

## The Impact of Serum Zinc Levels on Children with Acute Gastroenteritis

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### ABSTRACT:

#### BACKGROUND:

Diarrhea is the leading cause of morbidity and mortality in children in developing countries. Acute-onset diarrhea is usually a self-limited disease; however, acute infection can have a protracted course. Zinc is an essential nutritional element, with a broad spectrum of biological activities in humans, this element plays an important and vital role in the physical development of digestive and immune systems. Zinc deficiency is common in children from developing countries due to lack of intake of animal foods, high dietary phytate content, inadequate food intake, and increased fecal losses during diarrhea.

#### OBJECTIVE:

To assess serum zinc level in children with acute gastroenteritis.

#### PATIENTS AND METHODS:

We conducted a cross-sectional study on 53 patients who presented with acute gastroenteritis for less than 14 days duration admitted to casualty and general ward units at Children Welfare Teaching Hospital, their age ranged (6months-15years) from 1<sup>st</sup> of April 2018 to 31<sup>st</sup> of October 2018. A detailed history and examination were done for all cases. A special questionnaire was designed for the purpose of the study. Blood samples for complete blood count, C-Reactive Protein, total serum protein and serum zinc level measurement were obtained from patients at admission Serum samples of the patients for measurement of zinc levels were collected in tubes free of trace elements and stored at (-20°C) until measurement. Zinc concentrations were determined by atomic absorption spectrophotometer.

#### RESULTS:

Fifty-three children with acute gastroenteritis were included in the study (40 males and 13females), their age was between 6 months-15 years. The median duration of diarrhea ( $4 \pm 2.7$ ) days and mean serum zinc ( $86.2 \pm 26.6$ ). A total of 18 (34%) children had low serum zinc levels.

The mean serum zinc seen was lower in patients with duration of diarrhea  $> 5$  days than patients with duration of diarrhea  $\leq 5$  days; the result is statistically significant in both groups p-value  $< 0.05$ . There were no significant differences in demographic and clinical characteristics between patients with normal zinc levels and those with zinc deficiency.

#### CONCLUSION:

The serum zinc in children with gastroenteritis has revealed a significantly decreased level.

**KEYWORDS:** Acute gastroenteritis, children, serum zinc.

### INTRODUCTION:

Acute gastroenteritis is an extremely common illness among infants and children worldwide. According to the Centers for Disease Control and Prevention (CDC), in developing countries, diarrhea is a common cause of mortality among children younger than age 5 years, with an estimated 2 million deaths each year<sup>(1,2)</sup>.

Zinc is an essential nutritional element, with a broad spectrum of biological activities in humans. This element plays an important and

vital role in the physical development of the digestive and immune systems. Zinc deficiency in children can cause stunted growth and increased incidence of infections (gastroenteritis) by weakening the immune system and changing neural and behavioral actions. Zinc deficiency is a global problem affecting populations of low socioeconomic status in both developing and developed countries<sup>(3,4,5)</sup>.

### PATIENTS AND METHOD:

Cross-sectional study has been carried out on fifty-three (53) patients aged from 6 months - 15 years, who presented with acute gastroenteritis for less than 14 days admitted to emergency department and general ward unit at Children

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Welfare Teaching Hospital from 1st of April 2018 till 31st of October 2018.

A written consent was obtained from each patient's parents Before initiation of the study after informing them about the aim of the study; which was approved by the Ethics Committee of Children Welfare Teaching Hospital and was carried out according to the guidelines of the Helsinki Declaration<sup>(6)</sup>

A detailed history and proper examination were done for all patients. A special questionnaire was designed for the purpose of the study, the following information was assessed:

1. Age, sex, body weight and height or length.
2. The duration of diarrhea.
3. Consistency of stool (watery or semi formed).
4. Degree of dehydration according to standard WHO guidelines.
5. Type of feeding (breastfed, bottle-fed, mixed, or family feeding).

Children who had one or more of the following criteria were excluded:

1. Any patient presented with failure to thrive
2. Any evidence of extra intestinal cause of diarrhea like otitis media, urinary tract infections...etc.
3. Any patient vomits the zinc frequently and did not use it.
4. Bloody diarrhea.

The following investigations were done for the all patients:

Complete blood count, CRP, total serum protein, serum zinc, renal function test and serum electrolyte, stool samples were taken for culture and direct microscopic examination, urine samples were collected for direct microscopic examination and culture.

Serum samples of the patients for measurement of zinc levels were collected in tubes free of trace elements and stored at (-20°C) until measurement. Zinc concentrations were determined by atomic absorption spectrophotometer on Varian Techtron model 210 VGp `Buck Scientific (USA) at Medical City/ Toxicology Center.

The normal range of zinc was considered as 60-90 µg/dl between the ages of 1-12 months, 80-110 µg/dl between the ages of 1-10 years, 90-120 µg/dl between the ages of 10-15 years<sup>(7)</sup>.

All patients received IVF (according to WHO guidelines) and other usual support care without antibiotics. After aspirating S. Zinc, we prescribed Zinc sulfate tablet available in the forms of 20mg, given to the patient (according to WHO guideline) 10 mg/day for ≤ 6 months age and 20mg/day for > 6 months age

for 14 days. If vomiting or regurgitation happened within 1hr after ingestion of zinc, another dose was given (by dividing dose regime).

### Statistical analysis

Statistical analysis was done using SPSS version 23 used for data entry and analysis. Mean and standard deviation was used to represent numerical data, frequency and percentage for categorical data. Appropriate tests (paired sample t test, chi-square, binary logistic regression was done for the analysis of different marker by using Odd Ratio (OR) and 95% Confidence Interval (CI). P-value of ≤ 0.05 was considered as statistically.

### RESULTS:

In the present study, the total number of patients was 53, their age was between 6 months -15 years, 40(75.5%) were males & 13(24.5%) were females. The consistency of stool was divided into 35(66.0%) patients with watery diarrhea and 18 (34.0%) with semi-formed diarrhea. The 19 (35.8%) of patients presented with no dehydration, 25 (47.2%) with some dehydration and 9 (17.0%) patients with severe dehydration.

There were 5 (9.4%) of patients on breastfeeding, 19 (35.8%) bottle, 9 (17%) mixed and 20 (37.8%) family feeding. The number of patients who received zinc sulfate before admission to the hospital 9 (17%) while 44 (83%) patients did not receive it. The giving dose of zinc to the patients was calculated according to age group; 4 (7.5%) of patients on 10 mg (to whom younger than 6 months) and 49 (92.5%) on 20 mg (to whom older than 6 months).

Regarding the fever; 51(96.2%) of patients presented with fever while 2 (3.8%) of patients without fever. The CRP was positive in 6 (11.3%) of patients and negative in 47(88.7%) of patients All this is shown in **table (1)**.

The mean serum zinc distributed according to age group, 23 patients ≤ 1 year ( normal zinc value 60 – 90 µg/dl), 25 patients 1 – 10 years ( normal zinc value 80 – 110 µg/dl) and 5 of them >10 years ( normal zinc value 90 – 120 µg/dl); 81.4, 90.0 and 89.4 respectively. All these findings are shown in **table (2)**.

The serum zinc in the present study was found normal in (66.0%) of patients and (34.0%) of the low serum zinc. The low serum zinc seen in (21.7%) of patients ≤ 1 year, (40.0 %) from 1 – 10 years and (60.0%) > 10 years; all these findings seen in tables **(3)**.

The mean serum zinc was seen lower in patients with duration of diarrhea > 5 days than patients with duration of diarrhea ≤ 5 days; the result is

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statistically significant in both groups (p-value < 0.05). These findings were shown in tables (4) and figure (1).

In this study there was no correlation between serum zinc level and age, Hb, and TSP but only with duration of diarrhea. The result is statistically significant (p-value > 0.05). These findings were shown in table (5).

**Table 1: Frequency and percentage of some characteristics of the studied sample.**

Variables	No.	%	
Sex	Male	40	75.5%
	Female	13	24.5%
Consistency of stool	Watery	35	66.0%
	Semi formed	18	34.0%
Degree of dehydration	No dehydration	19	35.8%
	Some dehydration	25	47.2%
	Severe dehydration	9	17.0%
Type of feeding	Breast	5	9.4%
	Bottle	19	35.8%
	Mixed	9	17.1%
	Family feeding	20	37.7%
Recently received zinc sulfate	Yes	9	17.0%
	No	44	83.0%
Dose of given zinc	10 mg	4	7.5
	20 mg	49	92.5
Fever	Yes	51	96.2%
	No	2	3.8%
CRP	Positive	6	11.3%
	Negative	47	88.7%

**Table 2: Mean value of zinc according to age groups.**

Age group (years)	No.	Mean	Std. Deviation	Minimum	Maximum
< 1(normal value=(60-90))	23	81.4	26.2	40	130
1-10(normal value =80-110)	25	90.0	28.1	54	150
>10 normal value =(90-120)	5	89.4	19.5	67	110

**Table 3: Association between zinc level and age groups.**

Age range/year	Zinc level				p-value
	Low		Normal		
	No.	%	No.	%	
< 1	5	21.7%	18	78.3%	0.1
1-10	10	40.0%	15	60.0%	
> 10	3	60.0%	2	40.0%	

**Table 4: Mean value of zinc level according to the duration of diarrhea.**

Duration of diarrhea/day	Mean of zinc level	Std. Deviation	p-value
≤5 days(n=40)	90.9	25.9	0.02
> 5 days(n=13)	71.6	23.7	

**Table 5: Correlation of zinc level with age, duration of diarrhea, Hb and TSP level.**

Correlations		Zinc level	Age/year	Duration of diarrhea/day	Hb g/dl	TSP g/dl
Zinc level	Pearson Correlation	1	0.074	-0.3*	0.074	-0.02
	p-value		0.5	0.02	0.6	0.8

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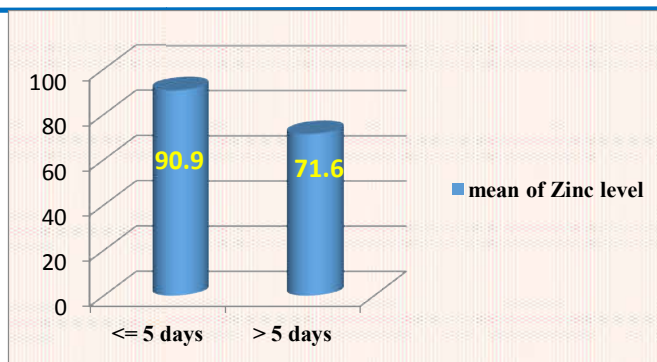


Figure 1: Mean value of zinc level according to the duration of diarrhea.

### DISCUSSION:

Zinc is an essential nutritional element, with a broad spectrum of biological activities in humans. This element plays an important and vital role in the physical the development of digestive and immune systems<sup>(3)</sup>.

In the present study, children with acute gastroenteritis on admission showed that (34%) were below the lower limit of the range for our laboratory at medical city / toxicology center and they were asymptomatic for zinc deficiency; while slightly different from other studies obtained by Kara aga oglu et al (39%) in Turkey<sup>(8)</sup> and Baqui et al<sup>(9)</sup> (44%) in India.

We found a big difference from other studies detected by Arora et al<sup>(10)</sup> (13.1%) in Pakistan, Fischer et al (56.2%) in Netherlands<sup>(11)</sup> and by Olmez et al (71%) in Turkey<sup>(12)</sup>, these findings may be explained by the differences in economic and nutritional status in different countries and small size study sample.

Also, there is no correlation was noticed between zinc level and the severity of dehydration these findings are in favor to the findings of a systematic review by Lamberti et al. in China<sup>(13)</sup>. We found that the serum zinc levels of the patients admitted suffering from acute gastroenteritis with fever and elevated CRP not affected but in another study done by Brown KH et al<sup>(14)</sup> serum zinc level was lower. There is a possibility that children with low serum zinc concentrations before their illness developed a more severe disease followed by higher body temperature and elevated CRP concentrations.

A reduction in serum zinc concentration has been found to be proportional to the level of induced parasitemia and the dose of administered bacterial endotoxin<sup>(10,11)</sup>. Fever is partly and directly mediated through an interleukin 1 response, which is followed by an increase in the hepatic synthesis of the metal binding protein

metallothionein that again increases zinc uptake from plasma<sup>(15)</sup>.

There is no association between fever or CRP and serum zinc that may have been mediated by an interleukin 1– metallothionein-induced zinc uptake in the liver. Furthermore, plasma CRP concentration and axillary temperature were strongly associated with plasma zinc concentration even when both variables were included in the linear regression model<sup>(16)</sup>.

The present study shows that the serum zinc levels of the patients admitted with acute gastroenteritis without any other disease and without moderate or severe malnutrition were not affected by disease state, type of feeding and degree of dehydration these results agree with other studies done by Cousins RJ et al. Also, gastroenteritis did not further decrease serum zinc levels in patients with asymptomatic or subclinical zinc deficiency<sup>(17)</sup>.

In this study, there were no significant relationships between low serum zinc regards to sex, weight and age this result is comparable to study done by Elnemr FM et al<sup>(18)</sup> in Egypt.

The study had some limitations. Firstly, the studied group was small size (that is because our hospital is a tertiary center so most of the patients with gastroenteritis were treated in primary health care centers, and many samples were discarded because of hemolysis during draw specimens); however, it was sufficient to detect the prevalence of low zinc levels in diarrheal children which were close to expectation of 34% in hypothesis. Secondly, the study did not measure serum zinc after zinc supplementation for 14 days or recovery because the parents did not agree to return to the hospital for follow up and reassessment of serum zinc level to determine the effect of zinc treatment, which include reductions in episode duration,

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stool output, stool frequency and length of hospitalization and for the same reason we could not study control group.

### CONCLUSION:

The present study which was undertaken to estimate the serum Zinc levels in children with gastroenteritis has revealed a significant decrease in Zinc levels.

### Recommendation

1. Recommend primary health care centers for prescribing oral zinc supplementation to patients with diarrhea.
2. Encourage the use of Zn in diarrhea and educate the mothers about the importance of Zn in the treatment of diarrhea and advise them to complete the course of treatment for 10-14 days.

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