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Association Between Serum Vitamin D Levels and Acute Respiratory Tract Infections Among Preschool Children in Gharyan Hospital, Libya

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العلاقة بين مستويات فيتامين د والتهابات الجهاز التنفسي الحادة لدى الأطفال في مرحلة ما قبل المدرسة في مستشفى غريان، ليبيا

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Abstract

Background: Acute respiratory tract infections (ARTIs) remain one of the leading causes of morbidity and hospitalization among preschool children worldwide. particularly in low- and middle- income countries. Vitamin D plays a crucial immunomodulatory role in respiratory health by enhancing innate immunity and maintaining epithelial barrier integrity. However, vitamin D deficiency is highly prevalent among children, including those living in sun- rich regions such as Libya.

Objectives: This study aimed to assess serum vitamin D levels among preschool children admitted with ARTIs at Gharyan Central Teaching Hospital and to evaluate the association between vitamin D status, disease severity, and recurrence.

Methods: A cross-sectional observation study was conducted among 100 preschool children aged 1-6 years admitted with clinically diagnosed ARTIs between January and December 2025. After applying the inclusion and exclusion criteria, 79 eligible participants were included in the final analysis. Serum 25-hydroxyvitamin D [25(OH)D] levels were measured and categorized according to Endocrine Society guidelines. Associations between vitamin D levels, ARTIs severity, and recurrence were analysed using chi-square tests and logistic regression models.

Results: Vitamin D deficiency and insufficiency were highly prevalent, affecting 87.3% of the studied children. Although lower vitamin D levels were more frequently observed among children with moderate and severe ARTIs, the association with disease severity was not statistically significant (p=0.115). In contrast, a significant association was identified between low vitamin D levels and recurrent ARTIs (p=0.019).

Conclusion: Vitamin D deficiency is highly prevalent among preschool children hospitalized with ARTIs and is significantly associated with recurrent infections. Improving vitamin D status may contribute to reducing the recurrence of ARTIs in this population.

Keywords: Acute respiratory tract infections; Preschool children; ARI severity; Recurrent ARI; Vitamin D; 25(OH) D; Libya.

الملخص

تعد التهابات الجهاز التنفسي الحادة من أكثر الأسباب شيوعا للأصابة بالأمراض ودخول المستشفيات بين الأطفال ما قبل المدرسة، خاصة في الدول منخفضة ومتوسطة الدخل. ويؤدي فيتامين د دورا مهما في تنظيم الاستجابة المناعية وتعزيز صحة الجهاز التنفسي، الا أن نقصه يعد شائعا بين الأطفال حتى في المناطق الغنية بأشعة الشمس مثل ليبيا. هدفت هذه الدراسة الى تقييم مستويات فيتامين د في مصل الدم لدى الأطفال ما قبل المدرسة المصابين بالتهابات الجهاز التنفسي الحادة، ودراسة العلاقة بين مستوى فيتامين د وشدة وتكرار الإصابة.

أجريت دراسة مقطعية في مستشفى غريان المركزي التعليمي بليبيا خلال الفترة من يناير الى ديسمبر 2025، وشملت 100 طفل تتراوح أعمارهم من سنة الى ست سنوات، تم تشخيصهم سريريا بالتهابات الجهاز التنفسي الحادة، وتم قياس مستوى 25- هيدروكسي فيتامين د وتصنيفه وفقا للإرشادات جمعية الغدد الصماء. كما استخدمت الاختبارات الإحصائية المناسبة لتحليل العلاقة بين مستوى فيتامين د وشدة المرض وتكراره.

أظهرت النتائج ان 79 طفلا استوفوا معايير الدراسة النهائية، وان نسبة النقص هو عدم كفاية فيتامين د بلغت 87.3% من اجمالي المشاركين. ولم تظهر النتائج وجود علاقة ذات دلالة إحصائية بين مستوى فيتامين د وشدة الالتهابات التنفسية الحادة (الاحتمالية = 0.115)، في حين وجدت علاقة ذات دلالة إحصائية بين انخفاض مستوى فيتامين د وتكرار الإصابة بالتهابات الجهاز التنفسي الحادة (الاحتمالية = 0.019).

خلصت الدراسة الى ان نقص فيتامين د منتشر بشكل كبير بين الأطفال المصابين بالتهابات الجهاز التنفسي الحادة، ويرتبط بشكل معنوي بتكرار الإصابة، مما يشير الى ان تحسين مستوى فيتامين د قد يسهم في تقليل تكرار هذه الالتهابات وتحسين صحة الأطفال.

الكلمات المفتاحية: فيتامين د، التهابات الجهاز التنفسي الحادة، أطفال ما قبل المدرسة، شدة الإصابة، تكرار العدوى، 25- هيدروكسي فيتامين د، ليبيا.

Introduction

Acute respiratory tract infections (ARTIs) represent a major global public health problem and remain one of the leading causes of morbidity and hospitalization among preschool children, particularly those under five years of age [1,2]. Despite advances in preventive and therapeutic strategies, ARTIs continue to account for a substantial proportion of paediatric hospital admissions, especially in low- and middle- income countries, where they contribute significantly to childhood mortality [3]. Upper respiratory tract infections are the most frequently encountered, while lower respiratory tract infections, including pneumonia and bronchiolitis, are associated with more severe clinical outcomes and higher mortality rates [4].

Vitamin D has gained increasing attention as an essential immunomodulatory hormone with an important role in respiratory health. In addition to its well-established function in calcium and phosphorus metabolism, and bone health, vitamin D enhances innate immune defence by inducing the expression of antimicrobial peptides such as (Cathelicidin and Beta- defensins) and by preserving the integrity of the respiratory epithelial barrier [5,6]. Furthermore, vitamin D influences adaptive immune responses by down regulating excessive pro-inflammatory pathways while promoting immune regulation, which may help limit tissue damage during respiratory infections [7,8].

A growing body of epidemiological evidence indicates that low serum 25-hydroxyvitamin D [25(OH)D] levels are associated with increased susceptibility to ARTIs, higher rates of recurrent infections, and prolonged hospital stays among children [9,10,11]. Several paediatric studies have reported a high prevalence of vitamin D deficiency among children hospitalized with ARTIs. While some investigations demonstrated a significant association between low vitamin D levels and disease severity, others reported inconsistent findings, particularly regarding severity outcomes, although the association with recurrence appears more consistent [12,13].

In the middle East and North Africa region (MENA), including Libya, vitamin D deficiency is paradoxically widespread despite abundant sunlight. This phenomenon has been attributed to limited sun exposure, cultural clothing, and inadequate dietary intake of vitamin D-rich foods [14,15]. Libya studies have reported high prevalence rates of vitamin D deficiency among preschool children and suggested a possible association with recurrent respiratory infections. However, available data remain limited and geographically restricted, with a notable lack of evidence from smaller cities such as Gharyan [16,17].

Given the substantial burden of ARTIs among preschool children and the potentially modifiable role of vitamin D in immune defence, this study aimed to assess serum vitamin D levels among preschool children admitted with ARTIs at Gharyan Central Teaching Hospital and to evaluate the association between vitamin D status, disease severity, and recurrence. Generating local evidence may contribute to improving clinical management and guiding public health strategies to reduce the burden of paediatric ARTIs in Libya.

Materials and Methods

Study Design and Setting

A cross-sectional observational study was conducted at Gharyan Central Teaching Hospital, Gharyan, Libya. The study was carried out over a one-year period from January to December 2025.
The hospital serves as the main referral center for paediatric cases in Gharyan and surrounding areas.

Study Population and Sample Size

The study included 100 preschool children aged 1-6 years who were admitted with clinically diagnosed acute respiratory tract infections (ARTIs). Children were enrolled consecutively during the study period.
Inclusion criteria included children with confirmed ARTIs based on clinical assessment by paediatricians. Children with chronic immunodeficiency diseases such as celiac disease, congenital anomalies, chronic kidney or liver disease, or those receiving vitamin D supplementation during the preceding three months were excluded from the study.

Data Collection

Demographic and clinical data were collected using a structured questionnaire. Information included age, sex, weight, types of ARTIs, history of recurrent respiratory tract infections, clinical presentation, disease severity. ARTIs were classified as mild, moderate, and severe based on clinical symptoms, physical findings, and the need for supportive care or hospitalization. Also, clinical data of currently taking vitamin D or other supplements, time spend for sun exposure and dietary intake.

Measurement of Serum Vitamin D

Venous blood samples were collected under aseptic conditions from all participants. Serum levels of 25-hydroxyvitamin D [25(OH)D] were measured using a Roche's Cobas analyser, which is fully automated analysis, and use an electrochemiluminescence immunoassay (ECLIA) method for quantifying total 25 (OH) D. Vitamin D status was categorised according to Endocrine Society clinical practices guidelines as follows: severe deficiency (<12ng/ml), deficiency (12-20ng/ml), insufficiency (20-30 ng/ml), and sufficiency (> 30ng/ml) [18].

Statistical Analysis

Data were analysed using the Statistical Package for Social Sciences (SPSS) version 26. Continuous variables were presented as means, medium, and standard deviation (SD), while categorical variables were expressed as frequencies and percentages.
Associations between vitamin D status and ARTIs severity or recurrence were evaluated using chi-square tests. Logistic regression analysis was performed to assess predictors of recurrent ARTIs.
A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Research Ethics Committee of the Academy of Postgraduate Studies, Gharyan. Written informed consent was obtained from the parents or legal guardians of all participating children prior to enrolment. The study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Demographic Characteristics

A total of 100 children aged 1-6 years admitted with acute respiratory tract infections were initially assessed for eligibility in the study. After excluding 19 children who were receiving vitamin D supplementation and 2 children who were taking neurological medications, 79 participants remained and were included in the final analysis.
The mean age of the participants was 3.86 ±1.7 years. the present study revealed that 40(50.63%) were females and 39 (49.37%) were males (Figure 1). Mean birth weight (BW) was 2.9 kg ± 0.60, and the minimum (BW) was 1.20 kg and the maximum was 4.1 kg. The current mean body weight (wt.). was 16.93 ± 6.03 kg (minimum wt.= 7.00& maximum wt. = 30.00 kg), and the mean vitamin D level 22.9 ±10.1 ng/mL and the minimum vitamin D level was 6.8 ng/mL and the maximum was 74.9 ng/mL (Table 1).

Table (1): Baseline Demographic and Biochemical Characteristics of Pre-school Children with ARTIs at Gharyan Teaching Hospital 2025

Variable	Mean	SD	Min	Max
Age	3.86	1.71	1.00	5.92
Child weight	16.93	6.03	7.00	30.00
Birth weight	2.98	.60	1.20	4.09
Vitamin D level	22.90	10.09	6.80	74.94

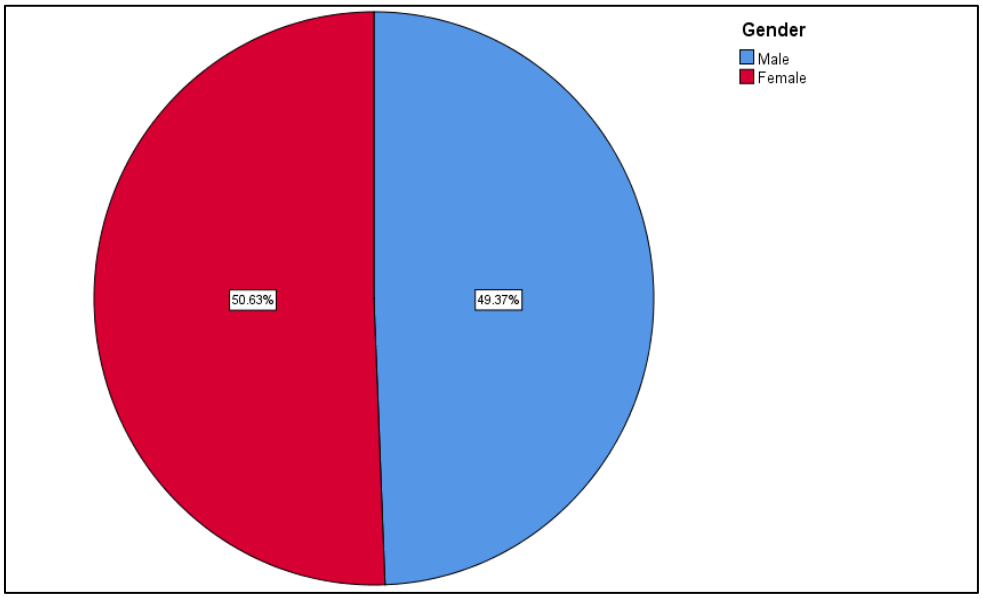

Figure (1): Gender -Distribution of the pre-school children with ARTIs at Gharyan Teaching Hospital 2025

Clinical Characteristics

The majority of the study population (96.2%) was diagnosed with ARTI, and about 04 % had not (Table 2 &Figure 2). The study reported that the most frequently condition was sore throat, accounting for approximately 28% of cases, 18% acute follicular tonsillitis ,18% pneumonia, 14% recurrent wheezy chest constituted roughly, while, 13% asthma exacerbation, 9% bronchiolitis, and only 1% of the children had no ARI diagnosis. Nearly half of the children (49.4%) had moderate illness, while (16.5%) were classified as severe and mild cases (about 33%). A history of recurrent ARTIs was reported in a considerable proportion of the studied children (Table 2).

Table (2): Clinical Characteristics, Severity, Type of ARTIs, and History of recurrent ARTIs among Children with Acute Respiratory Tract Infections (n = 79):

Variable	Category	Number (%)
1. Diagnosis of ARTI	Yes	76 (96.2)
	No	3 (3.8)
2. Type of ARTI	None	1 (1.3)
	Acute follicular tonsillitis	14 (17.7)
	Sore throat	22 (27.8)
	Bronchiolitis	7 (8.9)
	Pneumonia	14 (17.7)
	Asthma exacerbation	10 (12.7)
	Recurrent wheezy chest	11 (13.9)
3. Severity	Mild	27 (34.2)
	Moderate	39 (49.4)
	Severe	13 (16.5)
4. History of recurrent ARTIs	Yes	62 (78.5)
	No	17 (21.5)

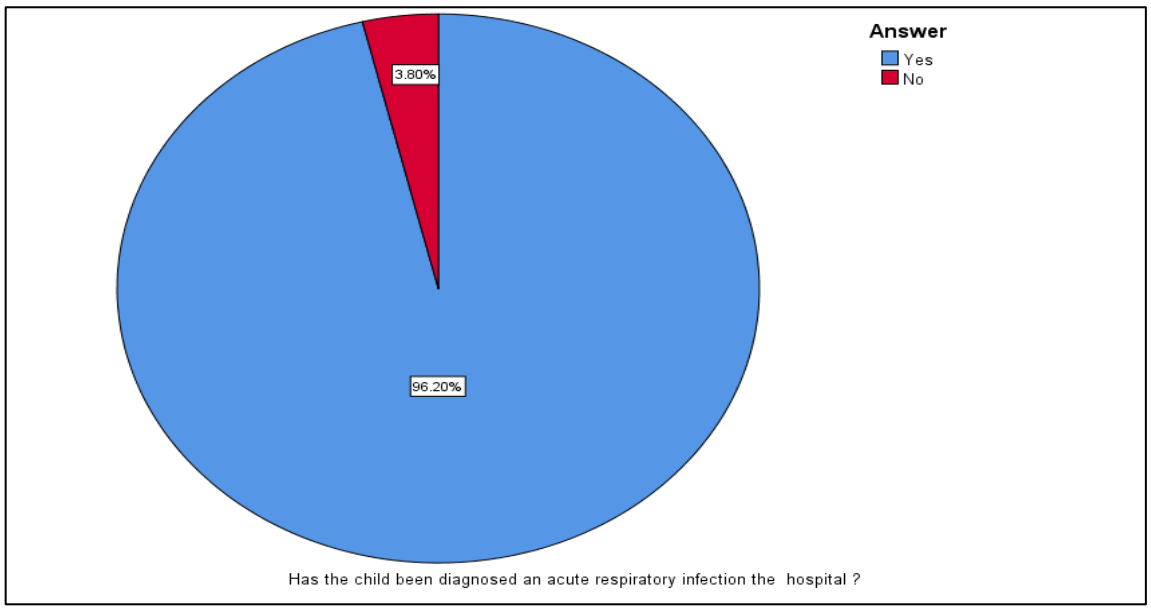

Figure (2): Distribution of the pre-school children diagnosed with ARTIs at Gharyan Teaching Hospital 2025.

Serum Vitamin D Status

- Vitamin D assessment revealed that only (12.7%) of children had sufficient levels, while the majority were either insufficient (50.6%), deficient (29.1%), or severely deficient (7.6%). Overall vitamin D assessment showed that 69 children (87.3%) had low vitamin D levels (severely deficient, deficient, or insufficient), whereas only 10 children (12.7%) had sufficient vitamin D levels (Table 3 &Figure 3).
- Vitamin D supplementation: the current study revealed that 30 children (38.0%) received supplementation after birth until the age of 1–2 years vitamin D supplementation, 3 (3.8%) received supplements due to documented deficiency, while more than half of the children 46 (58.2%) had no history of vitamin D supplementation (Table 3 &Figure 4).
- Outdoors exposure to sunlight: most children 72 (91.1%) spent time outdoors exposed to sunlight; however, the duration of daily exposure was limited. Only 15 children (19.0%) were exposed to sunlight for 45–60 minutes daily, while 20 (25.3%) were exposed for less than 15 minutes, and 7 (8.9%) had no sunlight exposure at all. Among children exposed to sunlight (n = 72), exposure most commonly occurred during midday 32 (44.4%) or afternoon hours 32 (44.4%), with fewer children exposed during morning hours 8 (11.1%) (Table 3).
- Dietary intake of vitamin D–rich foods: the study found that, only 2 children (2.5%) consumed such foods regularly, while 47 (59.5%) consumed them occasionally. The consumption of fatty fish rich in vitamin D, such as tuna, salmon, or cod liver oil, among the children is illustrated in table 3. None of the children reported consuming these foods regularly. About 11 (13.9%) consumed them occasionally, while the majority consumed them rarely 35 (44.3%) or never 33 (41.8%) (Table 3).

Table (3): Distribution of respiratory tract infections (RTIs) pre-children According to Vitamin D Status, and Related Factors among pre-school children at Gharyan Teaching Hospital 2025 (n = 79)

Items	Category	Number (%)
	No	73 (92.4)
1. Vitamin D Level (Re-categorized)		
	Low vitamin D*	69 (87.3)
	Sufficient	10 (12.7)
2. Vitamin D Level (Original Categories)		
	Severely deficient	6 (7.6)
	Deficient	23 (29.1)
	Insufficient	40 (50.6)
	Sufficient	10 (12.7)

3. History of Vitamin D Supplementation		
	Yes, after birth until 1–2 years	30 (38.0)
	Yes, due to deficiency	3 (3.8)
	No	46 (58.2)
4. Exposure to Sunlight	Yes	72 (91.1)
	No	7 (8.9)
5. Daily Sunlight Exposure Duration		
	None	7 (8.9)
	< 15 minutes	20 (25.3)
	15–29 minutes	20 (25.3)
	30–44 minutes	17 (21.5)
	45–60 minutes	15 (19.0)
6. Time of Day of Sunlight Exposure (n = 72)	Morning (Before 10 am)	8 (11.1)
	Midday (10 am–2 pm)	32 (44.4)
	Afternoon (After 2 pm)	32 (44.4)
7. Consumption of Vitamin D–Rich Foods	Yes, regular	2 (2.5)
	Yes, occasionally	47 (59.5)
	No, rarely	28 (35.4)
	No, never	2 (2.5)
8. Consumption of Fatty fish Foods	Yes, occasionally	11 (13.9)
	No, rarely	35 (44.3)
	No, never	33 (41.8)

***Low vitamin D includes severe deficiency, deficiency, and insufficiency**

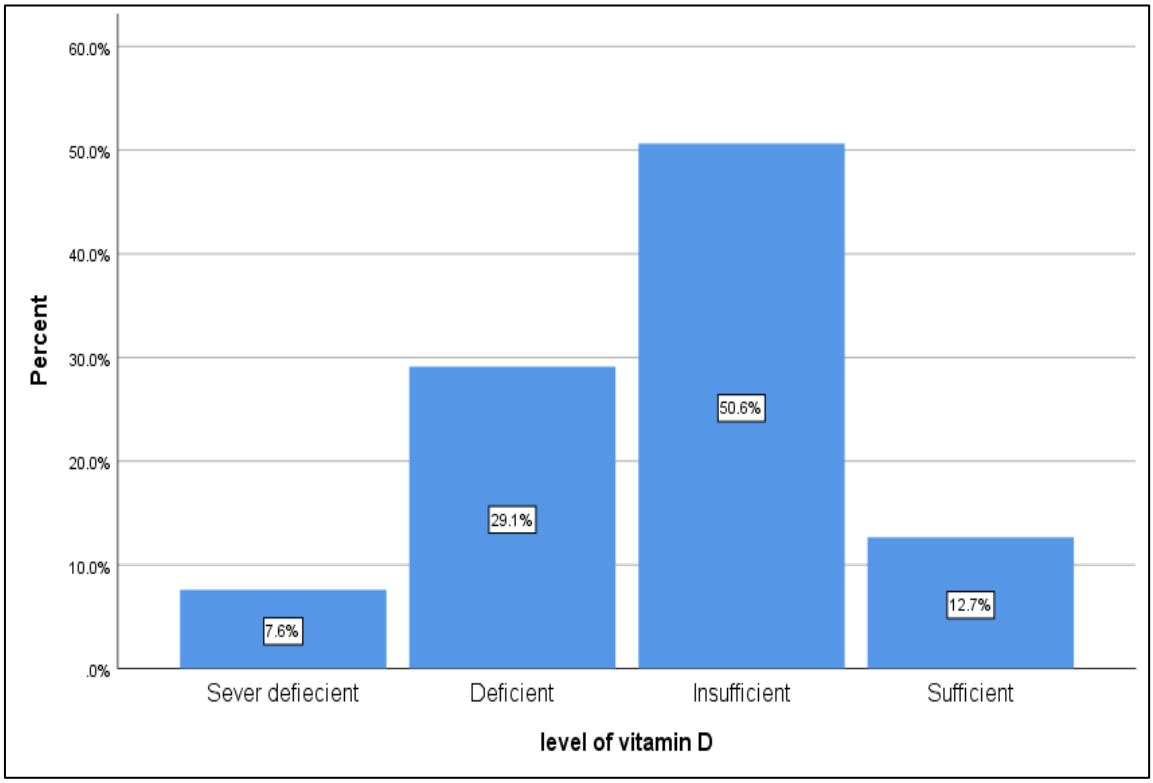

Figure (3): Distribution of vitamin D levels among all children in the study

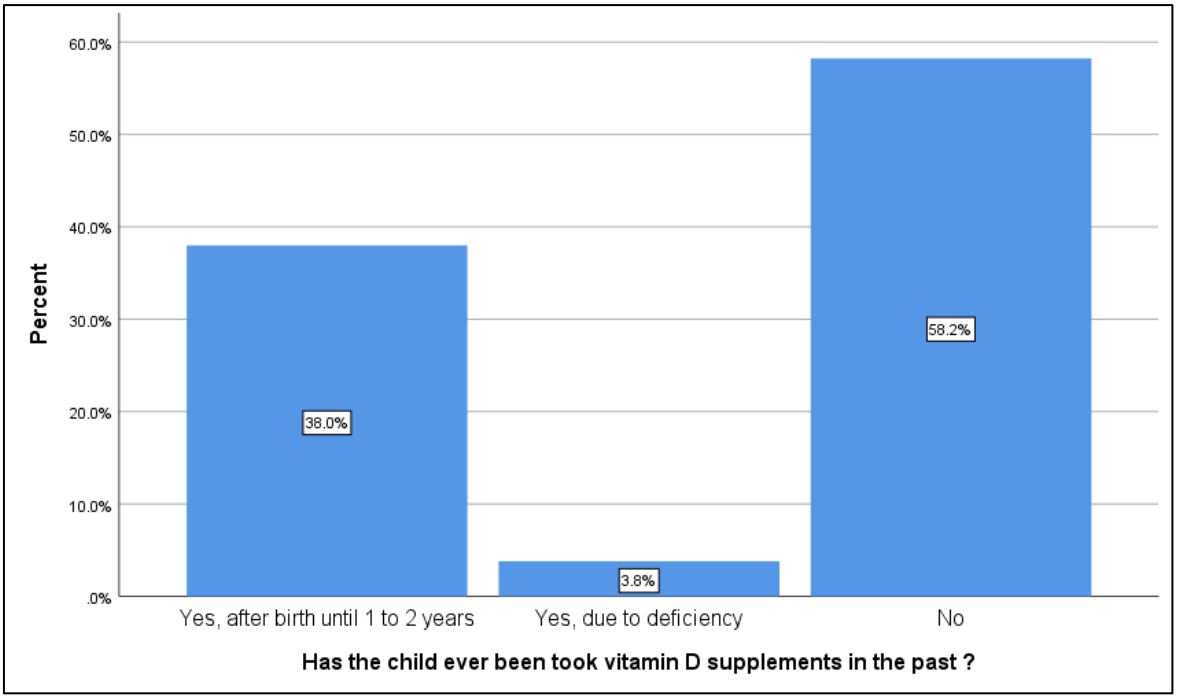

Figure (4): History of vitamin D supplementation among children among pre-school children at Gharyan Teaching Hospital 2025

Association Between Vitamin D Status and ARTI Severity

The distribution of vitamin D status across different levels of ARTI severity is presented in Table 4. Lower serum vitamin D levels were more frequently observed among children with moderate and severe ARTIs compared to those with mild disease. However, statistical analysis demonstrated no significant association between vitamin D status and ARTI severity (χ^2 test, $p = 0.115$).

Table (4): Distribution of ARI severity according to vitamin D levels pre-school among children at Gharyan Teaching Hospital 2025 (Chi-square test)

Level of vitamin D	ARI severity			Total	P-value
	Mild	Moderate	Severe		
low vitamin D levels	21 (78%)	35 (90%)	13 (100%)	69 (88%)	0.115
Sufficient	06 (22%)	04 (10%)	00	10 (12%)	
Total	27	39	13	79	

Association Between Vitamin D Status and Recurrent ARTIs

A statistically significant association was identified between serum vitamin D status and the recurrence of ARTIs (Table 5). Children with vitamin D deficiency and insufficiency had a significantly higher frequency of recurrent respiratory tract infections compared to those with sufficient vitamin D levels (χ^2 test, $p = 0.019$).

Table (5): Distribution of vitamin D levels according to history of recurrent acute respiratory infections in children (Chi-square test)

Level of vitamin D	History of recurrent ARIS		Total	P-value
	Yes No. (%)	No No. (%)		
Low vitamin D levels	57 (92%)	12 (08%)	69 (87%)	0.019
Sufficient	05 (71%)	05 (29%)	10 (13%)	
Total	62(78.5)	17(21.5)	79(100)	

Binary Logistic Regression Analysis of Predictors of Recurrent Acute Respiratory Infections

As presented in Table 6, none of the examined predictors demonstrated a statistically significant association with recurrent ARIs, as all p-values exceeded the conventional significance threshold of 0.05. Vitamin D level showed a small, positive, but non-significant association with recurrent ARIs (OR = 1.04; 95% CI: 0.89–1.00; $p = 0.173$).

Table 6: Binary Logistic Regression results for predictors of recurrent ARTIs

Predictor	OR	95% CI	P-value
Child Gender	1.52	0.16–1.63	0.518
Age	1.23	0.55–1.35	0.415
Vitamin D level	1.04	0.89–1.00	0.173
Sunlight exposure (Yes/No)	3.27	0.06–15.74	0.436
Duration of sunlight exposure	1.62	0.53–2.22	0.230
Time of day of exposure	0.57	0.66–5.23	0.311
Vitamin D-rich food intake	2.37	0.16–1.32	0.146
Fatty fish intake	1.30	0.38–2.38	0.617

Notes: OR = Odds Ratio; CI = Confidence Interval

DISCUSSION

The present study investigated serum vitamin D status among preschool children admitted with acute respiratory infections (ARTIs) at Gharyan Central Teaching Hospital and evaluated its association with disease severity and recurrence. The findings demonstrated a remarkably high prevalence of vitamin D deficiency and insufficiency, with 87.3% of the studied children exhibiting suboptimal vitamin D levels. This finding is consistent with previous reports indicating that vitamin D deficiency is highly prevalent among children in sun-rich regions, including countries in the Middle East and North Africa [14,15].

Regarding disease severity, although lower serum vitamin D levels were more frequently observed among children with moderate and severe ARTIs compared to those with mild disease, the association did not reach statistical significance. This result aligns with several pediatric studies that reported no significance relationship between vitamin D status and the clinical severity of ARTIs [10,12]. The lack of significant association may be explained by the multifactorial nature of disease severity, which is influenced by factors such as viral virulence, host immune response, nutritional status, and access to timely medical care, rather than vitamin D status alone.

In contrast, a statistically significant association was identified between low serum vitamin D levels and recurrent ARTIs. Children with vitamin D deficiency or insufficiency experienced recurrent respiratory infections more frequently than those with sufficient vitamin D levels. This finding supports earlier studies demonstrating that vitamin D deficiency is associated with an increased risk of recurrent respiratory tract infections in children [9,11,13]. The protective role of vitamin D against recurrent infections may attributed to its ability to enhance innate immunity through the induction of antimicrobial peptides and modulation of inflammatory responses, thereby reducing susceptibility to repeated infections [5,6].

Despite the significant association observed in the bivariate analysis, binary logistic regression did not identify vitamin D level or other examined variables as independent predictors of recurrent ARTIs. This finding may be related to the relatively small sample size, which limits the statistical power of multivariate analysis, as well as the potential influence of unmeasured confounding factors such as environmental factors, and socioeconomic status. Similar findings have been reported in previous studies, where associations observed in adjusted analysis were attenuated after controlling for multiple variables [10,13].

The high prevalence of vitamin D deficiency observed in this study is particularly noteworthy given that the majority of children reported some degree of sunlight exposure. However, the duration and timing of exposure were often insufficient to ensure adequate vitamin D synthesis, and dietary intake of vitamin D –rich foods was notably low. These findings are consistent with regional studies highlighted that limited effective sun exposure and inadequate dietary intake contribute substantially to vitamin D deficiency among children in the MENA region [14].

Several limitations should be acknowledged. The cross-sectional design precludes establishing causality between low vitamin D levels and ARTIs. Additionally, the single-center nature of the study and the modest sample size may limit the generalizability of the findings. Nonetheless, this study provides valuable local data and addresses an important knowledge gap regarding vitamin D status and respiratory infections among preschool children in Gharyan, Libya.

CONCLUSION and RECOMMENDATIONS

This study demonstrated a high prevalence of vitamin D deficiency and insufficiency among preschool children admitted with acute respiratory tract infections at Gharyan Central Teaching Hospital. Although no statistically significant association was observed between vitamin D status and disease severity, low vitamin D levels were significantly associated with recurrent respiratory tract infections. These findings highlight low vitamin D levels as a common and potentially modifiable risk factor for recurrent ARTIs in this pediatric population.

Based on the study findings, routine screening of vitamin D levels among preschool children, particularly those with recurrent respiratory infections, is recommended. Vitamin D supplementation should be considered as part of comprehensive preventive strategies aimed at reducing the recurrent of ARTIs, especially in high-risk children. In addition, public health initiatives should focus on improving awareness regarding adequate sun exposure, dietary intake of vitamin D-rich foods, and appropriate supplementation practices.

Future research with large sample sizes, multicenter designs, and longitudinal follow-up is recommended to further clarify the causal relationship between vitamin D status and ARTIs and to evaluate the effectiveness of vitamin D supplementation in reducing infection recurrence and improving clinical outcomes.

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Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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