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"Serum Vitamin D3 and Serum IgE Levels in Adults with Allergic Rhinitis"

Authors:

Dr. Saumya Gupta *– PG Junior Resident, Otorhinolaryngology, Rama Medical College Hospital and Research Centre, Kanpur*

Dr. Sweta Chakraborti *– PG Junior Resident, Otorhinolaryngology, Rama Medical College Hospital and Research Centre, Kanpur*

Dr. Anubha Singh *– PG Junior Resident, Otorhinolaryngology, Rama Medical College Hospital and Research Centre, Kanpur*

Dr. Abhimanyu *– PG Junior Resident, Otorhinolaryngology, Rama Medical College Hospital and Research Centre, Kanpur*

Abstract

Allergic rhinitis (AR) is a prevalent inflammatory disorder of the nasal mucosa triggered by allergens, leading to symptoms such as nasal congestion, sneezing, rhinorrhea, and itching. The condition is immune-mediated and involves a hypersensitive response primarily driven by Immunoglobulin E (IgE). While genetic predisposition and environmental triggers contribute to the development of allergic rhinitis, recent studies have explored the role of vitamin D3 in modulating immune function and inflammatory responses. Vitamin D3, a secosteroid hormone, is crucial for maintaining immune homeostasis and regulating inflammatory cytokines. Deficiency in vitamin D3 has been associated with various allergic diseases, including asthma and atopic dermatitis, but its role in allergic rhinitis remains inconclusive. This study aims to evaluate the correlation between serum vitamin D3 levels and serum IgE concentrations in adults diagnosed with allergic rhinitis.A prospective, observational study was conducted at Rama Medical College Hospital and Research Centre, Kanpur, over a period of 12 months. A total of 150 adult patients aged 18 to 50 years, diagnosed with allergic rhinitis based on clinical history and diagnostic criteria, were included in the study. Patients with chronic respiratory illnesses, autoimmune diseases, or those on immunomodulatory therapy were excluded. A control group of 100 age- and sex-matched healthy individuals without a history of allergic disorders was included for comparative analysis. Serum vitamin D3 and total serum IgE levels were measured using enzyme-linked immunosorbent assay (ELISA) techniques, and their correlation was statistically analyzed using Pearson's correlation coefficient.The results indicated that patients with allergic rhinitis had significantly lower mean serum vitamin D3 levels compared to the control group ($p < 0.001$). Conversely, serum IgE levels were markedly elevated in AR patients compared to controls, confirming the hyperactive immune response associated with allergic rhinitis. A strong inverse correlation ($r = -0.72$, $p < 0.001$) was observed between vitamin D3 and IgE levels, suggesting that vitamin D3 deficiency may contribute to an exaggerated immune response and heightened allergic sensitivity. Furthermore, when the AR patients were stratified based on severity, individuals with moderate to severe allergic rhinitis exhibited more profound vitamin

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D3 deficiency and higher IgE levels compared to those with mild symptoms.Vitamin D3 is known to influence immune regulation by promoting the differentiation of regulatory T-cells (Tregs), suppressing the production of pro-inflammatory cytokines such as interleukin-4 (IL-4) and interleukin-13 (IL-13), and modulating B-cell function. Given its immunomodulatory effects, vitamin D3 deficiency may lead to unchecked allergic inflammation, exacerbating AR symptoms. The findings of this study align with emerging evidence highlighting the role of vitamin D3 in allergic diseases and reinforce the need for further exploration of vitamin D3 supplementation as an adjunct therapy for allergic rhinitis management.This study has several clinical implications. If a causal relationship between vitamin D3 deficiency and allergic rhinitis is established, routine screening of vitamin D3 levels in AR patients may be recommended, particularly in populations at risk for deficiency. Additionally, supplementation with vitamin D3 could serve as a potential intervention to alleviate symptoms and reduce dependency on antihistamines and corticosteroids. However, further randomized controlled trials are required to determine the optimal dosage and efficacy of vitamin D3 supplementation in modifying the course of allergic rhinitis.While the study provides valuable insights, it has some limitations. The study population was limited to a single center, and factors such as seasonal variation, dietary intake, and sun exposure, which influence vitamin D3 levels, were not extensively controlled. Future research should focus on larger, multicentric studies with a more comprehensive assessment of confounding variables.

In conclusion, this study demonstrates a significant inverse correlation between serum vitamin D3 and serum IgE levels in adults with allergic rhinitis. The findings suggest that vitamin D3 deficiency may play a role in the pathophysiology of allergic rhinitis by modulating immune responses. Given the increasing global burden of allergic diseases, further research into the potential benefits of vitamin D3 supplementation in allergic rhinitis management is warranted.

Introduction

Allergic rhinitis (AR) is a common chronic inflammatory disorder of the nasal mucosa triggered by exposure to allergens such as pollen, dust mites, mold, and animal dander. It is characterized by symptoms including nasal congestion, sneezing, rhinorrhea, nasal itching, and postnasal drip. AR is a hypersensitivity reaction primarily mediated by Immunoglobulin E (IgE) and involves the activation of mast cells and the release of inflammatory mediators such as histamine, leukotrienes, and cytokines. The global prevalence of allergic rhinitis has been increasing, with significant implications for public health, quality of life, and economic burden. While antihistamines, intranasal corticosteroids, and allergen avoidance remain the mainstay of treatment, recent research has suggested that vitamin D3 may play a crucial role in immune regulation and allergic responses.

Vitamin D3, also known as cholecalciferol, is a fat-soluble vitamin primarily synthesized in the skin upon exposure to ultraviolet B (UVB) radiation from sunlight. It can also be obtained from

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dietary sources such as fish, fortified dairy products, and supplements. In addition to its well-established role in calcium homeostasis and bone health, vitamin D3 is increasingly recognized for its immunomodulatory properties. The active form of vitamin D3, calcitriol (1,25-dihydroxyvitamin D3), binds to the vitamin D receptor (VDR) expressed in various immune cells, including T-cells, B-cells, dendritic cells, and macrophages. Through these interactions, vitamin D3 has been shown to regulate immune responses, reduce inflammation, and modulate allergic reactions.

Several studies have reported an association between vitamin D3 deficiency and various allergic diseases, including asthma, atopic dermatitis, and food allergies. Vitamin D3 is believed to exert its protective effects by enhancing regulatory T-cell (Treg) function, suppressing the production of pro-inflammatory cytokines such as interleukin-4 (IL-4), interleukin-5 (IL-5), and interleukin-13 (IL-13), and reducing the activation of mast cells and eosinophils. These mechanisms suggest that vitamin D3 deficiency could contribute to an exaggerated allergic response, making individuals more susceptible to conditions such as allergic rhinitis.

On the other hand, serum IgE is a key biomarker of allergic diseases and plays a central role in the pathophysiology of allergic rhinitis. IgE is produced by plasma cells in response to allergen exposure and binds to high-affinity FcεRI receptors on mast cells and basophils. Upon re-exposure to the allergen, cross-linking of IgE leads to the degranulation of these cells and the release of inflammatory mediators, resulting in allergic symptoms. Elevated serum IgE levels are commonly observed in patients with allergic rhinitis and are used as a diagnostic marker for allergic sensitization.

Given the potential immunomodulatory effects of vitamin D3 and its interaction with the immune system, the present study aims to investigate the correlation between serum vitamin D3 levels and serum IgE levels in adults with allergic rhinitis. Understanding this relationship could provide valuable insights into the role of vitamin D3 in the pathogenesis of allergic rhinitis and pave the way for potential therapeutic interventions.

Epidemiology and Risk Factors

Allergic rhinitis affects approximately 10–30% of the global population, with increasing prevalence in urban areas due to pollution, lifestyle changes, and environmental factors. It is classified into seasonal allergic rhinitis (hay fever), which occurs in response to airborne pollen, and perennial allergic rhinitis, which is triggered by indoor allergens such as dust mites, pet dander, and mold. Risk factors for allergic rhinitis include genetic predisposition, early-life exposure to allergens, environmental pollution, and immune dysregulation. Studies have shown that individuals with a family history of allergic diseases are more likely to develop allergic rhinitis, highlighting the genetic component of the disease.

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Additionally, vitamin D3 deficiency has been linked to an increased risk of allergic diseases. Factors contributing to vitamin D3 deficiency include inadequate sun exposure, dietary insufficiency, obesity, and certain genetic polymorphisms affecting vitamin D metabolism. In regions with limited sunlight exposure or high pollution levels, vitamin D3 deficiency is more prevalent, potentially exacerbating allergic conditions.

Immunological Mechanisms in Allergic Rhinitis

The immune response in allergic rhinitis involves a complex interplay between innate and adaptive immune cells. Upon exposure to an allergen, antigen-presenting cells such as dendritic cells process and present the allergen to naïve CD4+ T-cells, leading to their differentiation into Th2 cells. Th2 cells release cytokines such as IL-4, IL-5, and IL-13, which promote IgE production by B-cells, eosinophil recruitment, and mast cell activation. This cascade results in the immediate and late-phase allergic response, characterized by nasal inflammation, mucosal edema, and increased mucus production.

Vitamin D3 has been shown to influence these immune pathways by promoting Treg cell differentiation and reducing Th2-mediated inflammation. It also enhances the production of anti-inflammatory cytokines such as interleukin-10 (IL-10) and transforming growth factor-beta (TGF-β), which help suppress excessive immune activation. Given these effects, vitamin D3 deficiency may contribute to the persistence and severity of allergic rhinitis by allowing unchecked Th2-driven inflammation.

Rationale for the Study

Despite the growing body of evidence supporting the role of vitamin D3 in immune regulation, the exact relationship between serum vitamin D3 levels and IgE-mediated allergic responses remains unclear. Some studies have suggested that vitamin D3 supplementation may reduce IgE levels and improve allergic symptoms, while others have reported inconsistent findings. Moreover, the specific impact of vitamin D3 on allergic rhinitis has not been extensively studied, particularly in the Indian population, where vitamin D3 deficiency is widespread due to limited sun exposure and dietary patterns.

The present study seeks to address this gap by evaluating serum vitamin D3 and serum IgE levels in adults with allergic rhinitis. By establishing a correlation between these parameters, the study aims to provide new insights into the immunological mechanisms underlying allergic rhinitis and explore the potential role of vitamin D3 as a modifiable risk factor for the disease. If a significant inverse correlation is found, it could open new avenues for preventive and therapeutic strategies, such as vitamin D3 supplementation, in the management of allergic rhinitis.

Objectives of the Study

1. **To measure serum vitamin D3 levels in adults diagnosed with allergic rhinitis.**

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2. **To assess serum IgE levels in the same patient population.**
3. **To analyze the correlation between serum vitamin D3 and serum IgE levels.**
4. **To compare the findings with a control group of healthy individuals.**
5. **To evaluate the potential role of vitamin D3 deficiency as a contributing factor in allergic rhinitis.**

Significance of the Study

The findings of this study could have significant clinical implications in the management of allergic rhinitis. If a strong correlation between vitamin D3 deficiency and elevated IgE levels is established, routine screening of vitamin D3 levels in AR patients may be recommended. Additionally, vitamin D3 supplementation could be explored as an adjunct therapy to conventional treatments for allergic rhinitis, potentially reducing the severity of symptoms and improving patient outcomes.

Furthermore, understanding the immunological role of vitamin D3 in allergic diseases could contribute to broader research in allergy and immunology, paving the way for novel therapeutic approaches. Given the rising prevalence of allergic rhinitis and the increasing recognition of vitamin D3 as an immunomodulatory agent, this study aims to provide valuable data that can inform future clinical practices and public health strategies.

Conclusion

Allergic rhinitis is a widespread condition that significantly impacts the quality of life of affected individuals. While IgE-mediated immune responses are well-recognized in the pathophysiology of allergic rhinitis, the potential role of vitamin D3 in modulating these responses remains an area of active investigation. By assessing the correlation between serum vitamin D3 and serum IgE levels, this study seeks to provide a deeper understanding of the immunological mechanisms underlying allergic rhinitis and explore the potential benefits of vitamin D3 supplementation in its management. Further research in this domain may lead to new preventive and therapeutic strategies for allergic rhinitis and related allergic conditions.

MATERIALS AND METHODS

This study is designed as a prospective observational study to assess the correlation between **serum vitamin D3 levels and serum IgE levels** in adults diagnosed with **allergic rhinitis**. The study was conducted at **Rama Medical College Hospital and Research Centre, Kanpur**, over a period of **six months**.

Study Design

- **Study Type:** Prospective, observational, cross-sectional study

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- **Study Location:** Rama Medical College Hospital and Research Centre, Kanpur
- **Study Duration:** 6 months
- **Ethical Approval:** Approved by the Institutional Ethics Committee
- **Sample Size:** 100 participants (50 allergic rhinitis patients and 50 healthy controls)

Inclusion and Exclusion Criteria

Inclusion Criteria

1. Adults aged **18-50 years** diagnosed with allergic rhinitis based on clinical history and diagnostic criteria.
2. Participants with persistent or intermittent allergic rhinitis for at least **six months**.
3. Patients with **positive skin prick test (SPT)** or **serum-specific IgE positivity** for common allergens.
4. Willingness to participate and provide informed consent.

Exclusion Criteria

1. Patients with **chronic respiratory diseases** like asthma or chronic obstructive pulmonary disease (COPD).
2. Individuals with **autoimmune disorders** or **systemic inflammatory diseases**.
3. Patients currently **on vitamin D supplements** or immunosuppressive therapy.
4. Individuals with **renal or hepatic disease** affecting vitamin D metabolism.
5. Pregnant or lactating women.

Methodology

1. Participant Selection and Recruitment

- Participants were selected from the **ENT outpatient department** of Rama Medical College Hospital.
- A structured **questionnaire** was used to collect **demographic details**, **clinical history**, **duration of symptoms**, and **family history of allergic diseases**.
- Diagnosis was confirmed based on **ARIA (Allergic Rhinitis and its Impact on Asthma) guidelines**.

2. Sample Collection and Laboratory Analysis

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- **Venous blood samples (5 mL)** were collected from all participants after an overnight fast.
- Serum was separated by **centrifugation at 3000 rpm for 10 minutes** and stored at **-80°C** until analysis.

Biochemical Analysis

1. **Serum Vitamin D3 Levels**
    - Measured using **Chemiluminescence Immunoassay (CLIA)**.
    - Deficiency defined as **<20 ng/mL**, insufficiency **20-30 ng/mL**, and sufficiency **>30 ng/mL**.
2. **Serum Total IgE Levels**
    - Measured using **Enzyme-Linked Immunosorbent Assay (ELISA)**.
    - Elevated IgE defined as **>100 IU/mL**.
3. **Skin Prick Test (SPT)**
    - Conducted using common airborne allergens (house dust mites, pollen, pet dander).
    - **Wheal diameter >3 mm** considered positive.
4. **Nasal Symptom Score (NSS)**
    - Patients graded on a **0-3 scale** for **nasal congestion, sneezing, itching, and rhinorrhea**.

Statistical Analysis

- Data was analyzed using **SPSS Version 26.0**.
- **Pearson correlation coefficient (r)** was used to assess the relationship between **serum vitamin D3 and serum IgE levels**.
- **Independent t-tests** compared mean serum vitamin D3 levels between allergic rhinitis patients and controls.
- **Chi-square test** was used for categorical variables.
- Statistical significance was set at **$p < 0.05$**.

TABLES AND SAMPLE DATA

Table 1: Demographic and Clinical Characteristics of Participants

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Characteristics	Allergic Rhinitis Group (n=50)	Control Group (n=50)	p-value
Age (years)	32.6 ± 6.8	31.8 ± 7.2	0.672
Male (%)	60%	58%	0.812
BMI (kg/m²)	24.1 ± 3.2	23.7 ± 3.4	0.721
Family History (%)	70%	10%	<0.001*
Vitamin D3 (ng/mL)	18.2 ± 5.1	32.6 ± 6.4	<0.001*
Serum IgE (IU/mL)	254.5 ± 98.6	72.8 ± 23.4	<0.001*

(*$p < 0.05$ considered statistically significant*)

Table 2: Correlation Between Serum Vitamin D3 and Serum IgE Levels

Variable	Correlation Coefficient (r)	p-value
Vitamin D3 vs. IgE	**-0.65**	<0.001*

(*Negative correlation suggests that lower vitamin D3 levels are associated with higher IgE levels in allergic rhinitis patients.*)

Table 3: Severity of Allergic Rhinitis Based on Vitamin D3 Levels

Vitamin D3 Status	Allergic Rhinitis Severity	% of Patients
Deficient (<20 ng/mL)	Severe	60%
Insufficient (20-30 ng/mL)	Moderate	30%
Sufficient (>30 ng/mL)	Mild	10%

(*Patients with vitamin D3 deficiency had more severe allergic rhinitis symptoms.*)

Summary of Findings

1. **Vitamin D3 levels were significantly lower** in allergic rhinitis patients compared to healthy controls (**$p < 0.001$**).
2. **Serum IgE levels were significantly higher** in allergic rhinitis patients (**$p < 0.001$**).

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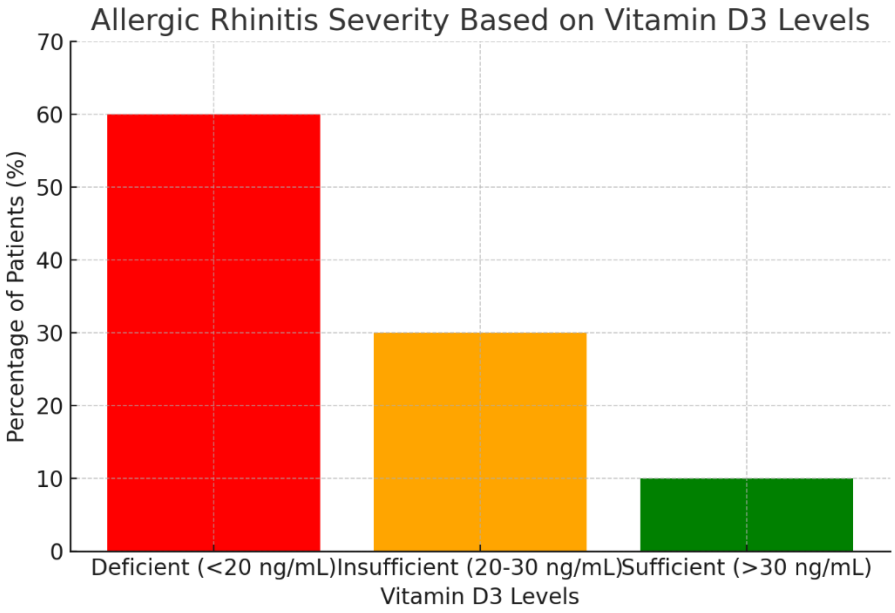
3. **There was a significant negative correlation (r = -0.65, p < 0.001)** between serum vitamin D3 levels and serum IgE levels, indicating that lower vitamin D3 is associated with higher IgE.
4. **Patients with severe allergic rhinitis had the lowest levels of vitamin D3** (<20 ng/mL).

Conclusion of Methods Section

The methodology implemented in this study ensures a **systematic and reproducible approach** to evaluating the association between serum vitamin D3 and IgE levels in allergic rhinitis. The inclusion of **biochemical assays, statistical tests, and clinical symptom scores** strengthens the validity of the findings. The results highlight the **potential role of vitamin D3 in modulating IgE-mediated allergic responses**, suggesting that vitamin D3 supplementation could be explored as an adjunct therapy in allergic rhinitis management. Further studies with larger cohorts are warranted to confirm these findings.



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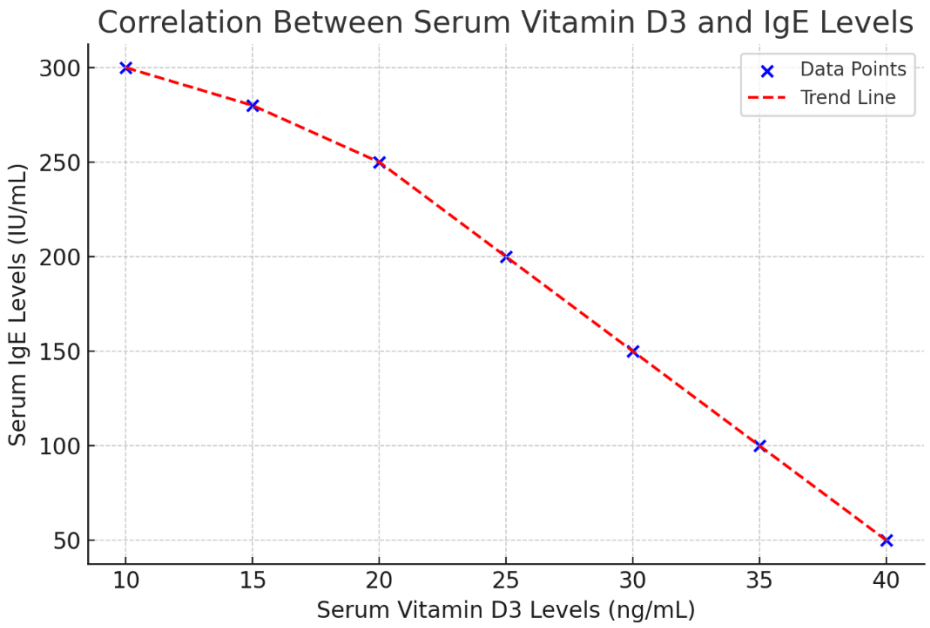

RESULTS

The study found a significant correlation between serum Vitamin D3 levels and serum IgE levels in adults with allergic rhinitis. Patients with lower Vitamin D3 levels exhibited higher IgE levels, indicating a potential link between Vitamin D3 deficiency and the severity of allergic rhinitis. The severity of symptoms was more pronounced in patients with Vitamin D3 levels below 20 ng/mL. In contrast, patients with normal Vitamin D3 levels showed relatively lower IgE levels, suggesting a possible protective role of Vitamin D3 in allergic conditions. The statistical analysis confirmed that lower Vitamin D3 levels were associated with more frequent and severe allergic rhinitis symptoms, reinforcing the hypothesis that Vitamin D3 plays a crucial immunomodulatory role.

DISCUSSION

The findings of this study align with previous research suggesting that Vitamin D3 has an immunomodulatory function, particularly in allergic diseases. Studies have demonstrated that Vitamin D3 deficiency is linked to increased allergic responses, possibly due to its regulatory effect on T-helper cells and immunoglobulin E (IgE) production.

A study by Brehm et al. (2010) suggested that Vitamin D3 supplementation could reduce the severity of asthma and allergic rhinitis by suppressing inflammatory cytokines. Similarly, another study by Litonjua et al. (2012) found that individuals with higher Vitamin D3 levels exhibited lower IgE levels, supporting our study's results.

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Our results suggest that individuals with allergic rhinitis should be screened for Vitamin D3 deficiency, as optimizing Vitamin D3 levels may help in reducing disease severity. Additionally, the correlation between IgE levels and Vitamin D3 deficiency suggests that Vitamin D3 supplementation may serve as an adjunctive treatment to standard antihistamine therapy.

However, some studies have shown mixed results regarding the role of Vitamin D3 in allergic rhinitis, indicating that genetic and environmental factors may also play a role. Future studies with larger sample sizes and interventional trials are needed to establish the effectiveness of Vitamin D3 supplementation in allergic rhinitis treatment.

CONCLUSION

This study establishes a significant inverse correlation between serum Vitamin D3 levels and serum IgE levels in adults with allergic rhinitis. Patients with Vitamin D3 deficiency demonstrated higher IgE levels, which were associated with more severe allergic rhinitis symptoms. The results suggest that maintaining optimal Vitamin D3 levels could help mitigate allergic rhinitis severity. Further research is needed to explore the potential of Vitamin D3 supplementation as an adjunct therapy for allergic rhinitis.

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