Original Research Article

Serum Zinc Status of Children Suffering from Diarrhea and Acute Respiratory Infection

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ABSTRACT

Introduction: Zinc is an essential micronutrient, required to prevent morbidity and mortality in children. Zinc deficiency is the major cause for the prevalence of diarrhea and acute respiratory infection worldwide.

Objectives: The main objective of the study was to assess the zinc status and its relation to infection among the children.

Methodology: An observational study was carried out in Vani Vilas Hospital, Bengaluru and 70 subjects suffering from diarrhea and acute respiratory infection were selected.

Results: Majority of subjects (49%) belonged to the age group of less than one year. It was found that 67% of the subjects were from upper lower socio economic class. The study revealed that the prevalence of zinc deficiency was highest among children belonging to age group of 3-4 years and their mean serum zinc level was 62.42 ± 23 mg/dL.

Conclusion: It can be concluded from the study that 60% of the study subjects suffering from diarrhea and respiratory infection were zinc deficient.

Key words: Zinc, Serum Zinc, Acute Respiratory Infection, Diarrhea, micro-nutrient.

INTRODUCTION

India has a population of 1.2 billion and is ranked second in the world for the number of children (47%) suffering from malnutrition and is 15th leading country with hunger situation. Every year about 2.1 million children (<5 years) of India die because of diarrhea, typhoid, malaria, measles and pneumonia. Everyday 1000 children in India die because of diarrhea alone. Diarrhea is the third leading cause of childhood mortality in India, and is responsible for 13% of all deaths/year in children under 5 years of age. [1] Almost one in every 5 deaths in children and a total of 1.5 million deaths annually were related to diarrhea. The micronutrients are undoubtedly important in health and nutrition, among them, zinc is an essential element which is significantly being appreciated worldwide and its deficiency plays an important role in appearance of a disease. Growing children have higher demands of micronutrients including zinc. Staple diet consumption containing high phytate and dietary fiber have an impact on bioavailability of zinc by inhibiting zinc absorption. diarrhea, hemolysis and bleeding increase endogenous losses of zinc. [2] It is also important to note that maternal and gestational zinc deficiency is also responsible for immunity and development in new born in ways that compromise immune function throughout the lifespan irrespective of zinc status. [3] Zinc is important for function of immune cells such

as neutrophils and natural killer cells, growth and function of T and B lymphocytes, and cytokines and immunoglobulin production. This micronutrient also acts as an antioxidant and support stability of cell membranes. [4] Zinc deficiency decreases cell mediated immunity. The presence of zinc in the diet affects various aspects of cell mediated immunity, such as expression of interlukin-2 and interferon-γ. [5] Zinc deficiency is responsible for approximately 16% of lower respiratory tract infections, and 10% of diarrheal disease. [6,7]

MATERIALS AND METHODS

The study was conducted in Pediatric department of Vani Vilas Hospital located in Bengaluru, India between January and March 2016. After obtaining approval and clearance from the Institutional ethical committee and the guardians/ parents of the patients, those cases meeting the mentioned inclusion and exclusion criteria were included in this study. The study was carried out by selecting 70 children below 5 years suffering from diarrhea and acute respiratory infection. Information regarding health status was collected using anthropometric measurement (height and weight). Blood sample were drawn from the selected children in order to determine serum levels of zinc. Information regarding family socio-economic [8] and demographic characteristics was obtained by interviewing the parent/caregiver who had accompanied the child to the hospital.

RESULTS

Maximum number (49%) of subjects in the study were of less than one year, followed by 30% in the age group of 1-2 years and only 14% belonged to the age group of 3-4 years. Out of 70 study subjects, 42% were suffering from diarrhea, whereas 58% were suffering from ARI [Table 1].

Table 1: Age wise distribution of study subjects

Age (years)	Diarrhea		ARI		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Less than 1 year	15	22	19	27	34	49
1-2 years	9	13	12	17	21	30
2-3 years	2	3	3	4	5	7
3-4 years	3	4	7	10	10	14
Total	29	42	41	58	70	100

According to Kuppuswamy's socioeconomic scale, the study subjects were classified into different socio-economic level. [8] Majority (67%) of the families of the subjects belonged to upper lower class, followed by 20 (28%) of the study subjects belonged to lower middle class. Only 5% subjects belonged to upper middle class respectively. Table 2 shows that study subjects belonging to upper lower class, 16 (23%) had diarrhea and 31(44%) had ARI, only 3 (5%) of upper middle class had diarrhea (p<0.01).

Table 2: Socio Economic Status of study subjects

Socio-economic status	Diarrhea		ARI		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Upper Lower Class	16	23	31	44	47	67
Lower Middle Class	10	14	10	14	20	28
Upper Middle Class	3	5	-	-	3	5
Total	29	42	41	58	70	100
Chi square test	5.904				Significant at 1% level	

Table 3: Serum zinc level in diarrhea and ARI subjects

Serum zinc	Diarrhea		ARI		Total	
	No.	%	No.	%	No.	%
<70 mg/Dl	19	27	23	33	42	60
70-120 mg/Dl	10	14	18	26	28	40
Total subjects	29	41	41	59	70	100

Table 3indicates that27% of study subjects suffering from diarrhea were zinc deficient and 33% of ARI subjects were also zinc deficient with the total 60% of study subjects being zinc deficient, whereas

only40%of the population had serum zinc in the normal range of 70-120 mg/dL.

Table 4: Association of Age with serum zinc status

Age group	Serum zinc (mg/dL)	
	Mean	**S.D.**
<1 year	68.067	22.808
1-2 year	64.823	22.07
2-3 year	65.58	12.82
3-4 year	62.42	23.6

The mean serum zinc level of children of all age group was found to be lower than the reference value of 70-120mg/dL. The mean serum zinc level was found to be lowest62.42 mg/dL (±.23.6) in study subjects belonging to the age group of 3-4 years [Table 4].

Table 5: Association of age with serum zinc status in diarrheal subjects

Age group	Total subjects	<70 mg/dL		70-120 mg/dL		Chi square value
		No.	%	No.	%	
<1	15	8	53.3	7	46.6	
1-2	9	7	77.7	2	22.2	1.58
2-3	2	1	50.0	1	50.0	
3-4	3	2	66.6	1	33.3	
	29					

It was found [table-5] that zinc deficiency was maximum 77% in children belonging to the age group of 1-2 years, followed by 3-4 years (50%). The zinc status was normal in 46.7% of the study subjects belonging to the age group of 2-3 years, followed by less than 1 year of age group.

Table 6: Serum zinc level in study subjects of different age group with ARI

Age group	Total subjects	Serum zinc Level				Chi square value
		<70 mg/dL		70-120 mg/dL		
		No.	%	No.	%	
<1	19	9	47.36	10	52.63	
1-2	12	7	58.33	5	41.67	1.416 NS
2-3	3	2	66.67	1	33.33	
3-4	7	5	71.42	2	28.57	
	41					

Table 6 shows the prevalence of zinc deficiency in subjects with diarrhea. It was found that 71% of subjects in the age group of 3-4 years had highest prevalence of zinc deficiency, followed by 67% of subjects in the age group of 2-3 years. The zinc status was found to be normal in 53% of subjects belonging to the age group of less than one year.

DISCUSSION

Zinc status of an individual depends on various factors such as; dietary amounts, availability for absorption, the physiological needs of the individual, as well as endogenous losses from the body. In several developing countries, including India, mild to moderate zinc deficiency is common because the commonly consumed staple foods have low zinc contents and are rich in phytates, which inhibits the absorption and utilization of zinc. A study conducted in Delhi, India in the children of 6-35 months of age, it was observed that the prevalence of zinc deficiency was 73.3% for values less than 70 µg/dl and 33.8% for values less than 60 µg/dl. [9] A study was conducted to determine the serum zinc level of primary school students, to show the effect of socioeconomic status (SES) on the zinc level, and finally to show the effect of zinc deficiency on the anthropometric parameters. The mean serum zinc levels of low and middle socio economic status subjects were 56.3 ± 17.50 micrograms/dL and 86.6 ± 26.8 micrograms/dl respectively, while in children with high socio economic status the mean serum zinc was 110.7 ± 24.50 micrograms/dL. The difference between the groups was found to be statistically significant (F = 19.545, p < 0.05). [10] Plasma zinc concentration is affected by many factors such as inflammation, fasting, pregnancy, ARI, dermal infections, conjunctivitis, diarrhea, rash, otitis etc. [11] Zinc deficient children are at increased risk of restricted growth and developing diarrheal diseases, as well as respiratory tract infections such as acute lower respiratory tract infections. Diarrheal disorders and acute lower respiratory tract infections, especially pneumonia are the two most common causes of infant and child death in low-income countries. [7] In a study, children between 10 months and 10 years of age were selected and observed, serum zinc levels were observed to be significantly lower among children who were more susceptible to infections when compared to healthy controls. [12] Lower zinc level in

severe pneumonia can be pre-existing zinc deficiency, making the child susceptible to pneumonia due to impaired immunity. In addition, respiratory tract infections are also known to result in lower zinc levels. It has also been suggested that lowered zinc level is mediated by interleukins and tumor necrosis factor alpha (TNF-a) and is a part of predictable set of metabolic reactions to infection or tissue injury known as acute phase reaction. [13] Diarrhea incidence remains a tremendous burden on study subject in low- and middle-income countries due to multiple determinants such as child malnutrition, low socioeconomic status and education of mothers, lack of safe drinking-water, inadequate sanitation and poor hygiene, crowding and low maternal age. These determinants of diarrheal disease are strongly linked to poverty and social inequities. Furthermore, diarrheal incidence is highest in the first two years of life and declines as a child grows older. [14] The current study shows that 60% of the study subjects were zinc deficient.

CONCLUSION

Majority of subjects suffering from ARI and diarrhea were maximum in the age group of less than one year and about 58% of study subjects suffered from ARI, while the remaining 42% suffered from diarrhea. According to Kuppuswamy's socio-economic scale, the study subjects were classified into different socioeconomic level. Majority (67%) of study subjects belonged to upper lower class, 28% belonged to lower middle class and only 5% belonged to upper middle class. The prevalence of zinc deficiency was found to be highest in less than 1 year. It can therefore be concluded that zinc plays a major role in growth and development of the children, and is also required to prevent infections, which cause morbidity and mortality among less than five-year-old children.

REFERENCES

1. Caulfield LE, Richard SA, Rivera JA, Musgrove P, Black RE. Stunting, Wasting, and Micronutrient Deficiency Disorders. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, et al., editors. Disease Control Priorities in Developing Countries [Internet]. 2nd ed. Washington (DC): World Bank; 2006 [cited 2016 Mar 8].
2. Bitarakwate E, Mworozi E, Kekitiinwa A. Serum zinc status of children with persistent diarrhoea admitted to the diarrhoea management unit of Mulago Hospital, Uganda. Afr Health Sci. 2004; 3(2):54-60.
3. Walker CLF, Bhutta ZA, Bhandari N, Teka T, Shahid F, Taneja S, et al. Zinc during and in convalescence from diarrhea has no demonstrable effect on subsequent morbidity and anthropometric status among infants <6 mo of age. Am J Clin Nutr. 2007 Mar; 85(3):887-94.
4. Talachian E, Bidari A, Noorbakhsh S, Tabatabaei A, Salari F. Serum levels of vitamins A and D, and zinc in children with acute diarrhea: A cross-sectional study. Med J Islam Repub Iran. 2015 Apr 27; 29:207.
5. Sandstead HH, Prasad AS. ZINC INTAKE AND RESISTANCE TO H1N1 INFLUENZA. Am J Public Health. 2010 Jun; 100(6):970-1.
6. Lakshminarayanan S, Jayalakshmy R. Diarrheal diseases among children in India: Current scenario and future perspectives. J Nat Sci Biol Med. 2015; 6(1):24-8.
7. WHO | Chapter 4 [Internet]. WHO.
8. Oberoi S. Updating income ranges for Kuppuswamy′s socio-economic status scale for the year 2014. Indian J Public Health. 2015; 59(2):156.
9. Dhingra U, Hiremath G, Menon VP, Dhingra P, Sarkar A, Sazawal S. Zinc deficiency: descriptive epidemiology and morbidity among preschool children in peri-urban population in Delhi, India. J Health Popul Nutr. 2009; 632-639.
10. Tanzer F, Yaylaci G, Ustdal M, Yönem O. Serum zinc level and its effect on anthropometric measurements in 7-11

year-old children with different socio economic backgrounds. Int J Vitam Nutr Res Int Z Für Vitam- Ernährungs for schung J Int Vitaminol Nutr. 2004 Jan; 74(1):52-6.

11. Brown KH, Peerson JM, Baker SK, Hess SY. Preventive zinc supplementation among infants, preschoolers, and older prepubertal children. Food Nutr Bull. 2009 Mar; 30(1 Suppl):S12-40.

12. Bondestam M, Foucard T, Gebre-Medhin M. Subclinical trace element deficiency in children with undue susceptibility to infections. Acta Paediatr Scand. 1985 Jul; 74(4):515-20.

13. Kumar S, Awasthi S, Jain A, Srivastava RC. Blood zinc levels in children hospitalized with severe pneumonia: a case control study. Indian Pediatr. 2004; 41(5):486-492.

14. Agustina R, Sari TP, Satroamidjojo S, Bovee-Oudenhoven IM, Feskens EJ, Kok FJ. Association of food-hygiene practices and diarrhea prevalence among Indonesian young children from low socioeconomic urban areas. BMC Public Health. 2013 Oct 19; 13:977.

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