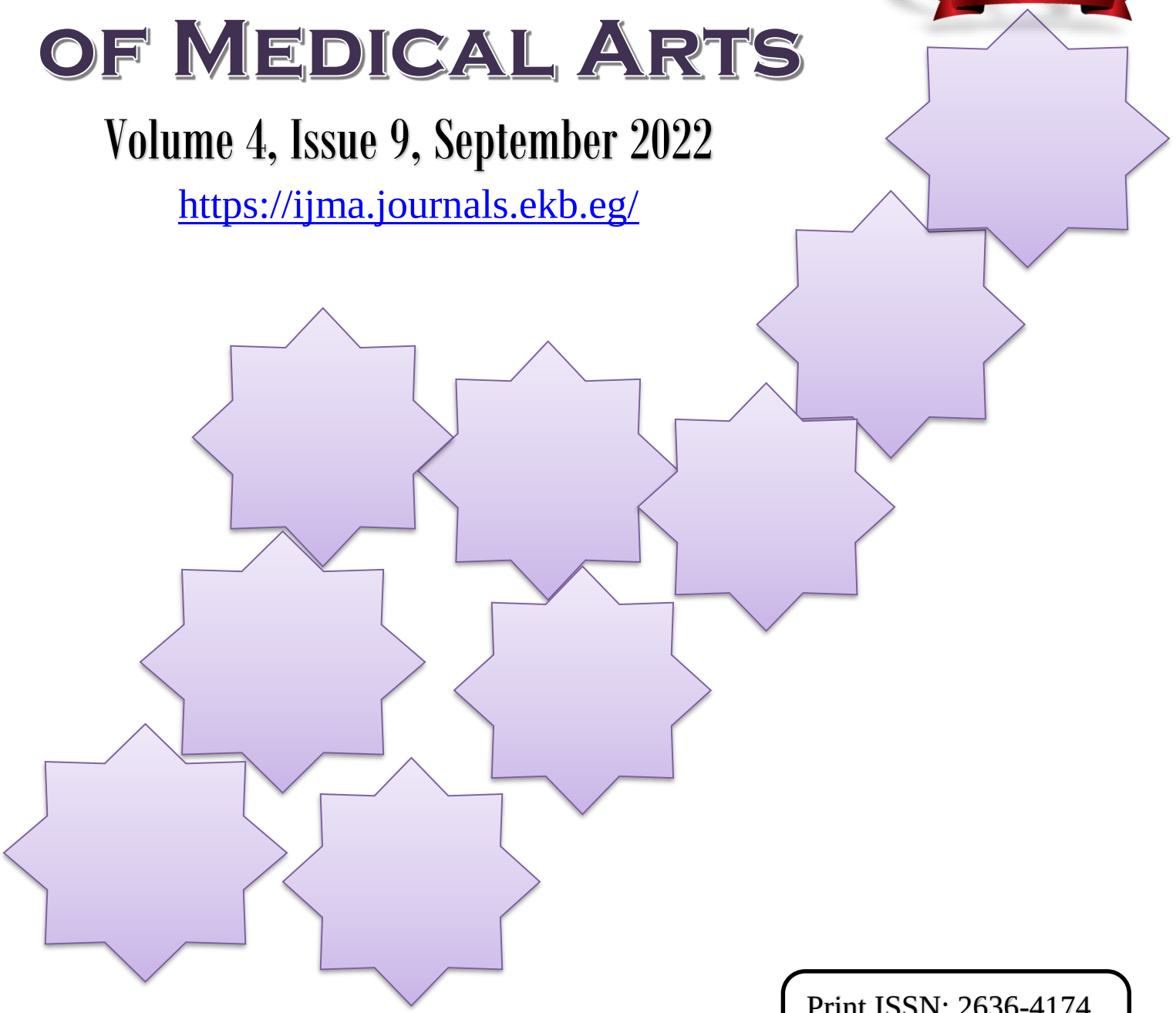
International Journal of Medical Arts

Volume 4, Issue 9, September 2022

https://ijma.journals.ekb.eg/



Print ISSN: 2636-4174

Online ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Otorhinolaryngology]

Original Article

Role of Vitamin D Deficiency and Radiological Assessment in The Diagnosis of Allergic Rhinitis in Children

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Article information

Received: 10-11-2022

Accepted: 14-12-2022

DOI: 10.21608/IJMA.2022.174014.1551

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Citation: Abdel alazim HAZ, Abdelaziz SNR, Tahoun SA, Sonbol MMFM. Role of Vitamin D Deficiency and Radiological Assessment in The Diagnosis of Allergic Rhinitis in Children. IJMA 2022 September; 4 [9]: 2664-2675. doi: 10.21608/IJMA.2022.174014.1551.

ABSTRACT

Objective: Determining whether there is any correlation between vitamin D status and the intensity of the allergic rhinitis [AR]. This study examined the serum vitamin D concentrations in a group of pediatric with AR.

Patients and methods: In this research, 150 children with AR and 150 unaffected kids were enrolled. Each participant's serum concentrations of vitamin D 25[OH]D and 1,25[OH]2D were observed. The relationships between the clinical features of AR and vitamin D status have been demonstrated. The occurrence of an allergy reaction, a positive multiple allergen simultaneously testing, and a serological total immunoglobulin E level [≥ 100 kU/L] were used to diagnose allergic rhinitis. For both groups, the smallest cross-sectional area on acoustic rhinometry was investigated. CT scanning nose and paranasal sinuses were used to quantify the hypertrophied inferior nasal turbinate, sinuses and nasal cavity.

Results: Participants in the AR group displayed significantly decreased serum concentrations of 25[OH]D, 1,25[OH]2D, and calcium than controls [$p < 0.0001$, $p < 0.001$, and $p < 0.0001$, accordingly]. Additionally, individuals with moderate to severe AR had considerably lower average 25-OHD3 concentrations than others with mild AR [$p < 0.001$]. In the AR group, a substantial negative relationship between average 25[OH]D concentrations were observed, total nasal symptoms rating, and total immunoglobulin E levels [$r = -0.71$, $p = 0.003$, and $r = -0.26$, $p = 0.032$].

Conclusion: As contrasted to the healthy participants, vitamin D insufficiency is a frequently occurrence amongst pediatric with AR. A substantial negative correlation between concentrations of vitamin D and the intensity of AR illness has been demonstrated.

Keywords: Children; Vitamin D; Allergic Rhinitis; Radiology; IgE level.

INTRODUCTION

Among the most significant allergic respiratory illnesses in children is allergic rhinitis [AR]. It affects the nasal passageways' mucosal membranes, which are allergic [1]. AR is currently regarded as a serious health issue that affects approximately over 40% of children globally, that might negatively impact children with AR's sleeping and quality of life as well as place a significant financial burden on health-care system [2, 3].

The primary pathophysiology of local allergic rhinitis [LAR] entails the termination of the antigen-antibody response regionally and the localized generation of antigen-specific IgE antibodies in the nasal mucosa [4]. Previous research showed that AR individuals' nasal mucosa produced sIgE in a concentrated area [5, 6]. Additionally, sIgE was found in the nasal secretions of twenty to forty percent of nasal-allergen provocation test [NAPT] positive patients who did not have systemic sensitization [7, 8].

Epsilon heavy chain IgE mRNA and germ-line gene transcripts for B cells were discovered to be expressed in the nasal mucosa [9]. In individuals having negative skin testing, in situ hybridizations showed a type 2 inflammation response with an enhancement in IgE ± B cells, mast cells, and eosinophils [10]. Even though the processes behind the LAR and AR condition concepts are yet unknown, it has been shown that individuals with LAR experience an inflammatory response controlled by Th2 lymphocytes and IgE antibodies in their nasal mucosa [11].

Children with LAR were discovered to have mast cells and eosinophils that were rapidly stimulated in the nasal mucosa and released the typical inflammation markers tryptase and eosinophils cationic proteins [ECP] [12].

In children with a negatively skin prick testing and impossibility in detecting sIgE, LAR is identified depending on a thorough background, clinical examination, nasal-allergic reaction by [NAPT], and the elimination of chronic sinusitis with or without nasal polyps [13, 14]. To definitively diagnose LAR, NAPT as well as the detection of antigen-specific IgE antibodies in nasal secretions are essential [15].

It is challenging to provide an official diagnosis for LAR because antigen recognition screening by skin pricks assays and the quantification of IgE antibodies in peripheral blood are insufficient diagnostic methods. As a result, the evaluation of local reactions in NAPT is necessary [16].

The NAPT, sIgE nasal cavities recognition, and basophil activation testing [BAT] are useful diagnostic tools. In order to diagnose LAR, NAPT is currently the golden standardized test; however, BAT and nasal sIgE analyses have limitations that make them challenging to utilize in clinical practice, and nasal sIgE tests have lower sensitivity and variable findings [17, 18]. A saline test must be conducted prior to NAPT in order to rule out non-specific hypersensitivity, even though NAPT can be employed to distinguish among allergic [AR and LAR] and nonallergic illness [19]. Children might undergo NAPT, a highly sensitive screening technique. Different businesses provide a variety of standardized allergen formulations, either ready-to-use alternatives or freeze-dried lyophilizates [20].

Whenever the combined objective and symptom data are somewhat higher or the symptom severity massively improves, NAPT is regarded as positive [21].

A non-invasive approach for the identification of LAR with good specificity but reduced sensitivity [22%-40% of answers] is the evaluation of sIgE in nasal discharges [22].

Numerous-allergic illnesses, such as asthma, eczema, and food allergies, have vitamin D insufficiency as a potential etiologic or disease-modifying component, according to a growing body of evidence [23]. Few studies, particularly in the Middle East, have assessed the connection among vitamin D level and AR in youngsters [24, 25].

Nowadays physicians need to combine radiographic and endoscopy scanning to undertake the gold recommended care for a refractory inflammations of the paranasal sinuses [PNS] [26]. The osteomeatal unit [OMU], soft tissue thickness, and the bones structure of the turbinate are some of the most important anatomical features that may be recognised by radiologic scanning and enhance the treatment and diagnosis of allergic rhinitis [27]. To choose the most effective course of action for the

management of allergic rhinopathy, all probable anatomic and pathophysiological circumstances must be taken into account. Nasal obstructions, one of the indications of allergic rhinitis, is documented to have a minimal reaction to medical treatments, and if medical treatments have failed to cure allergic rhinitis, a partial surgical turbinectomy [posterior pulp of the inferior turbinate] could be necessary [28]. Whenever a significant problem is detected and a diagnosis is unsure, a CT scan is typically used to determine whether a PNS disease exists since it enables for the assessment of both the bone and soft tissues [29]. The recognizable evidence of mucosa thickening could be seen on a CT scanning in those with chronic rhino-sinusitis. Furthermore, the patient's olfactory abnormalities could also be assessed with a CT scan by looking for opacification in the olfactory flexure [often due to nasal polyps]. The main drawback of the CT scanning is that it has a weak correlation with complaints and can detect changes in people who are completely asymptomatic [30].

The expanding epidemic of atopic and allergy illnesses in affluent countries, combined with the epidemiological trend for vitamin D insufficiency, increases the possibility that the two variables will be correlated [31]. The current research sought to measure the vitamin D serum concentrations in a sizable group of pediatrics with AR and to investigate if there were associations between vitamin D supplementation and the extent of the condition.

PATIENTS AND METHODS

Study Design: This case-controlled research was carried out in pediatric and ENT otorhinolaryngology clinic at Al-Azhar University for girls in Cairo, Egypt during the period from January 2021 to June 2022.

Patients: 150 AR children ages 7 to 13 were enrolled in this survey, and they came from outpatient clinic at Al-Azhar University Hospitals in Cairo, Egypt, in the winter of 2021. [To prevent the changing seasons in vitamin D status, from September to December]. The Allergic Rhinitis and its Impact on Asthma [ARIA] recommendations were followed, and a skin prick testing was used to verify the diagnosis of AR. Large panels of the most common aeroallergens in the present area, including home sand, hay dust, mixing mites, mixing moulds, mixing pollens, and cat epithelium, were tested on ten patients who had the same antigens. Positively and negatively controls were used in as well as tests for allergies. The positive control, histamine solutions, must start to itch after a short while, then turn red, bloated, and develop a wheal in the middle. Saline solution served as the negative control, which ought to have produced no effect. First before children were enrolled in the trial, all cases and controls underwent evaluations by a senior otorhinolaryngologist. Depending on ARIA guidelines, the intensity of all kids with AR was graded and classified into mild, moderate and severe, or severe rhinitis and overall nasal symptom rating [nasals congestions, sneezing, runny noses, itching noses, and Total Nasal Symptoms [TNSS]]. Based on the intensity of the AR manifestations, all participants had their overall nasal symptom score evaluated. The TNSS assigns the following ratings to each clinical signs: 0 indicates no symptom; one indicates minor, unnoticeable sensations, two moderate, distressing but acceptable illnesses, and three severe, distressing symptoms that interfere with daily activities and/or sleeping [13]. Two weeks prior to the research, all systemic corticosteroids and antihistamines treatments were discontinued.

As a healthy control subjects, 150 children who were not atopic and who were in good health were selected based on age and gender.

Exclusion criteria

[1] Every comorbid condition that might influence vitamin D levels, such as rheumatologic conditions, renal and chronic gastrointestinal illnesses, and endocrinal diseases;

[2] Those who had undergone immunotherapy;

[3] Those with some other forms of rhinitis, such as viral, drug-induced, hormonal, or some other non-AR; and

[4] Kids whom have taken certain medications, such as calcium-containing medicines and vitamin D.

Data collection: Data was collected by history taking [Age, weight, height and BMI], and existence of allergy symptoms among children in the patients group who had a

background of sneezing, rhinorrhea, itchy noses, throats, or palates, as well as itchy, teary, or red eyes with nasal obstructions. Individuals without these symptoms made up the non-AR healthy control group. Clinical Signs include widened pulse pressure and an early diastolic murmur. Endoscopic appearance data were collected and confirmed by lab and radiological assessment.

Laboratory Investigations

Once a 12-hour fasting, venous samples of blood were taken between the hours of 8:00 and 10:00 AM of both groups. Following ten min of spinning, serum samples were isolated and stored at -80 °C till the day of assessment. Using an automated standardized laboratory technique, serum calcium was assessed. Each sample was measured twice. Using immunoassay system design, serum 1,25[OH]2D and 25[OH]D were evaluated by radioimmunoassay [Immunodiagnostic System Ltd, Boldon Business Park, Boldon, Tyne and Wear, United Kingdom]. Vitamin D deficiency was known as serum 25OHD3 values< 20 ng/mL, vitamin D insufficiency as values among twenty and thirty ng/mL, and adequate as values among thirty and eighty ng/mL [32].

Total serum IgE [TIgE]: A 1470 WIZARD gamma counter [PerkinElmer, Turku, Finland] was used to quantify TIgE utilizing Immuno CAP100 [Phadia, Uppsala, Sweden]. The TIgE typical value was between ≥2 and ≤5000 kU/L. Whenever the TIgE concentration was greater than 100 kU/L, the diagnosis of AR was deemed positive.

Assessment of inferior turbinate and nasal cavity

After they stopped receiving medical care for at least two weeks, Endoscopy was conducted with a pediatric strict endoscopes, diameters 2.7 mm, with a 30 angle of vision [Karl Storz 7207; Karl Storz, Tuttlingen, Germany], and with a 300-W cold lightening sources [Storz Xenon Nova; Karl Storz] and lightening cables of 1.8 mm length. Microcamera attached to digital recording sets used to video recording endoscopy [Karl Storz Tele Pack; Karl Storz]. In order to treat restless youngsters and those with tiny nasal fossa brought on by anatomical anomalies, flexible endoscopes [2.7 mm in diameter] were utilized. The infant was positioned supine with a head tilt of roughly 45 °. Oxybuprocaine 1% anaesthetic solution-soaked cotton wool was inserted into the nostril for five minutes.

According to Lang's definition [33], the nasal fossa was briefly assessed in 3 phases that enabled examination of the following anatomical components: 1] the rhinopharynx, the inferior turbinate and how it connects to the inferior meatus, the inferior section of the septum, the aspects of the mucosa and whether or not it secretes; 2] the central middle turbinate and its connections with the septum or uncinate processes, the maxillary lines [starting superiorly at the central turbinate attachments matching at the agger nasi region], the olfactory tract when available; and 3] the ethmoidalis bulla and its mucosal connections, the uncinate procedure, the middle meatus and half of the nasal septum, as well as the sphenoethmoidal recesses [If there was sufficient space within the nasal fossa, this procedure could be performed; if not, localized decongestion may be necessary].

Three endoscopic parameters were assessed: 1] the place where the middle turbinate and nearby structures like the uncinate processes and septum converge; 2] the junction of the inferior meatus with inferior turbinate; and 3] the inferior or pale medium turbinate. These were all regarded as either being existing or not. The contacting point is a localized enlargement of mucosa, frequently swelling, with a portion of the middle or inferior turbinate that is white or pale in colour, and frequently matching to the head.

After evaluation, some participants who were selected had their CT scans for nose and paranasal sinuses reviewed. Additionally, daytime hours were used for all CT scans. Using a 16-slice CT scanner [Toshiba Aquilion Prime 160-Slice, Japan], all children were examined in axial portions that covered the areas from the tip of the nose to the area just posterior to the mastoid air cells and from the top of the frontal sinuses to the hard palate. Cranio-caudal ordering was used to obtain the images. The paranasal sinus technique used a 512x512 images matrix, a 3-mm slicing thickness at a 0.55 pitch, 120-kVp tubes voltage, and 240-mA tubular current. The pictures of each participant were rebuilt using 1.0-mm slice width from the basic volumetric dataset. Prior CT, none of the participants got a decongestant. [I] The inferior turbinates' anterior and posterior overall width,

encompassing the deviating and contralateral edges in the patients and control groups; [II] For both posterior and anterior parts of the inferior turbinate have medial mucosal thickening; and [III] nasal cavity patency is determined by using the choanal gap posterior aspect and the intranasal gap anteriorly. The intranasal distances were assessed anteriorly as the spacing between the nasal septum medially and the inferior turbinate laterally. The average discrepancies have been studied as a consequence of measuring the total width of the front and posterior sections of the bilateral inferior turbinates, medial mucosal width, intranasal distances, choanal distances, and posterior extensions to the nasopharynx. Three-dimensional CT was used to gather all parameters, which were then contrasted between the AR patients and control groups.

Ethical approval: A written consent was obtained from each child parents to participate in the current study. The Ethical committee of the faculty of medicine Al-Azhar University for girls has approved the study.

Statistical Analysis: Data from the current study has been entered, coded and analysed using the Statistical Package for Social Sciences version 22 [SPSS Inc, Chicago, Illinois, USA]. The average was utilized to represent the statistics as well as standard deviation [SD]. The unpaired Student t test and Mann-Whitney [U] analysis were utilized to contrast the mean scores between the AR and normal groups. Spearman rank correlations were used to calculate the correlation coefficient r. The cutoff for statistically significant was at p< .05.

RESULTS

Table 1 lists the demographics information and testing standards for each research respondents. The categorization and nasal symptoms of each subject are shown in Table 2. 300 kids participated in this study. The findings showed that 150 kids were in the control group [average age: 6.55 [3.95] years; 70 [46.7%] males] and 150 kids in the AR group [average age: 7.01 [3.15] years]. Age, gender, socio-economic position, and anthropometric statistics did not statistically vary between the two groups. Comparing children with AR and healthy controls' birth months and seasons didn't reveal any appreciable changes.

Children with AR showed considerably greater calcium and total blood IgE concentrations than the healthy control group [p< .0001 for each]. Table 1 shows that the mean serum concentrations of 25[OH]D and 1.25[OH]2D in the AR group were considerably lower than those in healthy children [p< 0.001 and p< 0.0001, accordingly].

In the current investigation, approximately 46.7% of the pediatric population exhibited vitamin D insufficiency [20-30 ng/mL] compared to 41.3% of total of the healthy controls [p =0.5], and only 24% of AR children exhibited typical blood 25-OHD levels [>30 ng/mL] against 52.6% of controls [p =.002]. the lack of vitamin D [<.0001, Table 1].

The average 25-OHD3 concentrations in participants with moderate to severe AR were considerably less than those with mild AR, due to both groups' AR severity, according to our research [p<0.001]. In the current research, correlation analyses were conducted between vitamin D levels and numerous indicators. Considering 25[OH]D and calcium ratios, a strong positive connection [r =0.31, p =0.012] was discovered. Additionally, the mean 25[OH]D levels in the AR group were found to be significantly correlated negatively with both the TNSS [r = -0.71, p = 0.003, Table 3] and overall IgE concentrations [r =- 0.26, p =0.032]. Comparing children with AR to normal participants by birthdate and seasons, no discernible differences were discovered.

Serum concentrations of sIgE: Regarding ARIA categorization, the sIgE concentrations to aeroallergens in individuals with AR altered considerably [p = 0.0021, Kruskal-Wallis testing]. Particularly, children with mild intermittent symptoms had significantly lower sIgE concentrations to house-dust mites [median, 7.01 kU/L; IQR, 1.46-24.28 kU/L] as well as those who experienced mild persistent symptoms [median, 13.4 kU/L; IQR, 5.02-35.34 kU/L] [p = 0.0352, Wilcoxon testing]; Moderate-to-severe persisting symptoms and mild intermittent symptoms [median, 31.3 kU/L; IQR, 7.02-101 kU/L] [Wilcoxon testing, p = 0.0004]; Interquartile range [0.49–35.14 kU/L]; median [11.09 kU/L]; comparing children with moderate-to-severe intermittent complaints, and with mild persistent symptoms and moderate-to-severe persistent symptoms [p = 0.0033, Wilcoxon testing].

AR evaluation of lowest cross-sectional area: Including both groups, the Minimal Cross-Sectional Area [MCA] on acoustical rhinometry was examined. The mean MCA for the right nasal cavity in the AR patient's group was 1.35 ± 0.07 cm2 while in the control group it was 1.58 ± 0.06 cm2 [p=0.823]. In contrast, the mean MCA for the left nasal cavity was 1.37 ± 0.07 cm2 in the AR patient's group and 1.12 ± 0.06 cm2 in the control group [p=0.743]. There was no discernible distinction between the two groups when the MCA was compared on the opposite sides of the nasal cavities [Table 4].

Contrast of the inferior turbinate based on the existence of AR

The posterior and anterior overall thicknesses of the inferior turbinate's average inter - group variation were examined. The mean posterior and anterior medial widths of the inferior turbinate in the AR patient group were 11.37 ± 2.47 and 12.75 ± 1.88 mm on the deviating side and 7.98 ± 2.31 and 11.46 ± 1.39 mm on the contralateral side, correspondingly. The mean posterior and anterior medial widths of the inferior turbinate in the control group were 11.62±2.53 and 12.63±2.32 mm on the deviating side and 9.32±1.87 and 11.18±1.62 mm on the contralateral side, correspondingly. As a result, there were no discernible intergroup variations in the average widths of the inferior turbinate [Table 5, figures 1, 2, 3, and 4].

Large disparities between the anterior inferior turbinate width in the deviating sides and that on the contralateral sides were found in all groups when comparing the inferior turbinate overall widths for the anterior and posterior sides [p=0.005] in the AR participants group and p <0.001 in the control group]. Furthermore, there was no statistically significant distinction in the posterior inferior turbinate width in the deviating sides and that in the contralateral sides for any of the groups [p=0.612 and p=0.758 in the AR patients and control groups, correspondingly] [Table 6].

Contrast of the AR patients and control groups' spatial distances

In terms of spatial distances measures, no discernible intergroup differences were found [Table 7].

Contrast of nasopharyngeal extending between the patients and control groups

It was thought about how the inferior turbinate's posterior extensions to the nasopharynx would exacerbate the symptom of nasal blockage. The exclusion of all children with adenoid hypertrophy or nasopharyngeal disease ensured that the inferior turbinate's posterior expansion was the only cause of nasopharyngeal constriction. Nasopharyngeal extensions occurred in 30 individuals [20%] in the AR patients' group and 7 [4.6%] in the control group. Although there were more children in the AR patient's group, the variation was not statistically significant [p=0.11].

Table [1]: Lab and demographic information for study participants

Variable	Children With Allergic Rhinitis [n =150]	Healthy Controls [n= 150]	P Value
Age	7.01 ± 3.15	6.55 ± 3.95	Non-significant
Gender	73 males, 77 females	70 males, 80 females	Non-significant
Weight	30.2 ± 13.7	29.2 ± 14.2	Non-significant
Height	120.0 ± 23.7	116.2 ± 32.1	Non-significant
Body Mass Index	16.1 ± 5.9	17.2 ± 9.4	Non-significant
Vitamin D status, n [%]			
• **Deficiency [<20 ng/mL]**	47 [31.3%]	13 [8.7%]	**<.0001***
• **Insufficiency [20-30 ng/mL]**	70 [46.7%]	62 [41.3%]	Non-significant
• **Normal [>30 ng/mL]**	36 [24%]	79 [52.6%]	**.002***
Total immunoglobulin E, IU/mL	315.9± 60.1	53.2 ± 16.7	**<.0001***
25[OH]D, ng/mL	28.7 ± 15.4	37.3 ±20.9	**<.001***
1, 25[OH]2D, ng/mL	20.1 ± 17.3	30.2 ± 13.8	**<.0001***
Calcium, mg/dL	9.2 ± 3.15	11.4 ± 3.25	**<.0001***

* Significant if $p \leq 0.05$.

Table [2]: Categorization, nasal Symptoms and signs in AR children

Allergic Rhinitis and its Impact on Asthma Categorization	N [%]
• Moderate/severe allergic rhinitis	71 [47.3%]
• Mild allergic rhinitis	79 [52.7%]
Clinical manifestations	**N [%]**
• Nasal obstruction	136 [90.7%]
• Nasal itching	120 [80%]
• Sneezing	146 [97.3%]
• Rhinorrhea	141 [94%]

Table [3]: Association between vitamin D levels and the total nasal symptoms scores

Scoring	Number of Participants	25[OH]D concentrations Mean ± SD	r	P
10-12	39	20.5 ± 13.6	-0.71	0.003
7-9	42	22.7 ± 12.9		
4-6	70	30.6 ± 13.6		

Table [4]: Minimal cross-sectional space on AR

Variable	Patients group [N=150] Mean ± SD	Control group [n=150] Mean ± SD	P-value
Right side [cm^2]	1.35±0.07	1.58±0.06	0.823
Left side [cm^2]	1.37±0.07	1.12±0.06	0.743
P – value	0.416	0.517	

Table [5]: Diameter of the inferior turbinate's posterior and anterior surfaces in regard to the deviated septum

Variable	Patients group [N=150] Mean ± SD	Control group [N=150] Mean ± SD	p-value
Posterior width [contralateral side]	11.46±1.39	11.18±1.62	0.283
Posterior width [deviated side]	12.75±1.88	12.63±2.32	0.754
Medial mucosa [contralateral side]	4.96±1.39	4.56±1.36	0.252
Medial mucosa [deviated side]	4.19±1.34	4.52±1.57	0.521
Anterior width [contralateral side]	7.98±2.31	9.32±1.87	0.461
Anterior width [deviated side]	11.37±2.47	11.62±2.53	0.546

Table [6]: Contrast of inferior turbinate breadth in groups with and without allergic rhinitis between the deviating and contralateral sides

Variable	Anterior patients Mean ± SD	Anterior control	Posterior patients	Posterior control
Contralateral side [mm]	12.71±1.99	12.72±1.95	13.3±1.61	13.17±1.85
Deviated side [mm]	8.67±1.65	9.16±1.73	11.31±1.85	10.92±1.68
p-value	**0.005**	**<0.001**	0.612	0.758

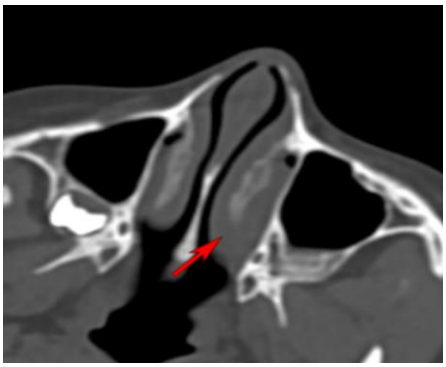

Figure [1]: Left inferior nasal turbinate hypertrophy [ARROW] is visible on the CT paranasal sinus axial image and is symptomatic of AR

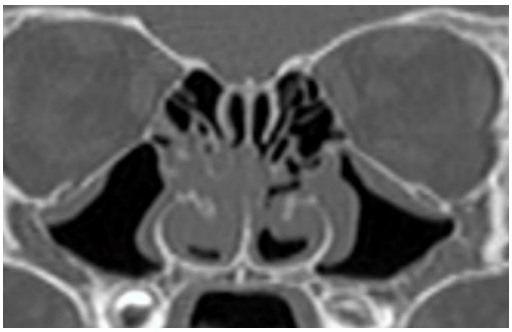

Figure [2]: CT paranasal sinus coronal view showing bilateral maxillary and ethmoidal mucosal thickening with hypertrophied right middle and inferior nasal turbinates

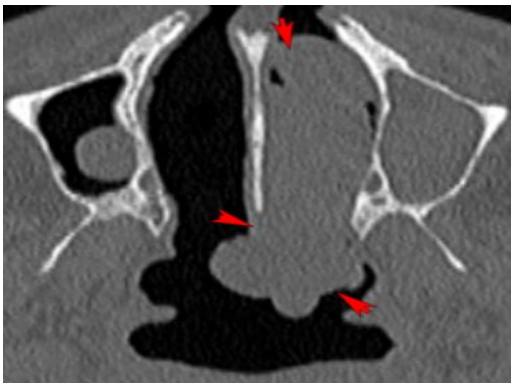

Figure [3]: CT paranasal sinus axial image showing polypoidal hypertrophied left inferior nasal turbinate with posterior extension seen partially encroaching upon the nasopharyngeal air column [ARROWs]

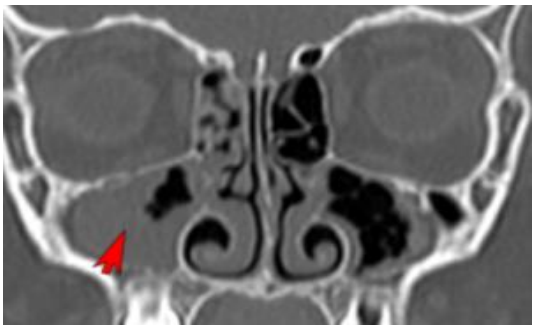

Figure [4]: CT paranasal sinus coronal view showing bilateral maxillary and ethmoidal sinuses mucosal thickening with retained secretions, more at the right maxillary sinus [ARROW], denoting acute exacerbation of chronic sinusitis

Table [7]: Spacing distances within the nasal cavities in regards to the inferior turbinate in the patients and control groups

Variable	Control group [N=150]	Patients group [N=150]	P value
Intranasal distance [contralateral side]	1.81±1.02	1.56±1.25	0.247
Choanal distance [deviated side]	2.32±1.53	2.18±1.17	0.795
Choanal distance [contralateral side]	2.82±1.33	2.64±1.46	0.664
Intranasal distance [deviated side]	1.73±0.64	1.68±1.31	0.728

DISCUSSION

The current research yielded significant findings in the expanding field of vitamin D status and allergic childhood. In this investigation, the vitamin D levels of a sizable group of kids with AR were examined. When compared to healthy controls, it was noticed that children with AR frequently had vitamin D deficiencies. **Dogru and Suleyman** [34] evaluated 65 healthy individuals and 76 kids with AR, which is in agreement with current findings. The average serum 25[OH]D3 concentrations of AR kids were substantially less than those of the healthy subjects [18.07 ± 6.1 ng/mL vs 24.03 ± 9.43 ng/mL; p =0.001] when they assessed the concentrations in both groups. They did not, though, discover any connection among vitamin D insufficiency and the intensity of AR, which is in contrast to our findings. In a different study [35], 1,25[OH]2D3 concentrations were examined between thirty kids with AR and recurring tonsillitis and thirty healthy children. When compared to healthy youngsters, the mean concentrations of 1,25[OH]2D3 were considerably lower in the AR group [34.65 pg/mL vs 52.86 pg/mL; p =0.001]. The same report [35] observed that children with acute nasal symptoms had substantially lower 1,25[OH]2D3 levels [p< 0.05] **Yenigun *et al.*** [36] and **Goksugur *et al.*** [37] looked at two smaller groups of kids with allergic rhino conjunctivitis, and they discovered that these kids had considerably decreased vitamin D concentrations than controls. The role of vitamin D in the immune response and allergy illnesses has received a great deal of attention recently. Although the fundamental pathophysiology of AR is generally acknowledged to be the change from a Th1 to a Th2 phenotype in CD4 T cells, the exact mechanisms of AR is still unclear. Recent studies revealed the importance of Th17 and T-regulatory cells in the development of AR. Vitamin D enhances the Th1 to Th2 transition by inhibiting T-lymphocyte proliferations and encouraging the growth of Th2 cells [1, 36]. Additionally, it inhibits the growth, transcriptions, and bioactivity of Th17 cells while promoting the generation of Treg cells [1, 36]. Such results suggest a connection between vitamin D and AR mortality [37]. Vitamin D deficiency causes smooth muscles contractions, prostaglandin control problems, impaired Th1-Th2 balancing, and increased inflammation of the airways [38].

Significant relation between consumption of vitamin D throughout gestation and its serum concentration and the occurrence of AR in various ethnic groups have been observed in some medical and epidemiological research. Two researches [39, 40] documented an

association among AR and maternal vitamin D consumption. The incidence of asthma and AR in 5-year-old children was found to be inversely related to maternal consumption of vitamin D during late gestation, according to a study by **Erkkola *et al.*** [40] [confidence interval [CI]: 0.64-0.99] and AR [CI: 0.75-0.97]. In a group of 1248 mother-child pairs, **Bunyavanich *et al.*** [41] discovered that consuming 100 IU of vitamin D per day during the first and second trimester of pregnancy was linked to 21% [odd ratio [OR]: 0.79 [95% CI: 0.67- 0.92]] and 20% [OR: 0.80 [95% CI: 0.68-0.93]] lower odds of ever having an AR at school age, respectively. According to **Bener *et al.*** [42], vitamin D insufficiency is strongly linked to AR in children. Statistics from the yearly Korean National Health and Nutrition Assessment 2009 recent Poll were used in a similar study by **Jung *et al.*** [43] Following correcting for demographic information, body mass index, sun exposure, socioeconomic position, activity, and body fat percentage, they found that children with AR had less average vitamin D concentrations than the healthy older group. Levels of vitamin D in adults AR sufferers were evaluated by **Arshi *et al.*** [38] and contrasted to findings from the general population [no control group]. Individuals with AR had a considerably greater incidence of acute 25[OH]D insufficiency than the general group [30% vs 5.1%, accordingly; p =0.03]. There were fewer publications that indicated no relationship between AR and vitamin D concentrations or a favourable relationship with the usage of vitamin D, which is contradictory with current findings and the conclusions of the earlier studies [45-47]. According to **Hyppönen *et al.*** [44], regular intake of vitamin D was linked to a higher incidence of atopy and AR. Additional investigations [46, 47] found no evidence of a connection between serum vitamin D concentrations and AR. The current data did not support the earlier results, which may be related to varied research approaches, the age of the subjects chosen, various clinical evaluation techniques for AR, and vitamin D level testing in the laboratory.

A recent systematic review and meta-analysis about vitamin D levels and AR was conducted by **Aryan *et al.*** [2]. They discovered that the relationship between levels of vitamin D and AR was sex- and age-specific children who had serum 25[OH]D levels greater than 30 ng/mL had a decreased risk of developing AR. In contrast to adults, this was significant in children [OR: 0.64; 95% CI: 0.51-0.81], but not in adults [OR: 0.91; 95% CI: 0.81-1.01].

Since children with moderate and severe chronic asthma had increased blood IgE concentrations, the current results were not unexpected. Previous research demonstrated a relation between elevated IgE concentration and an increasing incidence of asthma and an enhanced airway hyper-responsiveness [49], and a rapid decline in lungs capacity [50]. Elevated sIgE concentrations might indicate individuals who have the best indications for immune-therapy, making our findings practically applicable in determining whether individuals are candidates for such treatments. The association between the sIgE concentration and symptom improvements with allergen immune-therapy will have to be studied in order to assess this. Furthermore, the discovery that individuals with chronic AR had high sIgE levels along with significant symptoms increased the potential that sIgE might also be regarded as a predictive marker of AR intensity. A significant longitudinal population research should be conducted to examine this association.

Limited investigations have radiologically examined the link between AR and turbinate hypertrophy, despite the fact that several investigations have undertaken CT examination of the inferior turbinate in individuals with a deviated nasal septum. To ascertain the connection between AR and inferior turbinate hypertrophic, therefore CT was used to assess the inferior turbinate volumes in respect to the existence of AR.

Children with chronic AR benefit from inferior turbinate decrease [48]. In a study of individuals with persistent allergic rhinitis, **Mori *et al.*** [49] examined the long-term effects of submucous turbinectomy and recommended it as a helpful method for the long-term treatment of nasal-allergic conditions. In addition, 90% of participants who underwent the inferior turbinate operation demonstrated improvements in nasal blockage and complaints such rhinorrhea, headaches, and snoring, according to **Mucci and Sismanis** [50]. Many subsequent researches have revealed comparable findings, namely that AR worsens nasal obstruction and increases the severity of inferior turbinate hypertrophy [51-53]. Unfortunately, it can be challenging to discern between allergy symptoms and turbinate hypertrophy, particularly in individuals who

have grown accustomed to their complaints. Additionally, turbinate hypertrophy can be brought on by a variety of factors, includes temperature variations, medications, hormones, vasomotor rhinitis, and upper respiratory infections.

Conclusions and Recommendations

When opposed to the healthy subjects, children with AR frequently have vitamin D deficiencies. Assessing level of vitamin D must be taken into consideration while evaluating children with AR because a substantial negative relationship between those concentrations and the severity of the condition was seen. To ascertain the outcomes, dosage, and period of vitamin D therapy for the treatment of AR, additional research is necessary. Additionally, additional research is necessary to properly understand the precise vitamin D's mode of action in AR.

Conflict of interest and Financial Disclosure: None

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Print ISSN: 2636-4174
Online ISSN: 2682-3780