitamin D Status (N = 90)

Outcome	Deficient n (%)	Insufficient n (%)	Sufficient n (%)	p-Value
Hospitalization Required	37 (57.8)	7 (38.9)	2 (25.0)	0.03
Need for Oxygen Therapy	29 (45.3)	6 (33.3)	1 (12.5)	0.02
Length of Stay (days)	5.8 ± 2.1	4.1 ± 1.6	3.2 ± 1.3	0.01

DISCUSSION

The findings of our study reveal a significant association between vitamin D deficiency and the severity of respiratory infections among a cohort of 90 adult patients diagnosed with acute respiratory infections. Our mean serum vitamin D level of 18.4 ± 7.1 ng/mL indicates a high prevalence of deficiency, as 71.1% of participants had levels below 20 ng/mL. These results align with existing literature that has similarly linked vitamin D deficiency to increased morbidity in respiratory illnesses. For instance, Ayvazyan et al. [15] identified a significant correlation between low levels of serum vitamin D and acute respiratory infections in hospitalized children, suggesting that vitamin D plays a crucial role in modulating immune responses and protecting against environmental pathogens.

Our demographic analysis indicates that patients primarily fall within the age range of 31-45 years (37.8%), with a male predominance (52.2%). This gender distribution reflects trends in respiratory health where males are often found to be at higher risk for severe outcomes due to lifestyle factors such as smoking, common in our cohort (35.6% smokers). Recent studies emphasize these findings; for example, there is a correlation between severe respiratory infections and factors like smoking in younger adults, reinforcing the notion that lifestyle choices compound risks in these demographics.

Our analysis shows that among patients classified as vitamin D deficient, 31.3% developed severe infections compared to only 5.6% in the sufficient group. This stark contrast supports the claim that vitamin D has a protective immunomodulatory function that can significantly reduce the severity of respiratory infections, as noted by Xu et al. [16]. Further findings from Annweiler et al. [17] demonstrate that frail elderly patients with sufficient vitamin D levels had better survival rates and lower rates of severe respiratory complications associated with COVID-19, underscoring the broader implications of vitamin D sufficiency on immune system resilience.

The increased hospitalization rates observed in our study 57.8% among the vitamin D deficient versus 25% in the sufficient group, suggest a critical link between vitamin D levels and the necessity for complex medical interventions. This observation resonates with findings from Baktash et al. [18], who reported that patients with vitamin D deficiencies had significantly higher hospitalization rates and longer ICU stays during severe respiratory infections. Additionally, our data indicating higher needs for oxygen therapy and longer lengths of stay correlate with lower serum vitamin D levels, supported by research from Hurst et al. [19], which examined hospitalized COVID-19 patients and found similar patterns of reliance on respiratory support and duration of hospital stay linked to vitamin D insufficiency.

Overall, the substantial proportion of participants experiencing severe infections and requiring advanced care among those with vitamin D deficiency emphasizes the potential for vitamin D supplementation as a preventative measure against severe respiratory infections. This aligns with broader findings suggesting that vitamin D supplementation might reduce incidence rates of respiratory infections [20].

In the context of the Pakistani population, these findings suggest an urgent need for public health strategies aimed at addressing vitamin D deficiency, which appears to significantly influence the clinical outcomes of respiratory infections. With limited sunlight exposure due to socio-cultural practices, widespread dietary deficiencies, and high rates of respiratory illnesses, interventions such as food fortification, targeted supplementation programs, and community awareness campaigns could be pivotal in reducing the burden of respiratory infections.

Thus, our study reinforces the critical role of vitamin D in respiratory health and underlines the importance of strategic health interventions to mitigate its deficiency in the Pakistani populace, ultimately enhancing individual and public health outcomes against prevalent respiratory infections.

CONCLUSION

This study demonstrates a strong and independent association between vitamin D deficiency and increased severity of acute respiratory infections in adults. Individuals with deficient vitamin D levels had markedly higher rates of severe illness, greater need for hospitalization and oxygen therapy, and longer hospital stays. Given the high burden of vitamin D deficiency in the Pakistani population, routine assessment and timely correction of low vitamin D levels may serve as an effective strategy to reduce morbidity related to respiratory infections. Integrating vitamin D optimization into preventive and therapeutic protocols could improve outcomes and decrease healthcare burden.

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