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Original Research Article

Correlation between Vitamin D Deficiency and Bronchial Asthma in School Going Children in Rural Population of Southern Telangana

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Abstract:

Aim: The purpose of this research was to examine the correlation between asthma and vitamin D by measuring the amount of vitamin D in the blood of children with and without asthma.

Method: A hospital-based comparative cross-sectional study was conducted in the Rural Population of Southern Telangana. A total of 200 children (100 in non-asthmatic and asthmatic groups), aged 10-18, were used as participants. Their socio-demographic and anthropometric parameters parameters were recorded. High-performance liquid chromatography (HPLC) was used to measure the serum vitamin D levels of all the children, and the results were compared to the different illness severity and control levels, between the non-asthmatic and asthmatic children.

Result: Most of the studied population in both groups were sufficient (44 with and 48 without asthma) and mild vitamin D deficient (26 with and 37 without asthma). Moderate and severe deficiency was recorded lower among children without asthma (19 and 10 respectively) whereas a higher number of children was observed in children with asthma (27 and 12 respectively) ($P<0.05$). Children with asthma had substantially lower mean blood vitamin D levels (49.2±7.2 ng/mL) than children without asthma (51.2±6.9 ng/mL). Serum vitamin D levels did not affect the severity of the asthma or the degree of symptom management. Also, statistically, no correlation was observed between the prevalence of asthma and vitamin D deficiency ($P>0.05$).

Conclusion: In India, children with asthma had mean blood vitamin D levels that were slightly but substantially lower than those of their asthma-free peers. However, in these children with normal blood vitamin D levels, serum vitamin D level does not seem to be related to childhood asthma severity and management.

Keywords: Airway limitation, Asthma, Children, Vitamin D, Lung function.

Introduction

Asthma is a prevalent chronic illness that has shown an upward trend in global prevalence in recent decades. The genesis of asthma is a multifaceted phenomenon that is likely influenced by a combination of genetic and environmental variables that interact with each other [1-3]. The increasing incidence of asthma may be attributed to several environmental factors, including air pollution, dietary alterations, sensitivity to allergens, and lifestyle adjustments. Furthermore, compromised immunogenic tolerance and the interaction between cells and inflammatory mediators might exacerbate blockage of the airways. The role of vitamin D as a hormone has garnered increasing interest. In addition to its well-established roles in calcium absorption, bone mineralization, and regulation of neuromuscular function, vitamin D is recognized for its non-classical actions, including cellular differentiation, insulin secretion, and blood pressure regulation [4]. Moreover, emerging evidence suggests that vitamin D may serve as a powerful regulator of the immune system and potentially influence the development and progression of various allergic diseases. Vitamin D has been seen to have regulatory influences on several components of the immune system, whereas a shortage in vitamin D has been associated with a range of disorders that have immunological foundations, including asthma [5, 6]. Owing to the avoidance of solar exposure and the prevalence of disguised clothing styles, vitamin D insufficiency is very common in many Middle Eastern nations with plenty of sunshine, including India. Decreased blood vitamin D levels may be associated with an increase in the incidence of allergic disorders and asthma worldwide. Jolliffe et al. [7] concluded that vitamin D supplementation lowered the percentage of asthma exacerbations in children and adults who required steroid therapy. Furthermore, vitamin D has been shown to improve the development of the lungs in unborn children when taken throughout pregnancy and to have preventative benefits for asthma and wheezing that may arise later in life. Nevertheless, contradictory findings

have been documented indicating that vitamin D has either no impact or a negative effect on the severity or occurrence of asthma, leaving the relationship between vitamin D and asthma unclear. Globally, one of the biggest public health issues is the pandemic of allergies and asthma. In a study conducted in Costa Rica, Brehm et al. (2008) found that 28% of children with asthma had inadequate levels of vitamin D and that there was a strong negative relationship between indicators of asthma severity and blood vitamin D levels [8]. In a similar vein, Searing and Leung 2010 found that 48% of kids in Denver, Colorado, between the ages of 0 and 18 years, who had food allergies, atopic dermatitis, and asthma, had inadequate vitamin D levels. Therefore, it is critical to discover new risk factors for the development of asthma, such as vitamin D deficiency, to enhance asthma management, lower asthma-related morbidity, and assist in disease prevention in infancy. Several studies have been conducted in the industrialized world to monitor the vitamin D status of young infants [9].

Comparably, in developing nations, almost all research has been conducted in large cities with socioeconomic status and living standards comparable to those in industrialized nations. Few studies have examined the vitamin D status of young children living in underdeveloped rural settings where children receive little to no vitamin D supplementation. It is still unknown what the vitamin D status of young children is, and what possible variables may influence it in rural locations. Research has been conducted on the vitamin D status of young children in underprivileged rural areas who do not consume vitamin supplements. This cross-sectional study aimed to determine the relationship between vitamin D deficiency and asthma in school-aged girls in rural Southern Telangana.

Material and Methods

Study area: Between March 2023 and August 2023, this cross-sectional investigation was undertaken at medical centers.

Sample selection: Children with asthma between the ages of 10 and 18 who lived in rural areas and attended school were gradually recruited alongside a control group of healthy children of the same age and both sexes. Children whose doctors suspected they were suffering from chronic liver or kidney disease, or who were using anti-epileptic drugs or supplements containing vitamin D, were excluded from the study since their vitamin D levels might have been influenced by other factors.

Ethical consideration: The OAUTHC Ethics and Research Committee provided ethical approval for the study. Written informed permission was acquired from the parent or accompanying caregiver for every child recruited, and older children between the ages of 7 and 14 were asked for their approval.

Study procedure: Participants provided information on sociodemographics, asthma symptoms, severity, and management. Questions addressed wheezing, nighttime dry coughing, chest tightness, difficulty breathing, and asthma diagnosis to determine symptom frequency, exacerbations, and daily life disruption. Based on the National Asthma Education and Prevention Programme's Expert Panel Report, patients were classified as having intermittent, mild persistent, moderate persistent, or severe persistent asthma. Asthma control was classified using the Global Initiative for Asthma 2014 guidelines as uncontrolled, partially controlled, or well controlled. An acute asthma exacerbation was defined as a sudden onset of dyspnea, wheezing, and cough requiring steroid administration according to a documented action plan. Nutritional history included details on pre-lacteal meals, exclusive breastfeeding duration, total breastfeeding duration, and consumption of vitamin D-rich foods like milk, eggs, meat, fish, and poultry. Regular consumption of these foods indicated a high vitamin D diet. The amount of daily sun exposure was also recorded.

Each participant had three milliliters of blood drawn to measure serum 25-hydroxyvitamin D levels using a validated HPLC-UV technique. Reagents were of HPLC grade with over 98% purity, sourced from Sigma-Aldrich in St. Louis, Missouri, and purchased by Rophex Pharmaceuticals in Lagos, Nigeria. Method validation had a lower limit of quantification of 5 ng/mL for serum 25-hydroxyvitamin D concentrations between 5 and 100 ng/mL, with precision and accuracy ranging from 1.67 to 13.64% for low, medium, and high-quality control. Serum 25-hydroxyvitamin D levels were categorized as follows: ≤20 ng/mL indicated deficiency, 20-29 ng/mL indicated insufficiency, ≥30 ng/mL indicated sufficiency, and >150 ng/mL indicated hyper-vitaminosis.

Statistical analysis: For categorical variables, frequency analysis, descriptive statistics, and percentage analysis were used to characterize the data, while standard deviation (SD), mean, and standard error of the mean (SE) were employed for continuous variables. SPSS Statistics Software version 23.0 and MedCalc Statistical Software version 19.1.3 were used for statistical analysis.

Results

Table 1 shows the socio-demographic variables (age and gender), socioeconomic classes (upper, middle, and lower class), and residence (urban and rural) distribution between the group children with asthma and children without asthma. 100 children with asthma and 100 children as controls were taken in a study. The mean age in years ± SD in the controls was 13.93 ± 2.77 and 14.42 ± 3.4 in cases. Comparison of all variables except age and gender distribution were significant ($p<0.05$). There was no

difference in sex and age between asthmatic cases and healthy controls.

Table 1: Comparison of socio-demographic characteristics of the children with asthma and the children without asthma

Sociodemographic profile	Children with asthma	Children without asthma	P value
Sex			
Male	41	54	0.572
Female	59	46	
Age group in years			
10 – 14	43	52	0.279
15 – 18	56	47	
Mean age	13.93 ± 2.77	14.42 ± 3.4	
Socioeconomic Classes			
Upper	41	29	0.163
Middle	26	33	0.115
Lower	32	37	0.818
Household smoke exposure	5	1	0.214
Residence			
Urban	64	58	0.0355
Rural	36	42	0.0345

The study participants' anthropometric measurements are displayed in Table 2. Children with asthma had a higher family history of vitamin D insufficiency than children without asthma ($p = 0.005$), and there was a significant familial risk of allergic illness in this sample of asthmatics ($p = 0.009$). Compared to controls, children with asthma had a higher likelihood of having a wheatish skin tone ($p < 0.001$), engaged in less physical activity ($p < 0.001$), received less sunlight exposure ($p = 0.006$), and were more likely to be overweight or obese ($p = 0.008$) than their age-matched counterparts without asthma.

Table 3 provides a summary of the serum vitamin D levels in the study population. It represents the distribution of the participants based on their Serum Vitamin D levels. Out of 100 children with asthma, moderate deficiency was recorded in 27 children, similarly, 29 children had moderate levels of vitamin D deficiency without asthma ($P<0.05$), and severe deficiency was recorded in 22 children with asthma and 20 children without asthma ($P<0.05$). Statistically, a significant difference was also observed in serum vitamin D levels of children with and without asthma ($P<0.05$). The average level of serum vitamin D levels of both groups was represented in Table 4.

Children without asthma had blood vitamin D levels ranging from 32.0 to 63.2 ng/mL, whereas children with asthma had values between 28.8 and 62.3 ng/mL. The children with asthma had mean (SD) blood vitamin D levels of 49.2±7.2 ng/mL, while the controls had levels of 51.2±6.9 ng/mL. The children with asthma had substantially lower mean (SD) blood vitamin D levels than their age and sex-matched contemporaries without asthma ($P<0.05$) (Table 4). However, the differences between the serum vitamin D levels of both groups were statistically significant ($P>0.05$).

Correlation between vitamin D level and severity of asthma: When the relationship between vitamin D insufficiency and asthma was examined in individuals, $P = 0.13$ indicated that there was no discernible difference between the children with asthma and children without asthma. There was no discernible difference found after a thorough examination of the asthma patient group's asthma severity and asthma control status based on vitamin D deficiency. The association between vitamin D levels and sun exposure was another thing we attempted to research. For patients ($P = 0.173$) and controls ($P = 0.523$), there was no discernible relationship between sun exposure and calcium levels.

Table 2: Anthropometric parameters of the children included in the study

Anthropometric parameters	Children with Asthma	Children without asthma	P value
Mean age SD years	13.93 ± 2.77	14.42 ± 3.4	0.210
Familial history of asthma			
Yes	24	35	0.009
No	76	65	
Familial history of Vitamin D deficiency			
Yes	47	39	0.005
No	33	61	
Colour of skin			
White	31	32	<0.001
Whitish	55	43	
Brown or black	24	25	
Physical activity			
Vigorous physical activity	38	35	< 0.001
Less Physical activity	62	65	
Exposure to sunlight			
Yes	53	64	0.006
No	47	65	
Body Mass Index (BMI)			
Normal (<85th percentile)	54	64	0.008
Overweight (85 – 95th percentile)	29	28	
Obese (>95th percentile)	17	8	

Table 3: Frequency distribution of the participants based on their Serum Vitamin D levels

Serum Vitamin D Levels	Children with asthma	Children without asthma	Sig. (2-Tailed)
Sufficient (30–80 ng/ml)	44	48	<0.001
Mild deficiency (20–29 ng/ml)	26	37	
Moderate deficiency (10–19 ng/ml)	27	19	
Severe deficiency (<10 ng/ml)	12	10	

Table 4: Average level of Vitamin D levels in studies population

Group	Level (ng/mL)
Children with asthma	49.2 ± 7.2
Children without asthma	51.2 ± 6.9
Sig. (2-Tailed)	0.002

Discussion

Bronchial asthma, a common chronic inflammatory condition, causes hyperactive bronchi to narrow and potentially leads to irreversible airflow obstruction [10]. Vitamin D enhances steroid sensitivity and regulates inflammation via gene expression and cytokine production. It may aid tissue remodeling and lung function by inhibiting metalloproteinase, fibroblast proliferation, and collagen synthesis, and influencing airway remodeling, muscle movement, growth, and contractility through transforming growth factor beta inhibition. In this study on Indian children, none were vitamin D deficient and only 0.5% had insufficiency, likely due to abundant sunshine [11]. Low vitamin D levels are linked to higher respiratory infections and increased asthma severity [12], though age and inflammation studies show mixed results [13, 14].

In the study, 55.3% of children with asthma had wheatish skin, while 21.3% had darker skin. Darker skin reduces sunlight absorption, requiring more sun exposure to produce adequate vitamin D compared to fair skin. Mendes et al. [15] found that 40% of urban babies and toddlers with darker skin had insufficient vitamin D levels (<30 ng/ml). Similarly, 42% of urban teenagers with darker skin had levels below 20 ng/ml. Insufficient sun exposure and skin pigmentation differences contribute to lower vitamin D levels in asthmatic children. Bose et al. [16] indicated that limited sun exposure and deeper pigmentation increase vitamin D insufficiency and asthma morbidity.

Research from various regions, including the UK, Canada, Qatar, India, and the USA, indicates high rates of vitamin D insufficiency and deficiency among children. These countries, far from the equator, receive minimal sunlight, making vitamin

D-rich foods essential yet often insufficient [17 - 19]. In sunny countries like India, religious clothing restricts sun exposure, limiting vitamin D production. In this study, only 1% of asthmatic children had inadequate vitamin D levels, contrasting with higher rates elsewhere, such as 59.7% in Iran [20]. Boys had a higher asthma incidence than girls in Delhi [21].

In this study, only one child had insufficient vitamin D levels, and none had deficiencies. However, children with asthma had significantly lower mean serum vitamin D levels compared to their healthy peers. This could be due to reduced consumption of vitamin D-rich foods or less sun exposure to avoid allergens. Despite this, no significant differences in outdoor time or diet were found between asthmatic and non-asthmatic children. Vitamin D's anti-inflammatory and immunoregulatory properties might explain the lower levels in asthmatic children. Population-based longitudinal studies are needed to understand this relationship. Lower vitamin D levels were linked to better responses to inhaled glucocorticoids [22]. The study's reliance on participants' recollection for assessing vitamin D-rich food consumption and daily sun exposure introduces memory bias. Additionally, since the research was conducted at a tertiary health institution with children from upper socioeconomic classes, the findings may not represent a diverse community. Despite these limitations, the study serves as a starting point for further research to explore the causal relationship between blood vitamin D levels and the severity and management of pediatric asthma symptoms.

Conclusion

The present study found the frequency of Vitamin D deficiency and insufficiency was higher in children with asthma, compared to the controls. No significant correlation was found between Vitamin D levels and age, gender, obesity, sun exposure, and dietary intake in asthmatic patients. Vitamin D deficiency and insufficiency are strongly associated with childhood asthma without significant impact on disease severity and level of control. The use of routine vitamin D supplementation as an additional treatment for the management of childhood asthma in India is not advised due to the absence of vitamin D deficiency among the asthmatic children included in this research. Hence, more research is required to fully understand the role of vitamin D in the maintenance of airway homeostasis and address the diagnostic and therapeutic implications vitamin D may have in the future of asthma management.

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