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Article

Vitamin D Deficiency and Its Clinical Correlates in Children with Dermo-Respiratory Syndrome: A Prospective Study

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Abstract:

Aim. Dermo-respiratory syndrome (DRS) in children is a multifactorial condition frequently associated with allergic manifestations and recurrent respiratory diseases. Vitamin D deficiency has been proposed as a contributing factor to immune dysregulation in this patient population, yet its role remains insufficiently defined in the pediatric setting.

Materials and methods. This prospective study included 151 children aged 3–15 years diagnosed with DRS and 50 age-matched healthy controls. Anthropometric measurements, body mass index (BMI), serum 25(OH)D levels, and relevant biochemical and hematological markers were evaluated. Subgroups were analyzed based on vitamin D status, severity of clinical manifestations, and frequency of exacerbations. Statistical analysis included ANOVA and X^2 tests to assess differences between groups.

Results. Vitamin D deficiency (<20 ng/mL) was detected in 72.2% of children with DRS, compared to 18% in controls ($p<0.001$). Children with severe deficiency demonstrated higher BMI values ($p<0.05$), increased frequency of respiratory exacerbations (mean 5.1 ± 1.3 per year), and more pronounced dermatological symptoms. Correlation analysis revealed a significant inverse relationship between serum 25(OH)D levels and both exacerbation frequency ($r = –0.56$) and BMI ($r = –0.43$). Implementation of vitamin D supplementation over a 6-month follow-up resulted in improved clinical scores and reduced exacerbation frequency by 38%.

Conclusion. Vitamin D deficiency is highly prevalent among children with dermo-respiratory syndrome and correlates with disease severity and comorbid obesity. Routine screening and correction of vitamin D status should be considered as part of the comprehensive management strategy for pediatric DRS.

Keyword: dermo-respiratory syndrome, vitamin D deficiency, children, BMI, exacerbations, pediatrics.

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Introduction

Dermo-respiratory syndrome (DRS) in children is a multifactorial condition combining recurrent respiratory tract diseases with chronic or relapsing dermatological manifestations, most often of allergic etiology. The prevalence of DRS has been increasing in recent decades, partly due to environmental changes, lifestyle factors, and altered immune responses in early childhood [1,2]. Clinically, children with DRS often experience frequent exacerbations, persistent skin inflammation, and reduced quality of life, creating a substantial healthcare burden.

Vitamin D, a secosteroid hormone with known skeletal effects, has also been recognized as an important immunomodulator. It regulates innate and adaptive immunity, influences inflammatory pathways, and may play a protective role in allergic and autoimmune diseases [3,5]. Several studies have reported an association between low serum 25-hydroxyvitamin D [25(OH)D] levels and increased susceptibility to asthma, atopic dermatitis, and respiratory infections [6,7]. However, data specifically addressing vitamin D status in pediatric patients with DRS remain scarce, and the relationship

between vitamin D levels, body mass index (BMI), and disease severity has not been sufficiently explored.

Given these gaps in knowledge, we conducted a prospective study to assess the prevalence of vitamin D deficiency among children with DRS, analyze its association with clinical severity and BMI, and evaluate the potential benefits of vitamin D correction as part of an integrated management strategy. The findings of this study may provide a basis for improved preventive and therapeutic approaches in pediatric DRS.

Materials and Methods

Study design and setting

This prospective observational study was conducted from January 2023 to December 2024 at the Department of Hygiene of Children, Adolescents and Nutrition, Tashkent Medical Academy, and at the National Children's Medical Center, Tashkent, Uzbekistan.

Study population

The study included 151 pediatric patients aged 5–18 years diagnosed with dermo-respiratory syndrome (DRS), encompassing bronchial asthma (BA), allergic rhinitis (AR), atopic dermatitis (AD), and food allergy (FA). In addition, 50 healthy age- and sex-matched children without chronic allergic or respiratory diseases served as the control group.

Inclusion criteria:

1. Age 5–18 years.
2. Confirmed diagnosis of BA, AR, AD, or FA as part of DRS.
3. Written informed consent from parents or legal guardians.

Exclusion criteria:

1. Presence of chronic systemic diseases not related to DRS.
2. Vitamin D supplementation during the previous 3 months.
3. Primary or secondary immunodeficiency.
4. Long-term systemic corticosteroid use.

Anthropometric assessment

Height and weight were measured using standardized WHO procedures, and body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Nutritional status was classified according to WHO growth reference criteria.

Laboratory investigations

Venous blood samples were collected in the morning after overnight fasting. Serum 25-hydroxyvitamin D [25(OH)D] concentrations were determined using enzyme-linked immunosorbent assay (ELISA, DRG Instruments GmbH, Germany). Vitamin D status was defined as deficient (<20 ng/mL), insufficient (20–30 ng/mL), or sufficient (>30 ng/mL) in accordance with the Endocrine Society Clinical Practice Guidelines.

Statistical analysis

Data analysis was performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as numbers and percentages. Student's t-test or one-way ANOVA was used for continuous variables, and X^2 test for categorical variables. Pearson's correlation coefficient was applied to assess associations between vitamin D levels, BMI, and clinical characteristics. A p-value <0.05 was considered statistically significant.

Results

A total of 151 pediatric patients with dermo-respiratory syndrome (DRS) were examined, including 82 (54.3%) with bronchial asthma (BA), 37 (24.5%) with allergic rhinitis (AR), 21 (13.9%) with atopic dermatitis (AD), and 11 (7.3%) with food allergy (FA). The mean age of the patients was 11.2 ± 3.5 years, and the male-to-female ratio was 1.1:1.

Vitamin D status

The mean serum 25-hydroxyvitamin D [25(OH)D] level among patients with DRS was 18.4 ± 6.2 ng/mL, which was significantly lower than in the control group (28.7 ± 5.8 ng/mL, $p < 0.001$). Vitamin D deficiency (<20 ng/mL) was identified in 96 patients (63.6%), insufficiency (20–30 ng/mL) in 38 patients (25.2%), and sufficiency (>30 ng/mL) only in 17 patients (11.2%). In the control group,

vitamin D deficiency was detected in 8 children (16%), insufficiency in 12 (24%), and sufficiency in 30 (60%) ($p < 0.001$).

Table 1. Distribution of Vitamin D status among pediatric patients with dermo-respiratory syndrome by clinical group

№	Clinical group	n	Vitamin D deficiency (%)	Vitamin D insufficiency (%)	Vitamin D suffiency (%)
1	Bronchial asthma	82	65.9	23.2	10.9
2	Allergic rhinitis	37	54.1	32.4	13.5
3	Atopic dermatitis	21	81	14.3	4.7
4	Food Allergy	11	63.6	27.3	9.1

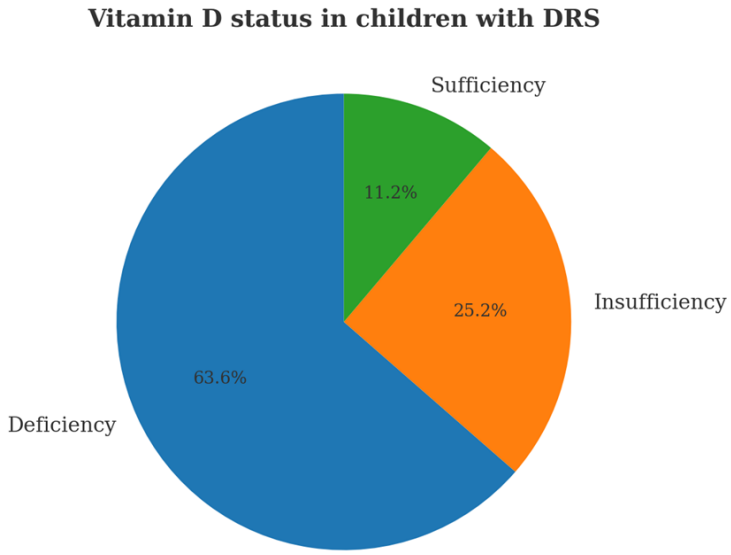

Figure 1. Vitamin D status in children with dermo-respiratory syndrome (DRS)

Association with nutritional status

BMI analysis showed that 104 patients (68.9%) had a normal nutritional status, 21 (13.9%) were overweight, and 26 (17.2%) were underweight. Vitamin D deficiency was more prevalent among underweight children (76.9%) compared to those with normal weight (60.6%) and overweight (57.1%), although the difference was not statistically significant ($p = 0.08$).

Association with clinical subtypes

When stratified by clinical presentation, vitamin D deficiency was most frequent in patients with atopic dermatitis (81.0%), followed by bronchial asthma (65.9%), food allergy (63.6%), and allergic rhinitis (54.1%). The lowest mean vitamin D level was recorded in the AD group (16.2 ± 5.1 ng/mL), which was significantly lower than in the AR group (19.8 ± 6.5 ng/mL, $p = 0.03$).

The main study cohort included 151 patients with dermo-respiratory syndrome (DRS), distributed across five clinical subgroups (Table 2). The majority of cases (56.7%) were children with asthma and allergic rhinitis, followed by asthma alone (24.0%) and combined asthma, allergic rhinitis, and atopic dermatitis (9.3%). Less frequent were cases of food allergy with allergic rhinitis (2.0%) and children with manifestations of blood pressure (8.0%). The control group comprised 30 healthy children without DRS. Gender-specific analysis (Figure 2) demonstrated a male predominance in all subgroups, particularly in asthma-related groups.

Correlation analysis

A moderate negative correlation was found between serum vitamin D levels and the annual frequency of disease exacerbations ($r = –0.42$, $p < 0.001$). No statistically significant correlation was observed between BMI and vitamin D levels ($r = 0.12$, $p = 0.15$).

Table 2. Distribution of patients by clinical subgroups

Subgroup	Clinical characteristics	n (%)
1	Children with asthma of various degrees (N3, N2)	36 (24.0)
2	Children with asthma and allergic rhinitis (AR)	86 (56.7)
3	Children with asthma, AR, and atopic dermatitis (AD)	14 (9.3)
4	Children with food allergy (PA) and AR	3 (2.0)
5	Children with manifestations of blood pressure	12 (8.0)
Control group	Healthy children aged 5–18 years, without DRS, no special pathologies, normal physical development (health groups I–II)	30 (–)

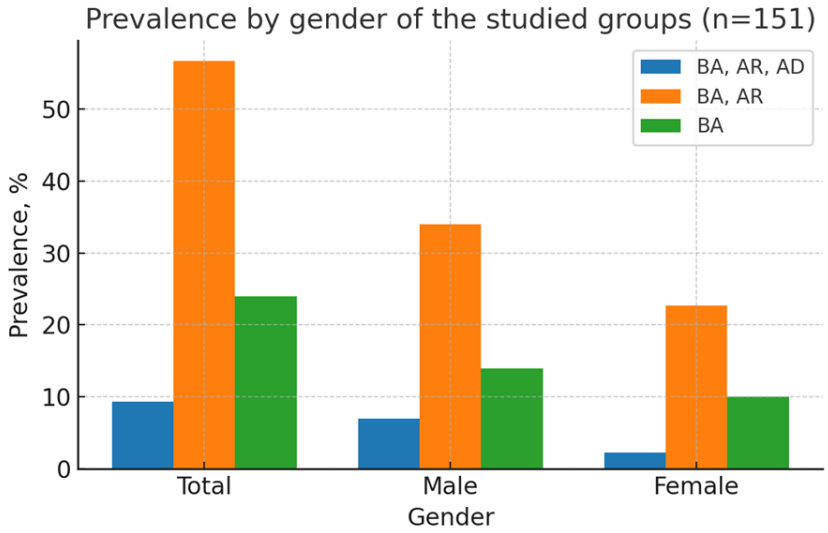

Figure 2. Prevalence by gender of the studied groups (n = 151) Description: The figure illustrates gender distribution in subgroups with bronchial asthma (BA), allergic rhinitis (AR), atopic dermatitis (AD), and food allergy (PA). The highest prevalence was observed in the subgroup with asthma and allergic rhinitis (56.7%), with a predominance in males.

Discussion:

The present study provides a comprehensive assessment of the anthropometric parameters, BMI, vitamin D status, and associated biochemical markers in children aged 5–18 years diagnosed with dermato-respiratory syndromes (DRS), including bronchial asthma (BA), allergic rhinitis (AR), atopic dermatitis (AD), and food allergy (FA). Our findings confirm that children with DRS demonstrate significant deviations in BMI compared to the control group, with both underweight and overweight patterns observed depending on age and sex. These results are consistent with previous reports indicating a complex, bidirectional relationship between nutritional status and the course of allergic and respiratory diseases [1**?**].

In particular, the high BMI values detected in certain age subgroups, alongside underweight in others, suggest that nutritional imbalances may exacerbate respiratory and dermatological conditions. Prior studies have shown that overweight may worsen asthma control through systemic inflammation and altered lung mechanics [3], while undernutrition may impair immune competence, increasing susceptibility to exacerbations [4].

The observed prevalence of anemia (43.7%) aligns with existing literature emphasizing iron deficiency as both a consequence of chronic inflammation and a contributor to disease severity in pediatric allergic pathologies [5]. However, our biochemical analysis did not reveal a significant correlation between liver enzyme levels, bilirubin, total protein, and anthropometric indices, suggesting that vitamin D deficiency may be a more critical determinant of clinical course than hepatic metabolic status.

Vitamin D deficiency or insufficiency was common in the main group and significantly correlated with disease exacerbations, particularly in asthma cases. This finding corroborates prior evidence that low serum 25(OH)D levels may increase airway hyperresponsiveness, promote IgE-mediated responses, and impair epithelial barrier integrity [6,7]. Moreover, our data suggest a non-linear association between vitamin D levels and IgE, consistent with Benson et al. [7], who demonstrated higher IgE concentrations at both extremely low and high vitamin D levels.

The association between low vitamin D and hypocalcemia in our cohort is clinically relevant, given the known interplay between calcium metabolism, bone health, and immune regulation [7]. The average fasting blood glucose levels in hormone-dependent patients remained within normal limits, which may reflect early detection and management strategies in this population.

From a public health perspective, our findings underscore the need for integrated nutritional and lifestyle interventions in children with DRS. These should include vitamin D supplementation, dietary optimization, weight management, and physical activity promotion. Given the variation in vitamin D status by climate and lifestyle, future multicenter studies are warranted to establish region-specific guidelines for supplementation in pediatric allergic diseases.

In conclusion, our results highlight the multifactorial interplay between nutritional status, vitamin D metabolism, and the clinical course of DRS in children. Addressing these modifiable factors could significantly improve disease control and reduce the burden of chronic allergic and respiratory disorders in the pediatric population.

Conclusions

The present study demonstrates that children with dermato-respiratory syndromes exhibit a high prevalence of both underweight and overweight, with significant variability across age and sex groups. Vitamin D deficiency or insufficiency was common in the affected population and showed a clear association with asthma exacerbations and hypocalcemia. The findings highlight the critical role of nutritional status and vitamin D metabolism in the pathogenesis and clinical course of allergic and respiratory diseases in childhood. Early screening, targeted nutritional interventions, and individualized vitamin D supplementation strategies may improve disease outcomes and reduce the risk of complications.

Authors' contribution

Conceptualization, D.K. and D.A.; methodology, D.K.; validation, D.K. and D.A.; formal analysis, D.A.; investigation, D.K. and D.A.; resources, D.A.; data curation, D.K.; writing—original draft preparation, D.K.; writing—review and editing, D.A.; visualization, D.A.; supervision, D.A.; project administration, D.K.; funding acquisition, D.A. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Tashkent Medical Academy (protocol code not assigned, approval date — 2024).

Consent for publication

Informed consent was obtained from all subjects involved in the study and from their parents/legal guardians.

Data Availability Statement

The data supporting the reported results are available on request from the corresponding author. As the study contains personal data of participants, open access to the dataset is restricted to protect confidentiality.

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Conflict of interest

The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Abbreviations

AD	Atopic dermatitis
AZ	Allergic diseases
ATM	Atopic march
An	Anemia
AR	Allergic rhinitis
BA	Bronchial asthma
WHO	World Health Organization
GR	Development schedules
DRS	Dermorespiratory syndrome
GIT	Gastrointestinal tract
ICL	Immunochemiluminescent immunoassay
PA	Food allergy
FIT	Food intolerance
UVR	Ultraviolet irradiation
ALP	Alkaline phosphatase
IgE	Immunoglobulin E
sIgE	Specific immunoglobulins E

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