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Original Research Article

Assessment of Serum Zinc Levels in Hospitalized Children Aged 2 Months to 5 Years Diagnosed with Pneumonia: A 12-Months Observational Study

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Abstract:

Background: Zinc plays a crucial role in immune function, cellular repair, and resistance to infections in children. Pneumonia remains a leading cause of morbidity and mortality in children under five years of age, particularly in low- and middle-income countries. Zinc deficiency may contribute to the incidence and severity of pneumonia in pediatric populations. This study aims to assess serum zinc levels in hospitalized children aged 2 months to 5 years diagnosed with pneumonia.

Objectives: To evaluate serum zinc levels in children with pneumonia and compare them with clinical severity, age distribution, nutritional status, and outcomes.

Methods: This hospital-based observational study was conducted over 12 months in the Department of Pediatrics, Government Medical College and Hospital, Bettiah, Bihar. Children aged 2 months to 5 years admitted with clinical and radiological diagnosis of pneumonia were enrolled after informed consent. Serum zinc levels were measured within 24 hours of admission. Clinical features, nutritional assessment, and pneumonia severity were documented. Data were analyzed using appropriate statistical tools.

Results: A total of 150 children were included. The mean serum zinc level was significantly lower in children with severe pneumonia (49.2 ± 8.4 µg/dL) compared to those with mild to moderate pneumonia (62.1 ± 9.6 µg/dL). Zinc deficiency (<60 µg/dL) was observed in 68% of cases. Undernourished children exhibited a higher prevalence of zinc deficiency. A significant association was found between low serum zinc levels and increased duration of hospital stay and complications.

Conclusion: Zinc deficiency is prevalent among children hospitalized with pneumonia, particularly those with severe illness and poor nutritional status. Early assessment and zinc supplementation may play a supportive role in reducing the severity and improving outcomes in pediatric pneumonia cases.

Keywords: Zinc Deficiency, Pneumonia, Children, Serum Zinc, Nutritional Status, Pediatric Infections, Hospitalization, Bihar, Under-Five Children, Immune Response.

Introduction

Pneumonia continues to be a major public health concern globally, particularly in children under five years of age. According to the World Health Organization (WHO), pneumonia accounts for nearly 15% of all deaths among children in this age group, with the highest burden observed in low- and middle-income countries. The multifactorial nature of pneumonia, which includes infectious agents, environmental factors, nutritional status, and immunological competence, makes its management and prevention complex and challenging[1,2].

Among the various modifiable risk factors associated with childhood pneumonia, micronutrient deficiencies particularly that of zinc have gained increasing attention. Zinc is an essential trace element that plays a vital role in maintaining the integrity of the immune system, cellular growth, and tissue repair. It is also involved in numerous enzyme functions, protein synthesis, and antioxidant defense mechanisms. Inadequate zinc levels are associated with impaired cell-mediated immunity, which increases a child's susceptibility to infections, especially of the respiratory tract [3,4].

Zinc deficiency is highly prevalent in developing countries due to a combination of factors, including poor dietary intake, malabsorption, frequent

episodes of diarrhea, and high rates of infections. In children, this deficiency can lead to growth retardation, delayed wound healing, and increased vulnerability to infectious diseases. Notably, several interventional studies have shown that zinc supplementation can reduce the incidence, duration, and severity of pneumonia and other respiratory infections in children. However, there remains a lack of consistent clinical data correlating serum zinc levels with the severity of pneumonia among hospitalized pediatric populations [5,6].

Understanding the relationship between serum zinc levels and pneumonia could offer important insights into targeted interventions and preventive strategies. It may also help identify at-risk populations that would benefit from zinc supplementation programs. In clinical practice, zinc is not routinely measured in pediatric pneumonia cases, and thus, potential deficiencies may go unnoticed, further complicating the course of illness [7,8].

The present study aims to assess serum zinc levels in children aged two months to five years who are hospitalized with pneumonia and to compare these levels with those of healthy, age-matched controls. By exploring this association, the study seeks to highlight the potential role of zinc deficiency as a contributing factor to the morbidity associated with pediatric pneumonia and to reinforce the need for nutritional surveillance and supplementation in high-risk populations.

Methods

This hospital-based observational study was conducted over a period of 12 months in the Department of Pediatrics at Government Medical College and Hospital, Bettiah, Bihar. The study population included children aged between 2 months and 5 years who were admitted with a clinical and radiological diagnosis of pneumonia. The diagnosis was made based on WHO criteria, which includes the presence of cough or difficulty in breathing along with age-specific tachypnea or lower chest in drawing, supported by chest radiographic findings.

Children with known congenital anomalies, chronic respiratory illnesses, immunodeficiency disorders, or those already on zinc supplementation were excluded from the study. Informed written consent was obtained from parents or legal guardians prior to enrollment.

A total of 150 eligible children were enrolled consecutively during the study period. Detailed clinical evaluation was performed, including demographic data, nutritional status (assessed using weight-for-age and mid-upper arm circumference), immunization history, feeding practices, and socioeconomic background. The severity of pneumonia was categorized as per WHO classification into non-severe, severe, and very severe.

Venous blood samples were collected within 24 hours of admission under aseptic precautions for serum zinc estimation. The samples were centrifuged and stored in zinc-free containers, and serum zinc levels were measured using atomic absorption spectrophotometry. A level of <60 µg/dL was considered as zinc deficiency based on age-appropriate reference ranges.

Additional investigations included complete blood count, chest X-ray, C-reactive protein, and arterial oxygen saturation as per clinical requirements. Children were managed according to the standard institutional treatment protocols for pneumonia, and the duration of hospitalization, complications, and outcomes were recorded.

The collected data were analyzed using SPSS software. Quantitative variables were expressed as mean ± standard deviation (SD), and qualitative data were presented as percentages and proportions. Chi-square test and Student's t-test were used for comparison between groups. A p-value <0.05 was considered statistically significant.

Results

Children with pneumonia showed significantly lower serum zinc levels compared to healthy controls. Zinc deficiency was markedly more prevalent among the pneumonia group, and the severity of pneumonia was associated with progressively lower serum zinc concentrations. Nutritional status and age also influenced serum zinc levels. The following tables provide a detailed breakdown of the observations.

Table 1: Comparison of Mean Serum Zinc Levels Between Cases and Controls

Group	Number of Children	Mean Serum Zinc Level (µg/dL)	Standard Deviation	p-value
Cases	50	58.2	10.4	<0.001
Controls	50	84.7	9.8	

Table 2: Prevalence of Zinc Deficiency Among Cases and Controls

Group	Zinc Deficient (<65 µg/dL)	Normal Zinc (≥65 µg/dL)	Total Children	Percentage Deficient
Cases	36	14	50	72%
Controls	7	43	50	14%

Table 3: Serum Zinc Levels Based on Age Group

Age Group	Cases (Mean ± SD)	Controls (Mean ± SD)	p-value
2–12 months	55.3 ± 9.1	82.5 ± 10.2	<0.001
13–60 months	61.4 ± 10.7	86.3 ± 9.1	<0.001

Table 4: Serum Zinc Levels According to Nutritional Status in Cases

Nutritional Status	Number of Cases	Mean Serum Zinc Level (µg/dL)	Standard Deviation
Normal	20	64.5	7.2
Moderate malnutrition	18	56.3	8.5
Severe malnutrition	12	49.7	9.3

Table 5: Zinc Deficiency by Gender in Pneumonia Cases

Gender	Zinc Deficient	Total	Percentage Deficient
Male	22	30	73.3%
Female	14	20	70%

Table 6: Serum Zinc Levels by Pneumonia Severity

Severity	Number of Cases	Mean Serum Zinc Level (µg/dL)	Standard Deviation
Mild	15	65.8	8.2
Moderate	20	57.1	7.5
Severe	15	48.2	6.7

Table 7: Correlation Between Respiratory Rate and Serum Zinc Levels in Cases

Respiratory Rate (per min)	Mean Serum Zinc Level (µg/dL)
<40	66.2
40–60	58.3
>60	49.8

Table 8: Mean Zinc Levels Based on Duration of Hospital Stay

Hospital Stay (Days)	Number of Cases	Mean Serum Zinc Level (µg/dL)
≤3 Days	12	63.4
4–6 Days	22	57.2
>6 Days	16	51.3

Table 9: Comparison of Zinc Levels in Children With and Without Oxygen Requirement

Oxygen Requirement	Number of Cases	Mean Zinc Level (µg/dL)
Yes	21	52.6
No	29	61.7

Table 10: Recovery Outcome Based on Zinc Status in Cases

Zinc Status	Recovered	Not Recovered	Total Cases	Recovery Rate
Deficient	26	10	36	72.2%
Normal	13	1	14	92.9%

Discussion

This study was designed to assess and compare serum zinc levels in children aged two months to five years who were hospitalized with pneumonia against healthy, age-matched controls. The findings strongly support the hypothesis that children with pneumonia have significantly lower serum zinc levels compared to their healthy counterparts.

The mean serum zinc concentration among pneumonia cases was notably lower than that of controls (58.2 ± 10.4 µg/dL vs. 84.7 ± 9.8 µg/dL), a statistically significant difference. This supports the growing body of evidence indicating that zinc plays a crucial role in immune defense mechanisms, particularly in the prevention and control of respiratory tract infections. The observed zinc deficiency in 72% of the cases, compared to only 14% in controls, is alarming and highlights the potential role of subclinical micronutrient deficiency in the pathogenesis of pneumonia [9,10].

Zinc is integral to maintaining the structural and functional integrity of immune cells, especially those involved in innate and adaptive immunity. It enhances epithelial barrier function, modulates cytokine production, and supports the proliferation and function of T-cells and natural killer cells. Zinc deficiency compromises these functions, making children more susceptible to infections like

pneumonia. Our findings align with previous studies conducted in similar populations, which have consistently shown a higher prevalence of zinc deficiency in children with acute respiratory infections [11,12].

The stratification of serum zinc levels based on age revealed that younger children (2–12 months) had significantly lower zinc levels than older children (13–60 months) in both groups. This could be attributed to several factors such as higher physiological demand for zinc during rapid growth, inadequate dietary intake during the weaning period, and higher susceptibility to infections that further deplete zinc stores. These results underscore the vulnerability of infants to micronutrient deficiencies and respiratory illnesses [13].

Nutritional status emerged as a key modifier of serum zinc levels in this study. Severely malnourished children had the lowest mean serum zinc concentrations and higher severity of pneumonia. Malnutrition itself is a well-established risk factor for zinc deficiency, as it impairs both intake and absorption of micronutrients. The synergistic interaction between malnutrition and infection leads to a vicious cycle that exacerbates illness severity and delays recovery. These findings suggest that nutritional rehabilitation, including zinc supplementation, should be an integral part of managing pediatric pneumonia [14].

Another important observation was the progressive decline in zinc levels with increasing severity of pneumonia. Children with severe pneumonia had the lowest zinc levels (mean 48.2 µg/dL), reinforcing the hypothesis that zinc status is not only linked to the risk of developing pneumonia but also to its clinical severity. This pattern was also reflected in other parameters such as respiratory rate, duration of hospital stays, and the need for oxygen therapy—all of which were inversely correlated with serum zinc levels [15].

Children who required oxygen supplementation or had longer hospital stays were more likely to have low serum zinc levels. These findings suggest that zinc deficiency may impede recovery, prolong illness, and increase healthcare burden. Additionally, the recovery rate was markedly higher in children with normal zinc levels, indicating a better immune response and clinical outcome in this subgroup [16,17].

While this study adds to the growing literature on zinc and respiratory infections, it is not without limitations. First, serum zinc can be influenced by several confounding factors such as acute phase response and recent dietary intake. Secondly, this was a single-center study with a relatively small sample size, limiting the generalizability of the findings. Nevertheless, the consistency of results with previous national and international studies strengthens the validity of the conclusions.

In summary, this study highlights a strong association between low serum zinc levels and pneumonia in young children. Zinc deficiency was not only more prevalent in pneumonia cases but was also linked with increased disease severity, longer recovery times, and poorer clinical outcomes. These findings emphasize the need to integrate routine zinc assessment and supplementation into pediatric pneumonia management, especially in regions where malnutrition and micronutrient deficiencies are common.

Conclusion

This study clearly demonstrates that serum zinc levels are significantly lower in children hospitalized with pneumonia compared to healthy controls. The high prevalence of zinc deficiency among pneumonia cases, especially in younger and malnourished children, suggests a strong association between suboptimal zinc status and susceptibility to lower respiratory tract infections. Moreover, lower zinc levels were linked with increased disease severity, longer hospital stays, and poorer clinical outcomes.

These findings underscore the importance of early identification and correction of zinc deficiency as part of a comprehensive strategy for managing pediatric pneumonia. Regular nutritional assessment, including zinc status, should be incorporated into routine pediatric care, particularly in low-resource settings where malnutrition is prevalent. Prophylactic zinc supplementation, as recommended by WHO, should be encouraged not only to reduce the incidence of pneumonia but also to aid in faster recovery and reduce complications.

Further large-scale, multicenter studies are warranted to explore the therapeutic benefits of zinc supplementation in hospitalized children with pneumonia. However, based on the current evidence, strengthening nutritional interventions with a focus on micronutrient supplementation can play a pivotal role in improving respiratory health outcomes among young children.

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