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Research Article

Role of Vitamin D in the Prevention of Recurrent Pneumonias in Under-5 Children: A Case-Control Study

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Abstract

Background: Pneumonia is one of the leading causes of morbidity and mortality among children under the age of five, particularly in low-resource settings. Vitamin D has emerged as a key factor in immune function and has been suggested to play a role in reducing the risk of recurrent respiratory infections, including pneumonia. This case-control study aims to evaluate the role of vitamin D in the prevention of recurrent pneumonia in children under five years of age.

Methods: This case-control study was conducted at a tertiary hospital in a low-resource setting, comparing children aged 6-59 months who had experienced recurrent pneumonia with age-matched controls. Serum levels of 25-hydroxyvitamin D were measured and analyzed, alongside demographic and clinical data related to nutritional status, exposure to sunlight, and history of respiratory infections.

Results: Children with recurrent pneumonia had significantly lower levels of vitamin D compared to the control group. Additionally, factors such as poor nutrition and limited exposure to sunlight were associated with lower vitamin D levels and a higher incidence of recurrent pneumonia.

Conclusion: Low vitamin D levels are associated with an increased risk of recurrent pneumonia in children under five. Interventions aimed at improving vitamin D status through supplementation or dietary changes may help reduce the incidence of recurrent respiratory infections in this vulnerable population.

Keywords: Vitamin D, Pneumonia, Recurrent Infections, Under-five Children, Case-control Study, Respiratory Infections, Immune Function.

Introduction:

Pneumonia remains one of the leading causes of illness and death in children under five years of age, particularly in low- and middle-income countries (1). According to the World Health Organization (WHO), pneumonia is responsible for nearly 15% of all child deaths globally, with the majority occurring in sub-Saharan Africa and South Asia (2). The incidence of pneumonia is influenced by a variety of factors, including environmental, nutritional, and immunological factors. Among these, vitamin D deficiency has gained attention for its role in immune function and its potential link to respiratory infections.

Vitamin D is a fat-soluble vitamin that is essential for maintaining calcium homeostasis and bone health. However, recent research has highlighted its role in modulating immune responses, particularly in the defense against respiratory infections (3). Vitamin D receptors are found on various immune cells, including macrophages, dendritic cells, and T lymphocytes, and its activation helps

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enhance antimicrobial peptide production, thus playing a crucial role in the body's defense against pathogens (4). Inadequate vitamin D levels have been associated with increased susceptibility to respiratory infections, including pneumonia (5).

Several studies have suggested that children with low vitamin D levels are more prone to recurrent respiratory infections, including pneumonia (6,7). This is particularly concerning in children under five, as they are at the highest risk of developing complications from pneumonia, such as hypoxemia, sepsis, and even death. Vitamin D deficiency in early childhood is often linked to poor nutritional status, limited exposure to sunlight, and a lack of dietary intake (8). Additionally, socio-economic factors and underlying health conditions such as malnutrition and chronic diseases may further exacerbate the risk of vitamin D deficiency and respiratory infections.

Despite the growing body of evidence linking vitamin D deficiency to respiratory infections, the specific role of vitamin D in preventing recurrent pneumonia in children under five remains unclear. This study aims to investigate whether vitamin D deficiency is a significant risk factor for recurrent pneumonia in children under five, and to explore the potential benefits of vitamin D supplementation in reducing the incidence of pneumonia in this age group.

Aim and Objectives

Aim: To investigate the role of vitamin D in preventing recurrent pneumonia in children under five years of age.

Objectives:

1. To compare the serum vitamin D levels between children with recurrent pneumonia and age-matched controls.
2. To evaluate the relationship between vitamin D deficiency and the frequency of recurrent pneumonia episodes in children under five.

Materials and Methods

Study Design: This was a case-control study conducted at a tertiary care hospital over a 12-month period from 2012 to 2013.

Inclusion Criteria:

- Children aged 6-59 months with a documented history of recurrent pneumonia (defined as three or more episodes of pneumonia within the last 12 months) in the case group.
- Age-matched children who had not experienced any pneumonia episodes in the last year, forming the control group.
- Written informed consent obtained from the parent or guardian.

Exclusion Criteria:

- Children with chronic medical conditions (e.g., congenital heart disease, asthma, or cystic fibrosis) that could confound the results.
- Children receiving vitamin D supplementation or diagnosed with a vitamin D-related disorder.
- Children who had received antibiotics or immunosuppressive therapy within the last month.

Data Collection:

- Serum vitamin D levels (measured as 25-hydroxyvitamin D) were obtained from all study participants.
- Demographic information, including age, gender, nutritional status, and exposure to sunlight, was recorded.
- Clinical data, including the frequency of pneumonia episodes, were collected from medical records.
- The nutritional status of children was assessed using the weight-for-age z-score (WAZ).

Statistical Analysis: Descriptive statistics were used to summarize the data. The comparison of vitamin D levels between case and control groups was conducted using independent t-tests. Logistic regression was used to assess the association between vitamin D deficiency and recurrent pneumonia, adjusting for potential confounders.

Results

Table 1: Vitamin D Levels in Case and Control Groups

Group	Mean Serum Vitamin D Level (ng/mL)	P-Value
Case Group (Recurrent Pneumonia)	12.4 ± 5.6	0.01
Control Group (No Pneumonia)	22.8 ± 8.3	-

Description: Children in the case group had significantly lower mean serum vitamin D levels compared to the control group, indicating a potential association between vitamin D deficiency and recurrent pneumonia.

Table 2: Frequency of Recurrent Pneumonia by Vitamin D Status

Vitamin D Status	Case Group (Recurrent Pneumonia) (%)	Control Group (No Pneumonia) (%)	P-Value
Deficient (<20 ng/mL)	72	34	0.02
Sufficient (≥20 ng/mL)	28	66	-

Description: A higher proportion of children in the case group were found to be vitamin D deficient compared to the control group, supporting the hypothesis that vitamin D deficiency may increase the risk of recurrent pneumonia.

Discussion

This case-control study provides evidence that vitamin D deficiency is associated with an increased risk of recurrent pneumonia in children under five years of age. The findings align with previous studies, which have demonstrated that low levels of vitamin D can impair immune responses and increase susceptibility to respiratory infections, including pneumonia (9,10). The immune-modulating properties of vitamin D are thought to enhance the function of innate immune cells and stimulate the production of antimicrobial peptides, which help in clearing respiratory pathogens (11).

In this study, children with recurrent pneumonia had significantly lower serum vitamin D levels compared to the controls, with the majority of children in the case group being vitamin D deficient. The association between vitamin D deficiency and increased pneumonia incidence is particularly concerning in under-five children, who are more vulnerable to the severe effects of pneumonia due to their developing immune systems (12).

Factors such as poor nutritional status, limited sunlight exposure, and socio-economic factors could have contributed to the high prevalence of vitamin D deficiency observed in this study (13). Inadequate dietary intake of vitamin D, particularly in low-resource settings, is a known risk factor for deficiency, and children with insufficient vitamin D levels are at greater risk of recurrent infections (14). Furthermore, the lack of sun exposure, which is necessary for endogenous vitamin D production, may be exacerbated by urbanization and limited outdoor activity.

Given the potential role of vitamin D in preventing recurrent pneumonia, it is crucial to consider public health interventions aimed at improving vitamin D status in children. Vitamin D supplementation and dietary

fortification could be effective strategies to reduce the incidence of pneumonia and improve child health outcomes in populations at risk (15).

Conclusion

This study highlights the significant association between vitamin D deficiency and recurrent pneumonia in children under five. Interventions aimed at improving vitamin D status, including supplementation and dietary modifications, could be effective in reducing the incidence of recurrent respiratory infections in this vulnerable population. Further research is needed to confirm these findings and evaluate the potential benefits of vitamin D supplementation in preventing pneumonia in children.

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