SRYAHWA PUBLICATIONS

Archives of Pediatrics and Neonatology
ISSN: 2638-5155 | Volume 9, Issue 1, 2026
https://doi.org/10.22259/2638-5155.0901001

RESEARCH ARTICLE

Association between the Vitamin D Deficiency and Recurrence of Respiratory Tract Infections in Children

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Received: 18 May 2026 Accepted: 02 June 2026 Published: 08 June 2026

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Abstract

Background: Respiratory tract infections (RTIs) continue to be one of the major contributors to morbidity among children. Vitamin D has a significant immunomodulatory activity and its deficiency has been linked with a growing number of recurrent respiratory tract infections in children

Objective: This study aims to evaluate the association between serum vitamin D deficiency and recurrent respiratory tract infections among pediatric patients.

Methodology: A prospective cohort study was conducted in the Department of Pediatric Medicine, Dr. MR Khan Shishu Hospital & Institute of Child Health, Dhaka, Bangladesh, between February 2025 and January 2026 with a total of 100 children (1-12 years) with recurrent respiratory tract infections. 25-hydroxy-vitamin D was determined and classified as deficient (<20 ng/mL), insufficient (20–29 ng/mL), and sufficient (≥30 ng/mL). All data was collected manually and later analyzed in SPSS version 25.0.

Results: The mean age of the participants was 5.8 ± 2.7 years with a majority being male (56%) and living in the rural area (61%). Overall, 58% of children were vitamin D deficient and 4–6 years (20%) of age group has highest deficiency. 39% children had 5–6 RTI episodes each year and children with vitamin D deficiency had significantly higher mean infection episodes per year (6.8 ± 1.9) with a statistically significant association ($p<0.001$). There were significantly different mean vitamin D levels in severe respiratory infections (15.6 ± 4.8 ng/mL) compared to moderate and mild infections ($p<0.001$). The seasonal variation analysis showed that the highest mean number of RTI episodes occurred during winter ($p=0.003$).

Conclusion: In our context, clinical and biological criteria were the only truly usable indicators. Probabilistic

Citation: Dr. Gazi Abdul Bari, Dr. Mostafizur Rahman, Dr. Md. Shakibur Rahman, *et al.* Association between the Vitamin D Deficiency and Recurrence of Respiratory Tract Infections in Children. Archives of Pediatrics and Neonatology. 2026; 9(1):01-06.

antibiotic therapy remains the main strategy to reduce neonatal mortality, which remains unacceptably high in our settings.

Keywords: Vitamin D Deficiency, Recurrent Respiratory Tract Infection, Pediatric Infection, Children, Respiratory Tract Infection, Serum Vitamin D, Bangladesh.

1. Introduction

Respiratory Tract Infection (RTI) is defined as any infectious diseases to the upper or lower respiratory tracts including common cold, laryngitis, pharyngitis/tonsillitis, acute rhinitis, acute rhinosinusitis and acute otitis media and acute bronchitis, bronchiolitis, pneumonia and tracheitis [1]. The human respiratory system is prepared with multiple organs which major function is to exhale waste gases or CO_2 from the bloodstream and to supply O_2 to cells by inhalation process [2]. RTI has been a major concern to public health due to its widespread contagiousness and elevated rate of morbidity and mortality. As an example, more than 14.9 million people deceased during COVID-19 pandemic in 2020-2021 worldwide [3]. According to data, from 12.8% children under five years used to admit hospitals with acute respiratory infection which dropped only 3% (9.8%) in 2018 in Bangladesh [4]. Vitamin D plays a significant role in inhibiting pulmonary inflammatory responses by enhancing innate defense mechanisms against respiratory pathogens [5]. Vitamin D is known for its anti-microbial activity against Mycobacterium tuberculosis which is responsible for Tuberculosis [6]. The prevalence of Influenza A virus is noticed in winter season most when sunlight is not at its peak that indicates another hypothesis between the Vitamin D deficiency and respiratory diseases [7]. According to records, Vitamin D deficiency has been observed in 21% to 75 % for infants, children, adolescents and 66% to 94.2 % for pregnant women [8]. A Pakistan based study proved a significant relationship between nasal Obstruction, Sinusitis, Tonsillitis, Pharyngitis and vitamin D deficiency in children aged 5 years to 14 years [9]. An Indian study also showed substantial vitamin deficiency in children aged 6 months to 5 years suffering from Lower respiratory tract infections (LRTIs) [10]. Although Recurrent Respiratory Tract Infections (RRTI) in Children in Bangladesh is 69.8% in 2024 while the vitamin D deficiency is also analyzed to a vital level, yet no study was performed in Bangladesh addressing the relationship between Vitamin D deficiency and recurrence of Respiratory Tract Infections. This study aims to assess the association between serum vitamin D levels and recurrent respiratory tract infections among pediatric patients.

2. Methodology

A prospective cohort study has taken place in the Department of Pediatric Medicine, Dr. MR Khan Shishu Hospital & Institute of Child Health, Dhaka, Bangladesh from February 2025 to January 2026. This yearlong study included 1-12 years old 100 pediatric patients presented to hospital with recurrent respiratory tract infections. The study was completed with the ethical approval of Institutional Review Board (IRB) and enrolled patient who satisfied study specific inclusion and exclusion criteria.

2.1 Inclusion Criteria

- Children aged 1-12 years.
- History of recurrence respiratory tract infections.
- Written informed consent from patients legally authorized guardian (LAR).

2.2 Exclusion Criteria

- Congenital immunodeficiency disorders.
- Chronic respiratory disorder by birth.
- Congenital heart disease.
- Patient's with prescribed vitamin D supplements from 3 months.
- Refused consent.

This cohort study observed patient's with RRTI for 1 year and investigated 25-hydroxy-vitamin D test from blood sample. The vitamin D level in blood serum was remarked as deficiency< 20 ng/mL, insufficient = 20-30 ng/mL, and sufficient≥ 30 ng/mL [11]. Every patient's information including demographic details, frequency of respiratory infections, infection severity, Seasonal distribution and vitamin D level was recorded in specific case report form (CRF) and also documented in MS Excel sheet for further analysis. After finishing the cohort, all data were set to analysis at SPSS version 25.0 software. A p-value<0.05 was considered statistically significant in 99% of confidence interval.

3. Result

After evaluating the complete dataset of 100 patients, the results from the relationship of recurrences of RTI in Bangladeshi children and its association to vitamin D deficiency came out.

Table 1. *Baseline demographic characteristics of study participants (N=100)*

Variables	Frequency (%) / Mean ± SD
Mean Age (years)	5.8 ± 2.7
Male	56 (56%)
Female	44 (44%)
Rural Residence	61 (61%)
Urban Residence	39 (39%)
Mean BMI (kg/m²)	16.9 ± 2.3
Exclusive Breastfeeding History	48 (48%)
Exposure to Passive Smoking	37 (37%)
Family History of Allergy/Asthma	29 (29%)

Table 1 showcases the baseline demographics of patients where the mean age of patients was calculated 5.8 ± 2.7 years, male patients are prevalent (56%), 61% patients are belonging to rural area and the mean BMI of patients are 16.9 ± 2.3. 48% patients are only on breastfeeding, 37% patient had given passive smoking history and genetical allergy/asthma was recorded for 29% of children.

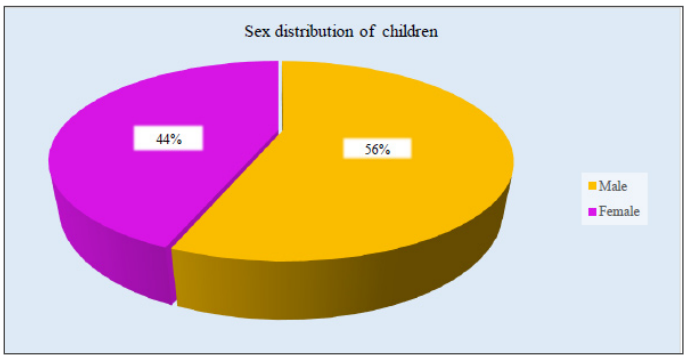

Figure 1. *Demographic distribution of patients, sex (N=100)*

Figure 1 clearly show that the dominance of male child (56%) over female child (44%). The graphical representation also discloses the male-to-female ratio documented 1.27:1 for this study.

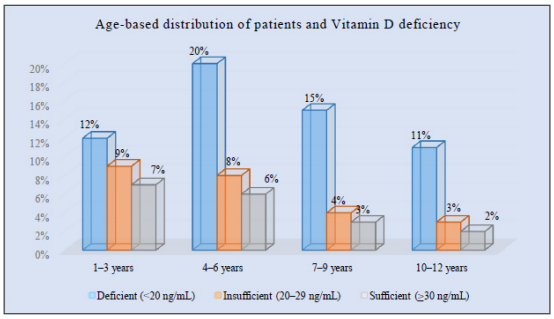

Figure 2. *Demographic distribution by Serum Vitamin D level of patients, age (N=100)*

Figure 2 defines the distribution of study participants by age where 28 study subjects were included in between 1-3 years, 34 patients from 4-6 years of age group, 22 patients were enrolled from 7-9 years and 16 patients were came from 10-12 years of age group. In the age-based distribution, 12% of 1-3 years old children, 20% of 4-6 years of children, 15% of 7-9 years old children and 11% of 10-12 years old children were found to having vitamin D deficiency (58%). Apart from that, overall 24% of children were detected with insufficient Vitamin D and only 18% children carry sufficient vitamin D in their body.

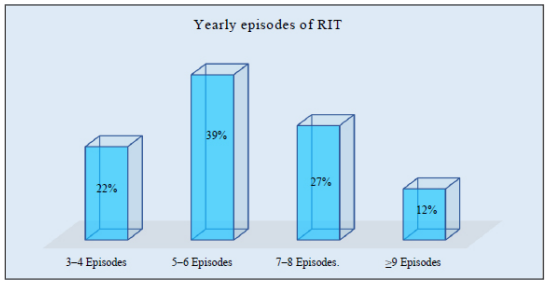

Figure 3. *Frequency of Respiratory Tract Infections among Study Participants per year (N=100)*

Figure 3 indicates the frequency of RTI per year of the study subjects. 39% of participants experienced 5-6 episodes of respiratory tract infection, followed by 27% of 7-8 episodes, 22% of 3-4 episodes and 12% of participants suffered from ≥9 episodes of RTI.

Table 2. *Frequency of Respiratory Infections According to Vitamin D Status (N=100)*

Vitamin D Status	Mean Infection Episodes/Year ± SD	p-value
Deficient (n=58)	6.8 ± 1.9	<0.001*
Insufficient (n=24)	4.9 ± 1.4	
Sufficient (n=18)	3.2 ± 1.1	

Table 2 stands for the frequency of RIT and its association to Vitamin D deficiency. A mean of 6.8 ± 1.9 episodes of RIT was occurred to the maximum pediatric patients which itself a significant finding (p<0.001*).

Table 3. *Association between Vitamin D deficiency and the severity of Respiratory Tract Infection (N=100)*

Severity Category	Mean Vitamin D Level (ng/mL) ± SD	p-value
Mild Infection (28%)	31.2 ± 6.4	<0.001*
Moderate Infection (46%)	23.8 ± 5.9	
Severe Infection (26%)	15.6 ± 4.8	

Table 3 concludes the severity of infections and its association with vitamin D deficiency. >20 ng/mL was considered as vitamin D deficiency and 26% of children was determined vitamin D deficient, although mostly moderate infection rate is high (46%) where patients vitamin D level was insufficient. 28% patients with sufficient vitamin D also reported mild infection, the overall p-value is significant at 99% of confidence interval.

Table 4. *Seasonal Variation of Respiratory Tract Infections among study participants (N=100)*

Season	Mean Infection Episodes ± SD	p-value
Winter (34%)	3.6 ± 1.2	0.003*
Spring (22%)	2.4 ± 1.0	
Summer (18%)	1.8 ± 0.8	
Autumn (26%)	2.2 ± 0.9	

According to table 04, the mean episodes of RTI (3.6 ± 1.2) is high in winter season (34%), followed by 26% in autumn (2.2 ± 0.9), 22% in spring (2.4 ± 1.0) and 18% in summer (1.8 ± 0.8). The seasonal variation in statistical analysis detects a significant p-value, 0.003*.

4. Discussion

Vitamin D is a fat-soluble nutrient that is essential for bone and hormonal development and balance [12]. From years, researchers claims the relationship between the vitamin D deficiency and the tendency of respiratory tract infection (RTI) in children [13] [14] [10]. The current study focuses on the association between vitamin D deficiency and the recurrence of respiratory tract infections among Bangladeshi children. This is a yearlong cohort study included children aged 1-12 years with the history of recurrence of RTI. The demographic data shows that the mean age of overall study participants are 5.8 ± 2.7 years and male children are prevalent to RRTI (56%) where majorities of study participants came from rural residency (61%). A 2016 Bangladeshi study on the recurrent and persistent pneumonia in Bangladeshi children also found male dominancy (61%) in their study and the mean age the calculated was 3.0 ±2.8 years [15] which is similar findings to this study and an Indian study with 60% male patients and 2.41±1.36 years of mean age [10]. Another Bangladeshi study also pointed similar patterns with 52.02% of male victims where 74.27% patients are belongs to rural area [16] probably due to their unawareness towards respiratory health. The study highlights that mostly 4-6 years old children are deficient to vitamin D (20%), followed by 7-9 years (15%), 1-3 years (12%) and 10-12 years (11%) where 9% of 1-3 years of children, 8% of 4-6 years of children, 4% of 7-9 years old children and 3% of 10-12 years old children are insufficient to vitamin D. According to 2024 statistics, majorities 30.3% of 5-10-year-olds and 9.9% children aged < 5 years are deficient to vitamin D [17]. Another Bangladeshi article published 31.88% of 0-1 years old Bangladeshi children are deficient to vitamin D level in their body where 52.17% of patients are insufficient to vitamin D of that age group; Among

2-5 years of age group, 8.16% were deficient and 50% were insufficient; 41.02% were deficient and 52.56% were insufficient was found in 6-11 of age group in that particular study [18]. 39% of patients experienced 5-6 episodes of respiratory tract infections, followed by 7-8 episodes (27%), 22% had 3-4 episodes and 12% had more than or equal 9 events. El-Azami-El-Idrissi M et al., 2016 quoted that the average respiratory events rate is 5-6 [19]. Hossain N et al., 2018 showed 80% of patients had recurrence event of RTI such as pneumonia [15]. According to this study findings, vitamin D deficiency has a significant correlation with respiratory tract infection ($p<0.001$). Ried K et al., 2025 also published a similar finding by showing the prevalence of RTI is 70% in patients with vitamin D deficiency [20]. Another research proved the significant relationship between vitamin D deficiency and tonsillitis ($p=0.027$) [21]. A significant correlation has also been proven between vitamin D deficiency and the severity of respiratory infection ($p<0.001$*). Muneeb A et al., 2023 found the resembled significant clinical association between RTI and vitamin D deficiency ($p=0.004$) [22]. Other findings were reveled about the seasonal basis rate of RTI in Bangladesh where in winter, most recurrence was observed (34%), followed by autumn (26%), spring (22%) and summer (18%); p value= 0.003*.

Limitation

The study was carried out in a single center and therefore the findings might not be generalizable to the larger pediatric population of Bangladesh. The seasonality and environmental factors impacting on vitamin D status and respiratory infections were non-assessable due to the short study period of one year. Further, dietary patterns, socioeconomic status, outdoor activity, and sun exposure were not thoroughly assessed and could have affected serum vitamin D levels and recurrent infections.

5. Conclusion

The present prospective cohort study showed that vitamin D deficiency was significantly associated with recurrent respiratory tract infections (RRTIs) in children from Bangladesh. In children with deficiency vitamin D status, the episodes of infection were more frequent than in those with insufficient and sufficient vitamin D status per year. The severity of respiratory tract infections was also significantly associated with lower serum vitamin D levels, where severe infections were observed predominantly among vitamin D deficient children. The seasonal variation analysis showed that the episodes of RTI were maximum during winter, suggesting the relation between the decreased amount of sun exposure and the increased frequency of infections. Vitamin D-deficiency is a potentially treatable condition that could decrease the burden and severity of recurrent respiratory tract infections in children.

Abbreviation

RTI – Respiratory Tract Infection

RRTI – Recurrent Respiratory Tract Infection

LRTI – Lower Respiratory Tract Infection

BMI – Body Mass Index

CRF – Case Report Form

IRB – Institutional Review Board

SPSS – Statistical Package for the Social Sciences

COVID-19 – Coronavirus Disease 2019

WHO – World Health Organization

ng/mL – Nanogram per milliliter

Conflicts of Interests

The authors declare no conflicts of interest regarding this publication.

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