

Original Research Article

Plasma zinc levels in normal and malnourished children with lower respiratory tract infection from 2 months to 5 years of age

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ABSTRACT

Background: Acute Lower Respiratory Tract Infection (ALRI) is an important cause of morbidity and mortality in the developing world. Pneumonia is a severe form of ALRI that cause over 2 million deaths annually among children younger than 5 years of age. About 19% of all deaths, pneumonia is the leading cause of child mortality. Malnutrition is known to be associated with greater intensity of lower respiratory tract infections, higher the frequency of complications, longer episodes of infections. This study is to assess the plasma zinc levels in normal and malnourished children with LRI aged 2 months to 5 years.

Methods: This is a case control study, which was carried out in the Department of Paediatrics, Sree Balaji Medical College and Hospital, the study period is one year from July 2016 to July 2017. 100 children between 2 months to 5 years of age with LRI was included in the study and children less than 2 months and more than 5 years. 50 Children with normal nutrition were taken as controls and 50 children with moderate and severe malnutrition were taken as cases. Age and sex were matched among cases and controls. Blood samples were collected for zinc estimation in both the cases and controls. All children were investigated and treated as per the department protocol for the particular condition. All statistical procedures were performed using SPSS v 21.0.

Results: In present study, 66% of children had normal zinc levels, 34% of children had low zinc levels. The mean zinc level in our cases was 54.84 ± 18.31 and in controls was 76.84 ± 15.2 , which was statistically significant ($p = 0.000$). Mean plasma zinc levels with respect to age and sex were not significant.

Conclusions: Total 34% of children with LRI had low plasma zinc levels. Plasma zinc level were significantly low in malnourished children than normally nourished children with LRI, which is one of the most important cause of high childhood mortality in developing countries.

Keywords: Lower respiratory tract infection, Malnutrition, Plasma zinc level

INTRODUCTION

Acute Lower Respiratory Tract Infection (ALRI) is an important cause of morbidity and mortality in the developing world. Pneumonia is a severe form of ALRI that cause over 2 million deaths annually among children younger than 5 years of age.¹ About 19% of all deaths, pneumonia is the leading cause of child mortality. Malnutrition is known to be associated with greater

intensity of lower respiratory tract infections, the frequency of complications, longer episodes of infections. All new cases of pneumonia is more than 95% in less than 5 years of children occur in developing countries, due to increased prevalence of under nutrition, which is 53% of all deaths among children less than 5 years of age.² The important role of Malnutrition in child deaths is that most nutritional deficiencies impair immune function and other host defences leading to a cycle of long lasting

and most severe infections and ever worsening nutritional status.³ Zinc deficiency is widely prevalent in the developing areas of the world, which also have a high incidence of ALRI.⁴ Zinc is an essential micronutrient in human. Zinc is second only to iron in quantity. Zinc stimulate the activity of multiple enzymes involved in various metabolic and immunologic responses in the body.⁵ This element known to have a direct antiviral activity and a demonstrable effect on immune mediated production of interferon.^{6,7} Also, Zinc prevents pathogen from gaining entry into cells and hinder these intracellular multiplication.^{6,7}

Zinc deficiency is common in children from developing countries due to high incidence of malnutrition, lack of intake of animal foods, high dietary phytate contents and inadequate food intake with increased faecal concentration during diarrhoea.⁸ Zinc deficiency increasing the inflammatory pathology in the respiratory tract with increased damage to the cells is a proposed mechanism.⁹ Zinc also prevents the recruitment of white blood cells and release cytokines from them and effectiveness of zinc said to increase with increase in severity of pneumonia.⁸ Studies suggest that there is greater risk of diarrhoea, pneumonia and growth failure in the zinc deficient population.¹⁰⁻¹² Improvements in nutrition are a keystone of current global efforts to reduce the burden of mortality and morbidity due to ALRIs among children living in developing countries.¹³ This study is to assess the plasma zinc levels in normal and malnourished children with LRI aged 2 months to 5 years.

METHODS

This is a Case Control Study, which was carried out in the Department of Paediatrics, Sree Balaji Medical College and Hospital, the study period is one year from July 2016 to July 2017. 100 children between 2 months to 5 years of age with LRI was included in the study and children less than 2 months and more than 5 years, those with clinical diagnosis of diarrhea and comorbid states, with zinc supplementation, and those with documented parenteral antibiotic intake prior to indoor admission for current illness were excluded from the study. In our study, 50 Children with normal nutrition were taken as controls and 50 children with moderate and severe malnutrition were taken as cases. Age and sex were matched among cases and controls. Informed and written consent of the parents of cases and controls were taken. Data was collected on age, sex, weight for height (Table 1) and mid arm circumference (Table 2), admission symptoms, baseline characteristics, and socio-economic status. Patients were examined clinically. Data on investigations was abstracted. Blood samples were collected for zinc estimation in both the cases and controls. All children were investigated and treated as per the department protocol for the particular condition. All statistical procedures were performed using SPSS v 21.0.

Table 1: WHO classification of malnutrition according weight for height.

Classification	Weight for height (Z score)
Normal	> -2 SD
Moderate malnutrition	< -2 SD to -3 SD
Severe malnutrition	< -3 SD

Table 2: Classification of mid arm circumference.

Classification	Mid arm circumference
Normal	Above 13.5 cm
Moderate malnutrition	12.5-13.5 cm
Severe malnutrition	Below 12.5 cm

RESULTS

In present study, 100 children who belong to 2 months to 60 months of age group were taken. Among this 100 children, 50 children belonged to cases (malnourished children with LRI) and 50 children belonged to controls (normally nourished children with LRI).

Table 3: Weight for height.

Weight for height	Cases	Control	Total
>-2SD	0 (0%)	50 (100%)	50 (50%)
<-2SD to -3SD	38 (76%)	0 (0%)	38 (38%)
< -3SD	12 (24%)	0 (0%)	12 (12%)

Table 4: Mid-arm circumference (1 - 5 years age).

Mid arm circumference	Cases (39)	Control (39)
>13.5 cm	0 (0%)	39 (100%)
12.5 cm-13.5 cm	27 (69%)	0 (0%)
<12.5 cm	12 (31%)	0 (0%)

Among the total study participant 22% of them were from age group 2 months to 12 months of age, 12% of them belonged to 13 to 24 months of age, and majority 66% of them were in the age group 25 to 60 months of age. The mean age of cases was 31.86±17.08 SD and the mean age of controls was 30.44±16.94 SD. About 44% of cases and controls were males and majority 56% of cases and control were females. Upper lower SES was majority in both cases and controls in our study. 55%, 30% and 15% of the study population were diagnosed with WALRI, Bronchiolitis and Pneumonia respectively. The most common clinical features were cough (95%), fast breathing (94%), wheeze and tachypnoea (93%), retractions (88%) and feeding difficulty (87%) whereas fever was present only in 23% of children. In about 55% of the study participant chest x-ray was normal, 30% had hyperinflation and 15% had pneumonia. 100% of the study participants in control groups belonged to more than -2 standard deviations. 76% of the study participant in cases belong to -2 standard deviations to -3 standard

deviations. 24% of cases belong to less than -3 standard deviations (Table 3). About 100% of the controls had a normal mid-arm circumference (>13.5 cm). 69% of the cases were between 12.5 cm to 13.5cm and 31% of cases were less than 12.5 cm (Table 4).

Table 5: Frequency of zinc levels.

Zinc	Cases	Control	Total
Normal	24 (48%)	42 (84%)	66 (66%)
Deficient	26 (52%)	8 (16%)	34 (34%)
Total	50 (100%)	50 (100%)	100 (100%)

Table 6: Plasma zinc values in cases and control: (mean zinc level expressed in mcg/dl).

Characteristics	Mean±SD	p value
Zinc levels		
Cases	54.84±18.31	0.000*
Control	76.84±15.2	

*statistically significant (less than 0.05)

In present study, 66% of children had normal zinc levels, 34% of children had low zinc levels (Table 5). The mean zinc level in our cases was 54.84±18.31 and in controls was 76.84±15.2, which was statistically significant (p = 0.000) (Table 6). Mean plasma zinc levels with respect to age and sex were not significant.

DISCUSSION

ALRI represents one of the most common infective illness in developing countries and is of great importance as a cause of preventable mortality in children. To attack this global problem, WHO shaped strategy for early diagnosis and effective case management that had remarkable impact on mortality due to LRI in developing countries. The burden caused by LRI in terms of morbidity and mortality is very high.

Malnutrition is associated with 2-3 fold increase in mortality from LRI. It is well known that malnourished children will have impaired cell mediated immunity. The impaired cell mediated immunity in children of developing countries are likely to be attributable to zinc deficiency as zinc plays an important role in cell mediated immunity.

Present study population consists of cases and controls between 2 months to 60 months of age which was similar to the study done Hussain A et al.¹⁴ The mean age of the study population was 31.5±16.94 months which was found to be in contrast to studies done by Rady HI et al, in which the mean age was 24±16.3 months.¹⁵ This difference in mean age among various studies may be due to wide variation in the causative organisms that led to LRI. There is no significant difference between the mean plasma zinc levels between the different age group of children admitted with LRI. Similar studies done by

Kumar S et al, and Arica S et al, showed results that age is not a confounding factor.^{16,17}

In present study the most common diagnosis was WALRI (55%) followed by bronchiolitis (30%) and pneumonia (15%) which was in contrast to a study conducted by Hussain A et al, in which 40% of the study population had pneumonia and 18% of the children had WALRI and 14% of children had bronchiolitis and also in contrast to the studies conducted by Ibraheem R et al, in which 79% of the children had pneumonia and 9% had bronchiolitis.^{14,18} Other studies conducted by Panneerselvam R et al, Memon M et al, Kumar S et al, and Arica S et al, also revealed majority of children had pneumonia as the leading diagnosis which was not similar to our study.^{16,17,19,20}

In present study, 46% of children belonged to upper lower socio-economic class, 24%, 16%, 8% and 6% belonged to middle, upper middle, upper and lower respectively. Majority of children belonged to upper lower socioeconomic class which was similar to a study done by Reddy MLN et al.²¹

In the present study, 95% of the children had cough as the common symptom followed by fast breathing in 94%, wheezing in 93%, feeding difficulty in 87% of children and fever in 23% which is slightly similar to the study conducted by Kumar S et al, in which 96% of children had fast breathing and other features were in contrast to current study.¹⁶

In 55% of the study population, chest x-ray was normal, 30% had hyperinflation and 15% had pneumonia which was contrast to the study conducted Hussain A et al,¹⁴ in which 16% of children were normal, 24% had pneumonia and 8% had hyperinflation.¹⁴

In present study, 52% of the cases and 8% of controls had low plasma zinc levels. The mean zinc level in our cases was 54.84±18.31 and controls was 76.84±15.2 which was statistically significant (p = 0.000) which was similar to the study done by Ansar Murtuza H et al, where malnourished children with significantly low plasma zinc level than normally nourished children (p = 0.02) and also similar to the studies done Singla PN et al, in which plasma zinc levels was found to be significantly low in malnourished children when compared to normally nourished children z which was statistically significant (p = <0.001).^{21,22}

In a study conducted by Panneerselvam R et al, among the children with LRI, mean blood zinc in children with malnutrition is significantly low when compared to normally nourished children (p= 0.002) which is similar to our study and similar findings were found in the study done by Kumar S et al.^{16,19} In a study done Reddy MLN et al, malnourished children with LRI was found to have low blood zinc levels which was statistically significant (p= 0.01).¹

CONCLUSION

Authors found that low zinc in malnutrition can be a pre-existing zinc deficiency making the child malnourished due to impaired immunity. Even though there is a strong association between low blood zinc values and LRI in the previous studies, it does not indicate that all the normally nourished children with LRI will have low blood zinc values. 34% of children with LRI had low plasma zinc levels. Plasma zinc level were significantly low in malnourished children than normally nourished children with LRI, which is one of the most important cause of high childhood mortality in developing countries.

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