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THE SERUM LEVELS OF ZINC IN SCHOOL CHILDREN: A CROSSTALK WITH STUNTING AND GIARDIASIS

By

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Abstract

Zinc deficiency is an increasing public health problem. It may be related to compromised neurobehavioral function in children and adolescents. An association between giardiasis and zinc levels in human hosts had been reported. The occurrence of recurrent intestinal infection by *Giardia lamblia* may reflect a failure to correct an undefined specific nutrient deficiency, for example, the need for adequate zinc repletion. This study estimated the level of serum zinc in a sample of primary school children and to study the associations between it and height for age and giardiasis. A cross section study was carried out on randomly selected primary schools in Dubai and Ajman. They were 500 school children with age range from 6-12 years in Dubai and Ajman. The level of serum zinc, height for age and giardia infection were estimated

The results showed that the prevalence of zinc deficiency was 23% with no relationship to age or gender. The low serum zinc was significantly associated with stunting and giardiasis. Regression analysis showed that stunting and giardiasis were significant predictors for low serum zinc (β = 0.365, 0.684 respectively)

Keywords: Serum zinc, primary school children, stunting, giardiasis

Introduction

Zinc deficiency is an increasing public health problem, with 17.3% of world's population at risk of inadequate zinc intake (Wessells and Brown, 2012). Evidence of human zinc deficiency began to emerge during 1960s, when cases of zinc-responsive dwarfism and delayed sexual maturation were first reported among Egyptian adolescents (Prasad, 1991). Since then, clinical studies of children with acrodermatitis enteropathica; an inborn error of zinc metabolism that results in poor zinc absorption and, consequently, in severe, secondary zinc deficiency-have ascertained the critical role of zinc in physical growth of humans and normal functioning of the gastrointestinal tract and immune system (Moynahan,1974).

Development of zinc deficiency can be attributed to at least five general causes occurring either in isolation or in combination. These include inadequate intake, increased requirements, malabsorption, increased losses, and impaired utilization (Cuong, 2008).

The children and adolescents are the risky in development of zinc deficiency. The zinc deficiency may be related to compromised neurobehavioral function in them that argue strong need to define extent of zinc deficiency (Maureen, 2003). To date, plasma/serum zinc concentration, dietary intake, and stunting prevalence are the best-known indicators of zinc deficiency (Brown *et al*, 2004).

There are links between micronutrient deficiencies and immune impairment (Hugues and Kelly, 2006). This evidence is strongest for the trace element Zinc (Zn). Zn deficiency could be important for susceptibility to infections, since it is essential for numerous immune functions (Ibs and Rink, 2003). Change in zinc level in blood of *G. lamblia* infected children was reported (Jendryczko *et al*, 1993; Karakas *et al*, 2001; Ertan *et al*, 2002). Besides, Quihui *et al*. (2010) found that eradication of *G. lamblia* led to a significant improvement in the mean serum Zn levels six months after treatment in school children. They concluded that giardiasis might be a risk factor for zinc deficiency in schoolchildren from northwestern Mexico.

G. lamblia causes a generally self-limited clinical illness characterized by diarrhea, abdominal cramps, bloating, weight loss, and malabsorption. However, asymptomatic giardiasis with high reinfection rates occurs frequently, especially in developing countries for reasons that remain obscure (Feng and Xiao, 2011; Cotton, Beatty and Buret, 2011). The occurrence of recurrent intestinal infection by *G. lamblia* required consideration of humoral immune deficiency (Selmi, 2004), and associations between *G. lamblia* infection and low serum concentrations of zinc were reported in young children (Iñigo-Figueroa *et al*, 2015).

This study aimed at estimating the level of serum zinc in a sample of primary school children in United Arab Emirates and to study the associations between zinc status, height for age and giardiasis in the selected sample.

Subjects, Materials and Methods

Study setting: A cross section study was designed; a sample size of 500 students was calculated according to the estimated sample sizes for surveys of serum zinc concentration by the International Zinc Nutrition Consultative Group (IZiNCG) (Brown et al, 2004). A multi-stage random sample was performed; the emirates of Dubai and Ajman were randomly selected then four primary schools were randomly selected to be included in the study and students in the schools were randomly selected to satisfy the sample size (350 from Dubai and 150 from Ajman). Informed consent was obtained from parents or guardians of participating children.

Height for age: Height was measured (without shoes) using an anthropometric stadiometer to the nearest 0.1 cm. Measures were expressed as height for age (HFA) according to WHO parameters (WHO, 2006). Stunting was defined by values below the 3rd percentile line for HFA.

Biochemical estimation: Three ml. venous blood were collected in sterile tubes. Sera were separated and stored at -20°C until analyzed. Serum zinc concentration was measured by fully automated spectrophotometer (Audit Diagnostic 350). Children were classified as having low or normal serum zinc level according to the suggested lower cut-offs (2.5th percentile) for the assessment of serum zinc concentration in population studies, derived from NHANES II data (Pilch and Senti, 1984). The lower cut off value was 65 μmol/L for children (whatever their gender) less than 10 years old and 66 and 70 μmol/L for girls and boys more than 10 years old respectively.

Parasitological examination: Clean, dry, well labelled specimen containers were distributed to the selected students to deposit their fecal samples. The procedure for introducing the sample into the container was explained to old students and instruction paper was sent home for parents of younger students. Fecal examination was performed by formaldehyde-ether method concentration technique (WHO, 1993).

Statistical analysis: Data were analysed using SPSS 17.0. Continuous numerical variables were displayed as means, while categorical variables were displayed as observed frequencies and proportions. Linear regression was used to estimate the coefficients of the linear equation, involving one or more independent variables that best predict the value of the dependent variable.

Results

The age range of the students was 6-12 years with a mean of 9.2±1.8 years. The boys represented 60% of the sample size and the girls 40%. The prevalence of low serum zinc in the sample was 23% (115/500). Boys represented about 55% of the students in the low serum zinc group. There was no statistical significant difference in the level of serum zinc between boys and girls. Older students (10-12 years) represented more than half the students in low serum zinc group. There was no significant difference in the level of serum zinc between the different age groups (Tab. 1). Measuring the students' height and comparing it to their age showed that 30.4% of the students were having HFA lower than the 3rd percentile (stunted). The stunted students (61.2%) were having low serum zinc level. There was a significant difference in serum zinc mean concentration between the stunted and normal students. The prevalence of giardiasis was 27.6%. Students with giardiasis showed significantly lower serum zinc concentration than non-infected ones (Tab. 2).

The linear regression model for the possible predictors of the serum zinc concentration including the age, gender, stunting and *Giardia* infection turned to be statistically significant with R square 0.13. The stunting and giardiasis (Tab. 3) were the only variables significantly decreasing the level of serum zinc (β = 0.365 & 0.684 respectively).

Table 1: Serum zinc level according to gender and age

Variable		Low zinc level	Normal zinc level	**X^2, P**
Gender	Boys	63 (54.8%)	237 (61.6%)	$X^2 = 1.69$
	Girls	52 (45.2%)	148 (38.4%)	P > 0.05
Age	6-9 years	54 (47%)	200 (51.9%)	$X^2 = 0.88$
	10-12 years	61 (53%)	185 (48.1%)	P > 0.05

Table 2: Mean zinc level in stunting and giardiasis

Variable		Zinc concentration (μmol/L)		t, P
		X`	SD	
Stunting	Yes	63.4	4.4	t= 7.41
	No	66.1	3.3	P < 0.05
Giardiasis	Yes	63.8	4.3	t = 5.38
	No	65.8	3.5	P < 0.05

Table 3: Predictors of serum zinc concentration: Linear regression model

Model	Standardized coefficient (β)	t	P
(Constant)		120.211	.000
Stunting (HFA)	.365	3.466	.001
Giardiasis	.684	6.333	.000
Gender	.086	1.361	.174
Age	.024	.394	.694

Discussion

The current study evaluates the level of serum zinc in a sample of primary school children in Dubai and Ajman and its relation with giardiasis infection and stunting.

Nowadays, there is growing interest in dietary factors, in particular micronutrients, from the perspective of disease pathogenesis and potential for treatment. Results of field and laboratory studies provide convincing evidence that micronutrient deficiencies contribute to the mortality and morbidity of infectious diseases (Walker and Black, 2004; Wolfgang and Harold, 2006). Zinc is an essential trace element in the diets of humans for optimal health and growth (Prasad, 1991). It is required for the genetic makeup of every cell and considered as an absolute requirement for all biologic reproduction hence; widespread sub optimal zinc nutrient constitutes a notable health risk for children in terms of growth and development (Berg and Shi, 1996).

In the present study, the prevalence of low serum zinc to be 23%. The prevalence and burden of zinc deficiency was quite different worldwide, according to disease control priorities in developing countries (2006), the prevalence of zinc deficiency in the Middle East was about 46% (Dehghani *et al*, 2011). Studies in primary school children found a prevalence of 0.7% in China (Qin *et al*, 2009) and 28.1% in Iran (Fesharakinia *et al*, 2009). Also, low serum zinc concentration (57%) was found among 6-13 years old school children in North-East Thailand (Thurlow *et al*, 2006). In Mexican school-age children (below 12 years), zinc deficiency based on serum zinc was 19-24% (Villalpando *et al*, 2003).

The present results agreed with Arvanitidou (2007) in Greece and with Fesharakinia *et al*. (2009) as there was no significant relationship between sex and serum zinc level but low serum zinc was slightly more among boys. On the other hand, Qin *et al*. (2009) and Gibson *et al.* (2007) found that boys had significantly lower serum zinc level.

While the aetiology of stunting is complex, inadequate nutrition and infection are among factors thought to play major roles in reducing a child's height-for-age (Mikhail *et al*, 2013). Stunting was a functional indicator of population zinc status (Fischer and Black, 2007). This was marked in the present study where the prevalence of stunting was significantly higher in zinc deficient children compared to those with normal zinc level. Impaired linear growth proved to be a prominent feature of zinc deficiency among children in both developed and developing countries (Aggett, 1995; Hambidge, 2000; Brown *et al*, 2002; Gibson *et al*, 2007)

The level of zinc in blood of *G.* lamblia infected children decreased during giardiasis infection (Berkman, 2003; Demirci, 2003; Abou-Shady *et al*, 2011). This agreed with the present study, as children with giardiasis was significantly associated with lower mean serum zinc. This could be related to the fact that giardiasis resulted in sequestration of zinc in the liver (Liu *et al*, 2012), which led to decrease circulating levels of zinc and reduced zinc as well in other tissues.

In Egypt giardiasis as an endemic protozoan causing diarrhoea was reported in nearly all governorates (El-Gebaly *et al*, 2012) particularly among children (El-Sherbini *et al*, 2008) with pathological grading related to Giardia genotypes (Rizk *et al*, 2004).

Eldash *et al*. (2013) stated that recurrent abdominal pain (RAP) affected 10-20% of school-aged children and that *Helicobacter pylori* and *Giardia intestinalis* were reported among organic causes of RAP, with different prevalence particularly in developing countries as one of the commonest associated diseases causing agents. They evaluated *H. pylori* and G. intestinalis co-infection in RAP Egyptian among 90 children and 90 cross matched healthy controls. They concluded that incidence of *H. pylori* infection among cases was higher among age group above 5 years (p=0.001), as a significant predictor for RAP. The association of *H. pylori* and G. *intestinalis* was among 36 (40.0%) patients and 11 (12.2%) controls with a significant difference (p<0.001). They added that in treatment of H. pylori giardiasis must be treated. Helmy *et al.* (2014) stated that the risk of zoonotic infection emanating from ruminants even in high prevalence areas is negligible. Genetic characterization indicated a predominant anthropogenic cycle of infection within the pediatric population studied. Integration of sequence typing data with information on geographic origins of samples allows parasite sub-population tracing using current typing tools. Abdel-Hafeez et al. (2013) found that the percentage of zoonotic *Cryptosporidium* spp., *Entamoeba histolytica/dispar, Giardia lamblia,* and *Bla-stocystis* sp. was significantly lower in brea-st-fed infants than that in non-breast-fed infants. There were significant positive associations between the serum levels of IgE and TNF-α and the intensity of parasite infection in the breast-fed group. They concluded that breast-feeding has an attenuating effect on the rate and intensity of parasite infection.

Conclusion

The current study proved that zinc deficiency in the school children in Dubai and Ajman. Stunting was associated giardiasis infection. Considering the critical roles of adequate zinc in supporting normal growth and development, preventing morbidity from common infections, and possibly reducing child mortality, it is recommended to target this circle and break it up.

The nutritional education and screening programs are advised to improve the general nutritional status of giardiasis infected children which would be reflected on their cognitive function.

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