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Original Research Article

A Hospital Based Case Control Study to Estimate Zinc Levels in Children with Acute Lower Respiratory Tract Infections

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Conflict of interest: Nil

Abstract

Background: The importance of zinc in treating illnesses in children, such as acute lower respiratory tract infections (ALRTIs), has been demonstrated, which has increased interest among researchers. Thus, the aim of this study was to measure serum zinc levels in ALRTI patients and correlate those levels with the disease's clinical progression.

Methods: In the hospital-based case-control study, 61 patients aged 2 months to 5 years had ALRTI along with 61 control subjects who were matched for age and diet. When a patient was admitted, their serum zinc level was measured. Details of the clinical course, including the duration of stay, oxygen requirement, severity of illness, and outcome, were recorded together with a thorough history, sociodemographic information, and examination.

Results: The difference between the mean serum zinc levels of patients and controls (patients 58.88±12.40 µg/dl, Controls 85.36±16.27 µg/dl) was determined to be statistically significant (p value = 0.0001). Zinc levels and length of stay had a negative connection (r = -0.052, p value = 0.691). When compared to cases of pneumonia (WHO IMNCI grading), cases of severe pneumonia had considerably lower mean serum zinc levels (p value = 0.0001). As compared to the patients who were released, those who required higher O_2 concentrations and those who died had considerably lower mean serum zinc levels (p value = 0.0001) and respectively.

Conclusion: Lower serum zinc levels are significantly associated with ALRTI and the lower the serum zinc levels; the more is the severity of disease and duration of stay in hospital for the patient, along with increased oxygen requirement and also increased incidence of mortality.

Keywords: Serum zinc estimation, acute lower respiratory tract infection, Children, Pneumonia.

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Introduction

Globally, the leading cause of sickness and death for children under five is acute lower respiratory tract infections, or ALRTIs. About 19% of these children's fatalities are believed to be caused by ALRTI (19 million deaths per year). Two thirds of these deaths happen in infancy, and over 90% of them take place in developing countries. ALRTI is treated with oxygen, intravenous antibiotics, or (in severe cases) assisted ventilation.

The rise in antibiotic resistance, limited access to healthcare facilities, and the difficulty to extensively disseminate vaccines against Streptococcus pneumoniae and Haemophilus influenzae in most underdeveloped countries are the primary barriers to reducing the fatality rate from ALRTI.[1,2]According to a recent meta-analysis of randomised controlled trials (RCTs), habitual oral zinc supplementation given daily or weekly for at least three months significantly reduced the occurrence of lower respiratory tract infections (LRTIs) among children under five in developing nations. With varying degrees of success, several studies have evaluated the usefulness of short-term zinc use in addition to supportive care and antibiotics for the treatment of juvenile pneumonia.

Further confusing the situation regarding zinc's involvement in treating pneumonia in young children is the fact that certain textbooks have begun to discuss the advantages of zinc in the treatment of pneumonia. [3,4]In order to determine if short-term zinc supplementation during an acute pneumonia episode has any bearing on the treatment of children under the age of five who are hospitalized with severe ALRTI, the current meta-analysis was designed. Seminal fluid contains a higher proportion of zinc. Iron is a vital constituent of numerous enzymes, including as superoxide dismutase, carbonic anhydrase, alkaline phosphatase, DNA and RNA polymerase, and reverse transcriptase. It fulfills various physiological functions. Both cell division and DNA replication are dependent on it. Preserving cell integrity and immunity is crucial in cells that have a high turnover rate. Therefore, it is crucial for maintaining infection control and preventing the spread of illnesses. [5,6]

The body does not store zinc, despite its numerous use. Zinc is a vital nutrient that cannot be stored in the body like iron. Therefore, it must be ingested regularly to maintain adequate levels. Foods such as nuts, cereals, seafood, dairy, red meat, and other animal proteins contain zinc. Due to the presence of phytate, a compound that forms complexes with zinc and inhibits its absorption, the majority of vegetables are not considered to be substantial sources of zinc. Extensive research has confirmed the importance of zinc in treating diarrhoea. Numerous studies have demonstrated that zinc supplementation can effectively decrease the severity, duration, and frequency of diarrhoea. Therefore, it is advisable to take zinc supplements when experiencing diarrhea.[7-10]

Several studies have established a correlation between zinc deficiency and a higher risk of acute lower respiratory tract infections. Additionally, the administration of zinc supplements has been proven to reduce the frequency of these illnesses. Trials showed a decrease in the occurrence of acute lower respiratory tract infections when individuals with pneumonia were given zinc supplementation. Furthermore, the inclusion of zinc in antibiotic treatment has not demonstrated any therapeutic benefit in clinical trials. This inquiry focuses on the serum levels of zinc in patients with acute lower respiratory tract infections. This is linked to the severity of acute lower respiratory tract infection, the need for intravenous antibiotics, and the pattern of recovery. [11-13]

Material and Methods

From February 2025 to October 2025, a hospital-based case-control study was carried out in the pediatric department of the Jawaharlal Nehru Medical College and Hospital Bhagalpur, Bihar.

The study enrolled participants after obtaining informed permission. Children between the ages of two months and five years who were hospitalized for an acute lower respiratory tract infection in the OPD or who were casualties throughout the study period were identified as cases. Acute gastroenteritis or diarrhea, a clinical diagnosis of asthma or reactive airway disease, underlying chronic illnesses, congenital heart disease, or beginning zinc supplementation within one month of study enrollment were all grounds for exclusion from the study for children.

OPD or casualty patients admitted for reasons other than the inclusion and exclusion criteria were included as controls, along with age, sex, and nutritional matching.

The ages of the samples and the controls coincided within six months. The statistical calculation for this two-sided study yielded a sample size of 61 with an 80% power and an alpha error of 0.5%. There were 61 cases and 61 controls total in the research.

The complete demographic information, history, clinical findings, laboratory results, and details about the clinical progression of the study's cases and controls were entered into a predesigned and validated proforma. The socioeconomic status (SES) was ascertained using the 2025 Modified Kuppuswamy scale.[14]

Specific a clinical diagnosis was made and entered into the proforma after the patients underwent a general examination, systemic, respiratory, and other exams. The specifics of the imaging and blood tests performed for clinical diagnostic confirmation were also documented during the patient's hospital stay. The serum zinc estimation was done by using colorimetric test to used kit.

Serum was the sample that was used, and it was created by centrifuging two milliliters of blood samples at 3000 rpm for three to five minutes. On the first day of the patients' and controls' admission, a blood sample was obtained. Two ependoff tubes were filled with 1000 µl of reagent each, 50 µl of serum in one tube, and standard solution in the other. The tubes were then incubated at 370C for five minutes. The concentration of total zinc in the sample was calculated using a spectrophotometer by comparing the absorbance of the standard A (Standard) and sample A (Sample) against the reagent blank A (Blank).

The clinical information of the cases, such as the duration of stay, oxygen requirements, severity of disease as assessed by the WHO IMNCI grading system for 2023, and case outcomes, were documented in addition to the serum zinc levels.

Using the data acquired from the cases and controls, a Microsoft Excel case sheet was made and completed. The statistical analysis used both descriptive and inferential statistics, such as

Pearson's correlation coefficient and chi ANOVA. The analysis software used was GraphPad Prism 6.0 and SPSS 24.0, with a significance threshold set at p <0.05.

Results

The mean age of the cases was 1.55±1.29 years, whereas the mean age of the controls was 1.95±1.63 years. Gender-wise, there were 36 (59.02%) male cases and 25 (40.98%) female controls among the cases and controls, compared to 35 (57.38%) male controls and 26 (42.62%) female cases. When compared, the distribution of cases and controls in this study by age, sex, socioeconomic status, and nutritional status was statistically insignificant. After comparison, the mean serum zinc levels in the patients and controls were found to be substantially different [p=0.0001], with the mean value for the cases being 58.88 ± 12.40 µg/dl and the control group's mean value being 85.36 ± 16.27 µg/dl (Table 1). Zinc deficiency was discovered in 33 cases and controls (27.05%), the majority of which (93.93%) were cases (normal range of 60 to 150 µg/dl). [7]

Table 1: Comparison of Zinc level in cases and controls

Group	No.	Mean(µg/dl)	Std. Deviation(µg/dl)	Std. ErrorMean	t-value
Cases	61	58.88	12.40	1.54	10.10 p=0.0001, S
Controls	61	85.36	16.27	2.08	

Serum zinc levels are compared in Table 2 based on the clinical features of the cases.

The WHO IMNCI grading of the cases showed a statistically significant difference in mean serum zinc levels (p value = 0.0001), with cases in the Severe Pneumonia group (Mean = 42.88 ± 5.93 µg/dl) having a significantly lower value than those in the Pneumonia group (Mean = 65.06 ± 7.81 µg/dl).This is also reflected when we see serum zinc levels according to oxygen requirements, with cases managed on room air having mean of 66.03 ± 7.69 µg/dl, cases requiring supplemental oxygen by nasal prongs having mean of 59.63 ± 10.00 µg/dl and cases requiring mechanical ventilation having mean of 41.41 ± 6.93 µg/dl(Table 2).

Zinc concentrations were significantly lower (p value = 0.0001) in cases where the ALRTI and related repercussions finally led to death (n = 9), compared to cases where the patient was released from therapy (n = 52) (Table 2).

Table 2: Zinc level according to clinical characteristics in cases

IMNCI Grading	No. ofcases	Mean (µg/dl)	SD	t-value
Pneumonia	44(72.13%)	65.06	7.81	10.56 p=0.0001, S
Severe Pneumonia	17(27.86%)	42.88	5.93	
Total	61(100%)	58.88	12.40	
O2 Requirement				
Room Air	27(44.26%)	66.03	7.69	35.14 p=0.0001, S
Supplemental Oxygen	22(36.07%)	59.63	10.00	
Mechanical Ventilation	12(19.67%)	41.41	6.93	
Outcome				
Discharge	52(85.25%)	62.13	10.15	39.88 p=0.0001, S
Death	9(14.75%)	40.11	6.09	

It was shown that there was a negative correlation (r = -0.052) between the average serum zinc level and the average duration of stay for cases; however, this correlation was statistically insignificant (p value = 0.691).

Discussion

The average serum zinc levels matched those found in the study by Hussain et al.[15].Studies by Shakur et al. in Bangladesh and Rady et al. in Egypt revealed that patients' mean serum zinc levels were higher. This variation in mean zinc values can be attributed to national dietary patterns and the overall nutritional condition of study participants.[16,17] The differences in serum zinc levels between the patients and controls in this study and the ones mentioned above are statistically significant (p value = 0.0001). Studies by Arica et al. in Greece and Kumar et al. in India also produced results that were similar.[18,19] These findings could be explained by the fact that interleukins and the tumor cute phase reaction reduce serum zinc levels in response to an inflammatory stimuli.[18]Severe pneumonia cases had a substantially lower value in terms of illness severity than pneumonia patients, according to WHO IMNCI grading 2023; similar results were reported in research by Rady et al., Hussain et al., and Brooks et al.[15][17][20] This could be as a result of zinc's immunomodulatory role being lacking, which raises the risk of airway damage and causes an uncontrollable immune response in the respiratory tract.[20] On the other hand, research by Valentiner-Branth et al. and Bose et al. showed the opposite.[21,22] According to the aforementioned research, increased damage to the respiratory epithelium due to the heightened immune response caused by zinc deficiency will exacerbate symptoms by causing the host to mount a stronger defense against infection. [22]

When it came to the duration of stay for patients, Basnet et al. found that those who took zinc supplements had shorter stays than those who took a placebo,[26] but the difference was not statistically significant. However, Brooks et al., Singh et al., and Malik et al. found that patients with ALRTI had a considerably reduced length of stay after taking a zinc supplement. [20,23,24] During this time, Bose et al., Valentiner - Branth et al., and Yuan et al. found that increasing a patient's zinc intake either had no effect or caused the patient to stay in the hospital longer.[21][22][25]

A comparable pattern is also seen when determining the patients' oxygen requirements during therapy. The results of our investigation are corroborated by studies conducted by Rady et al., Brooks et al., and Valentiner-Branth et al., while Bose et al. and Valentiner-Branth et al. have not observed a discernible drop in oxygen consumption.[17,20,21,22]

Comparing the case outcomes based on serum zinc levels, our findings concurred with those of Rady et al., Brooks et al., and Basnet et al.[17][20][26] Furthermore, Mayo-Wilson et al.'s comprehensive systematic research of zinc supplementation demonstrated that giving zinc to kids may reduce their chance of dying from lower respiratory tract infections as well as their overall risk of death.[27]

Conclusion

Zinc levels were considerably lower in ALRTI patients than in age-, sex-, and nutritionally matched controls. This implies that zinc has a significant role in the development and course of ALRTI in children aged two months to five years. Additionally, a zinc shortage results in a more severe form of the sickness, increasing the patient's risk of death, lengthening hospital stays, and requiring more oxygen.

Large-scale, community-based longitudinal investigations are still required because randomized trials on zinc supplementation have yielded contradictory results regarding the therapeutic and prognostic usefulness of zinc. The study's capacity to accurately depict the prevalence of zinc deficiency in the general population was hampered by its small sample size and hospital environment.

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