

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

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Abstract:

Background: Pneumonia remains one of the leading causes of morbidity and mortality in children under five years of age, especially in developing countries. Zinc, an essential micronutrient, plays a crucial role in maintaining immune function. Deficiency of zinc has been associated with increased susceptibility to respiratory tract infections, including pneumonia. This study was conducted to assess serum zinc levels in children aged 2 months to 5 years hospitalized with pneumonia.

Methods: This prospective observational study was carried out in the Department of Paediatrics, Nalanda Medical College and Hospital, Patna, Bihar, over a period of 12 months from July 2018 to June 2019. A total of 100 children aged between 2 months and 5 years, admitted with clinically and radiologically confirmed pneumonia, were enrolled. Serum zinc levels were estimated within 24 hours of admission using atomic absorption spectrophotometry. Children were categorized based on their zinc levels into normal and deficient groups, and correlations were made with the severity of pneumonia and clinical outcomes.

Results: Out of the 100 children included, 64% were found to have low serum zinc levels ($<70 \mu\text{g/dL}$). A significant association was found between low zinc levels and increased severity of pneumonia. Children with zinc deficiency had a higher incidence of complications, longer hospital stays, and delayed recovery. The majority of zinc-deficient children were below the age of two and belonged to lower socioeconomic groups.

Conclusion: Serum zinc deficiency is highly prevalent among children with pneumonia and is associated with increased disease severity and prolonged recovery. Routine screening for zinc levels and consideration of zinc supplementation may be beneficial in the management and prevention of pneumonia in young children.

Keywords: Pneumonia, Zinc deficiency, Serum zinc, Children under five, Micronutrient, Respiratory infection, Hospitalized children

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Introduction

Pneumonia is a major public health concern and remains a leading cause of morbidity and mortality in children under the age of five, particularly in developing nations like India. According to the World Health Organization (WHO), pneumonia accounts for approximately 15% of all deaths of children under 5 years of age, claiming the lives of more than 800,000 children globally each year. In India alone, pneumonia continues to significantly burden pediatric healthcare facilities despite advancements in vaccination and antibiotic therapy [1,2].

Zinc, an essential trace element, plays a pivotal role in various physiological processes, including cellular growth, immune response, enzyme function, and antioxidant defense mechanisms. The role of zinc in modulating the immune system has garnered

particular interest in recent years. Zinc deficiency is known to impair macrophage and neutrophil function, reduce antibody production, and affect cytokine expression, all of which contribute to a diminished ability to combat infections, especially those involving the respiratory tract[3,4].

Numerous studies have demonstrated a strong correlation between zinc deficiency and increased susceptibility to infectious diseases, particularly acute lower respiratory tract infections (ALRIs) such as pneumonia [5]. In low-resource settings, where malnutrition and micronutrient deficiencies are prevalent, the risk of pneumonia is significantly heightened. The WHO and UNICEF recommend zinc supplementation for children with diarrhea and have also explored its role in reducing pneumonia incidence and severity [6].

Despite growing awareness, routine evaluation of serum zinc levels is not commonly practiced in clinical settings managing pneumonia. This study aims to fill that gap by assessing serum zinc levels in children aged 2 months to 5 years admitted with pneumonia and evaluating the association between zinc deficiency and disease severity. By identifying the prevalence and clinical impact of low serum zinc in this population, the study seeks to emphasize the importance of considering zinc status in the routine evaluation and management of pediatric pneumonia.

Methods

This prospective observational study was conducted in the Department of Paediatrics at Nalanda Medical College and Hospital, Patna, Bihar, over a 12-month period from July 2018 to June 2019. The study enrolled 100 children aged between 2 months and 5 years who were admitted with clinically and radiologically confirmed pneumonia. A detailed history was taken from parents or guardians, and relevant clinical data, including signs, symptoms, and physical findings, were recorded at the time of admission.

Children with known congenital anomalies, chronic respiratory or cardiac diseases, immunodeficiency disorders, severe malnutrition, recent zinc supplementation (within the last 3 months), or systemic infections other than pneumonia were excluded from the study to avoid confounding effects.

Serum samples for zinc estimation were collected within 24 hours of admission using sterile, trace element-free vacutainers. The samples were centrifuged, and the serum was separated and analyzed for zinc concentration using atomic

absorption spectrophotometry. A serum zinc level of less than 70 µg/dL was considered as zinc deficiency.

The severity of pneumonia was categorized according to the WHO classification into non-severe, severe, and very severe pneumonia based on clinical features such as respiratory rate, chest in drawing, hypoxia, feeding difficulties, convulsions, and level of consciousness. Nutritional status was evaluated using anthropometric measurements, and socioeconomic status was recorded using a standardized questionnaire.

The data collected were compiled and statistically analyzed to determine the prevalence of zinc deficiency and its correlation with pneumonia severity, complications, duration of hospitalization, and recovery outcomes. The goal was to assess the significance of serum zinc levels in pediatric pneumonia and their possible role as a prognostic indicator.

Results

A total of 100 children aged 2 months to 5 years with clinically and radiologically diagnosed pneumonia were enrolled. Out of these, 64% were found to have serum zinc levels below 70 µg/dL. The mean serum zinc level among all participants was 67.8 µg/dL. Zinc deficiency was significantly associated with greater severity of pneumonia, prolonged hospital stays, and higher incidence of complications. Children under 2 years of age and those belonging to lower socioeconomic groups were more likely to be zinc deficient.

Table 1: Distribution of Children Based on Age Groups

Age Group	Number of Children	Percentage (%)
2–6 months	20	20%
7–12 months	24	24%
13–24 months	28	28%
25–60 months	28	28%

Table 2: Gender Distribution of Study Participants

Gender	Number of Children	Percentage (%)
Male	58	58%
Female	42	42%

Table 3. Nutritional Status of Children Based on WHO Criteria.

Nutritional Status	Number of Children	Percentage (%)
Normal	38	38%
Mild malnutrition	36	36%
Moderate	18	18%
Severe	8	8%

Table 4: Serum Zinc Levels Among Participants

Serum Zinc Level (µg/dL)	Number of Children	Percentage (%)
< 70 (Deficient)	64	64%
≥ 70 (Normal)	36	36%

Table 5: Correlation Between Serum Zinc and Age Group

Age Group	Zinc Deficient (n)	Total (n)	Percentage Deficient (%)
2–6 months	16	20	80%
7–12 months	18	24	75%
13–24 months	18	28	64.3%
25–60 months	12	28	42.9%

Table 6: Association Between Zinc Level and Severity of Pneumonia.

Severity of Pneumonia	Zinc Deficient	Normal Zinc	Total
Non-severe	10	18	28
Severe	28	12	40
Very severe	26	6	32

Table 7: Duration of Hospital Stay in Relation to Zinc Status

Zinc Status	Mean Duration of Stay (days)	Standard Deviation
Deficient	6.4	±1.2
Normal	4.3	±0.9

Table 8: Frequency of Complications by Zinc Status

Complications Present	Zinc Deficient (n)	Normal Zinc (n)	Total (n)
Yes	22	4	26
No	42	32	74

Table 9: Socioeconomic Status and Zinc Deficiency

Socioeconomic Class	Zinc Deficient (n)	Total (n)	Percentage Deficient (%)
Lower	40	50	80%
Middle	18	36	50%
Upper	6	14	42.9%

Table 10: Immunization Status and Zinc Deficiency

Immunization Status	Zinc Deficient (n)	Total (n)	Percentage Deficient (%)
Complete	42	72	58.3%
Incomplete	22	28	78.6%

Discussion

Pneumonia remains a major cause of morbidity and mortality among children under five years of age, especially in low- and middle-income countries like India. The role of micronutrients, particularly zinc, in modulating immune function and improving disease outcomes has been widely researched in recent years[7]. This study aimed to assess serum zinc levels in hospitalized children with pneumonia and explore its correlation with disease severity, clinical outcomes, and demographic factors.

In the present study, 64% of the enrolled children were found to have serum zinc levels below the normal threshold of 70 µg/dL, highlighting a high prevalence of zinc deficiency in this population. The mean serum zinc level among all participants was 67.8 µg/dL, which is lower than the optimal level required for immune competence and recovery from infections.

A strong correlation was observed between serum zinc deficiency and increased severity of pneumonia. Among children with very severe pneumonia, 81.2% were zinc deficient, compared to only 35.7% in the non-severe group. This supports the hypothesis that zinc deficiency compromises host immunity and increases susceptibility to more

severe infections. These findings are consistent with previous studies that reported a link between low zinc levels and poor clinical outcomes in respiratory tract infections [8,9].

The age-wise distribution showed that younger children, particularly those below 12 months of age, were more likely to be zinc deficient. This may be attributed to insufficient dietary intake, inadequate complementary feeding practices, and higher physiological demands during rapid growth phases. The prevalence of zinc deficiency decreased with increasing age, suggesting that dietary diversification and better feeding practices in older children may contribute to improved zinc status [10,11].

Socioeconomic status also played a significant role, with 80% of zinc-deficient children belonging to lower socioeconomic strata. This reflects the impact of poverty on nutritional health, as families with limited resources often struggle to provide balanced diets rich in essential micronutrients. Similarly, children with incomplete immunization status had higher rates of zinc deficiency, possibly indicating overall neglect of preventive healthcare and nutritional awareness in these groups [12,13].

The average duration of hospital stay was significantly longer in zinc-deficient children (6.4 days) compared to those with normal zinc levels (4.3 days). Moreover, complications such as prolonged fever, respiratory distress, and secondary bacterial infections were more frequently observed in zinc-deficient patients. These findings reaffirm the potential of zinc as a prognostic marker and as an adjunct in the management of pediatric pneumonia [14,15].

Our results are in line with global and national studies that emphasize the immunomodulatory, antioxidant, and anti-inflammatory properties of zinc. Its supplementation has been shown to reduce the duration and severity of pneumonia and lower the risk of recurrence. WHO and UNICEF recommend zinc supplementation as part of the treatment protocol for acute respiratory infections in children, particularly in resource-limited settings [16,17].

Limitations of the study include a relatively small sample size and the absence of a control group comprising healthy children. Additionally, this was a single-center study, which may limit the generalizability of the findings. Future studies with larger, multicentric samples and long-term follow-up are needed to further validate the role of zinc in respiratory infections.

Despite these limitations, the study provides valuable insights into the widespread burden of zinc deficiency among children with pneumonia and underscores the importance of early identification and management of micronutrient deficiencies in improving pediatric health outcomes.

Conclusion

Zinc deficiency was found to be highly prevalent among hospitalized children with pneumonia in the studied population. A significant association was observed between low serum zinc levels and increased severity of pneumonia, prolonged duration of hospital stays, and higher incidence of complications. Younger age groups, children from lower socioeconomic backgrounds, and those with incomplete immunization were more prone to zinc deficiency.

These findings highlight the critical role of zinc in immune function and recovery from respiratory infections. Early identification of zinc deficiency and timely intervention through dietary counseling or supplementation can improve clinical outcomes in pediatric pneumonia. The study supports the inclusion of zinc assessment and supplementation as a component of routine management in children with pneumonia, especially in high-risk populations.

Further large-scale, multicenter studies are warranted to validate these findings and explore the long-term benefits of zinc supplementation in

reducing pneumonia-related morbidity and mortality among children.

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