EVALUATION OF ZINC STATUS OF PRESCHOOL CHILDREN AS ASSESSED BY HAIR ZINC LEVEL IN PUNJAB PROVINCE

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ABSTRACT

Objectives: To determine status of zinc in healthy children in some parts of Punjab province by estimation of hair zinc levels.

Study design: Descriptive study (cross sectional survey)

Place and Duration of Study: The study was organized at KRL Hospital from August 2004 to January 2005. Study samples were selected randomly from a larger study (To evaluate vitamin A status) carried out in 6 districts of Punjab.

Subjects and Methods: This community-based study was done in 6 districts of Punjab including Mianwali, Jhang, Attock, Multan, Pak Pattan and Faisalabad. The population selected was 1-5 yr old healthy children. Both male and female healthy children were included. Malnourished children with mid arm circumference < 12 cm, children with skin and hair disorders, liver disease and prolonged illnesses were excluded from the study.

After parental consent and filling up of questionnaire data, hair samples were collected. Relevant features like age, sex, dietary history and previous illnesses were recorded. Hair samples were taken, sealed in dry plastic bags and dispatched to Dr A Q Khan Research Laboratories (KRL) Kahuta where they were analyzed using atomic absorption spectrophotometery. Data analysis was performed through SPSS-10.0.

Results: Mean age of study population was 37.51 ± 13.39 months and male to female ratio was 1:1.32. Hair zinc levels ranged from 69 to 227 µgm/ gm of hair. Mean hair zinc level was 164.79 ± 53.7 µgm/gm of hair. Majority of children (62) had an adequate zinc level, while 13 were identified with low zinc status (<100 µgm/gm). Hair zinc was not significantly higher in children with adequate dietary habits, similarly there was no association with age and gender.

Conclusion: Majority of healthy pre-school children in the sampled districts of Punjab did not have zinc deficiency as assessed by hair zinc level. However about 1 in 10 children was deficient in zinc even in the healthy population.

Keywords: Hair zinc levels, Children

INTRODUCTION

Zinc is an essential mineral found in abundance in the human body, being the second most common trace element. It is a component of over 300 enzymes and proteins involved in cell division, nucleic acid metabolism and protein synthesis [1].

Functions of zinc are enzymatic, antioxidant [2] and immune mediation [3]. Growth and development, reproductive function, immune integrity and brain homeostasis are dependent on zinc mediated reactions [1].

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Growth retardation, increased susceptibility to infection and cognitive impairment are common in developing countries where nutritional deficiency of zinc is also prevalent. Zinc deficiency is specially observed in malnourished children [4].

Zinc can be measured in serum, leukocytes, sweat and hair. Serum zinc level in 1-19 years old population is estimated to be 64 - 118 µg/dl [5]. Dietary zinc deficiency is prevalent in the developing world affecting nearly 2 billion people. Zinc deficiency as assessed by hair zinc concentration of less than 70 micro gram/gm of hair is established to occur in children aged 1 - 4 years [6].

Human scalp hair is a recording filament that can reflect metabolic changes of many elements over long period of time and thus furnish a print out of post nutritional events. The use of scalp hair has the advantages of being non-invasive. There is ease of collection, preservation, transport and lack of matrix effect when standard solutions are prepared in solublising fluid.

Besides, hair zinc values are not affected by haemolysis, as it happens in serum zinc determinations. Flynn et al have emphasized that hair can be very useful in nutritional assessment if attention is paid to proper sampling technique and appropriate statistical analysis [7].

The disadvantage of using hair has been attributed to its contamination with greasy products and difficulties in sampling technique [7]. Hair samples must be taken near the scalp to reflect the true chronic status of zinc as proximal hair has less and distal hair has more concentrations of zinc. Hair must be washed repeatedly with different types of solvents to get rid of all possible contaminants. Use of the hair sample is a non-invasive screening technique and can be used as an alternative to more accurate measuring techniques due to being less expensive and convenient [8].

Zinc is present in a wide variety of foods, especially in association with proteins. A vegetarian diet often contains less zinc than a meat based diet. Good sources for vegetarians include dairy products, beans, lentils, yeast, nuts, seeds and wholegrain cereals. Pumpkin seeds provide one of the most concentrated vegetarian food sources of zinc. To identify deficiency, zinc status needs to be established in healthy population in our part of the world [9].

This study was carried out to establish the zinc status of children through estimation of hair zinc. After establishment of zinc status, the zinc deficient target population can be identified, and measures for improvement if undertaken can have a great impact on large population. Such measures include food fortification plans and provision of mega doses to vulnerable community on regular intervals.

SUBJECTS AND METHODS

This descriptive study (cross sectional survey) was carried out by using simple convenient sampling technique and organized at KRL Hospital from Aug 2004 to Jan 2005. This was a community-based study and carried out in 6 districts of Punjab including Mianwali, Jhang, Attock, Multan, Pak Pattan and Faisalabad. The population selected was 1-5 yr old healthy children. Both male and female children were included and malnourished children with mid arm circumference < 12 cm, children with skin and hair disorders, liver disease and prolonged illnesses were excluded from the study.

Data for this analysis was obtained as a sub-project of another study, which was conducted with the help of UNICEF to find the "effect of Vitamin A supplementation on Serum Retinol Level in Children 1-5 years of age in Punjab". The original study was an interventional study conducted by a team (consisting of doctors of Pakistan Institute of Medical Sciences, King Edward Medical College and KRL Hospital and funded by UNICEF).

For studying hair zinc levels, 100 children were selected at random. A field team with the help of local vaccinator/LHW was responsible for data and sample collection. Team members were trained in sample collection, and filling up the questionnaire.

A questionnaire was filled meeting the defined inclusion and exclusion criteria. Relevant features like age, sex, dietary history and previous illnesses were recorded. Approximately 0.30 gm of hair was taken from the nape of neck after parental consent. The samples were numbered and stored in dry plastic bag.

Samples were then sent to Dr AQ Khan Research Laboratories (K R L) Kahuta, where they were treated and analyzed. Sample preparation was done by first washing the hair with detergent followed by plentiful tap water & finally by distilled water. Drying was done at 70^0C for 24 hours. 0.20 gm of dried scalp hair was digested using HNO3 /HClO4 solution. A blank solution was also prepared using the same acid and by following the same procedure which served as a control. Zinc levels were estimated with inductively coupled plasma atomic emission spectrometer by atomic spectrophotometery method.

Zinc status was categorized as low (with hair zinc of <100 μgm /gm of hair), adequate (with hair zinc of 100-200 μgm / gm of hair) and good (with hair zinc of > 200 μgm /gm of hair).

Dietary adequacy was determined by intake of milk, meat and egg with consideration of proportion of serving and number of times these items were consumed during 7 days of a week. Daily intake of milk and egg along with adequate intake of meat (>3days/week) was labeled as good diet. An average diet included intake of milk on daily basis with <3days /week consumption of egg or meat. When milk was the sole nutrition of the child with occasional intake (<1 day/week) of meat or eggs, the diet was considered inadequate.

Regarding illnesses parents were asked about the episodes of diarrhea (one episode defined as 3 or more loose stools /day persisting for at least 3 days) and acute respiratory tract infection (defined as fever and cough along with fast or difficult breathing) during past six months.

The results were compiled and analyzed using SPSS 10. Main study variables were age, gender, and nutritional status, illnesses and hair zinc levels. p-value <0.05 was considered statistically significant.

RESULTS

Out of 100 children, 43 were males and 57 were females with male to female ratio of 1: 1.32. Average age of children was 37.51 ± 13.39 (Range: 12-60) months. Majority of samples n=76 were from Jhang with the remaining n=34 from other districts.

Hair zinc levels ranged from 69 to 227 μgm/ gm of hair. Mean hair zinc level was 164.79 ± 53.7 μgm/gm of hair. Mean hair zinc levels were slightly higher in males (163.17 ± 37.07) as compared to females (159.71 ± 55.51). However the difference was not statistically significant with a P-value of 0.719.

Significant majority of children 62 (p<0.001), were having adequate hair zinc level (100-200 μgm/gm of hair), 25 had good zinc status (>200 μgm/gm of hair), while 13 were identified with low zinc status (<100 μgm/gm of hair) (Figure).

DISCUSSION

Hair zinc levels of majority of study population was adequate to good. Mean hair zinc level was comparable to levels observed in a study from Ghana by Takyi [10] which revealed that 72% of the study population of same age group had adequate zinc stores. Similar results were obtained in a study from Rural Costa Rican infants of low-income families [11].

Regarding minor illnesses in last 6 months, out of 100 subjects, 33 reported ARI and 24 reported diarrhea while 43 had no illness.

Regarding dietary habits, significant majority 80 (p< 0.001) were taking adequate to good diet whereas, 20 children were identified as not taking adequate diet.

Regarding the association of age and dietary adequacy with hair zinc, it was observed that adequate diet was not associated with adequate hair zinc levels and there was no association with the age (p=0.576) (Table).

Adequacy of hair zinc stores is also supported by the study of Collip et al with mean hair zinc levels of >100 μgm in the pediatric population [12]. However these results were in contrast to that of preschool

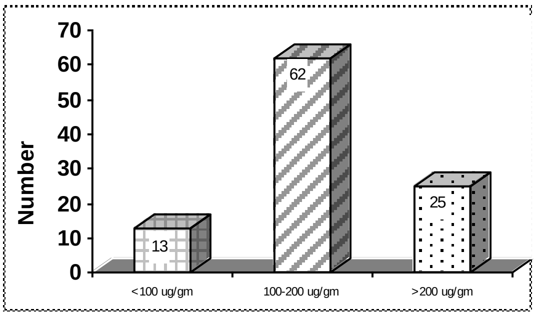

Figure: Hair Zinc Status Distribution n=100

*Significant number of children with adequate hair zinc level (p<0.001)

Low: with hair zinc of <100 ugm /gm of hair.
Adequate: with hair zinc of 100-200 ugm / gm of hair.
Good: with hair zinc of > 200 ugm /gm of hair.

Table: Hair Zinc Status According To Dietary Habit and Age n=100

Variables	Hair Zinc status (ug/gm of hair)		
	Low <100	**Adequate 100-200**	**Good >200**
Dietary habit	(n = 13)	(n = 62)	(n = 25)
Good diet	5 (38.5%)	9 (14.5%)	9 (36.0%)
Adequate diet	5 (38.5%)	41 (66.1%)	11 (44.0%)
Inadequate diet	3 (23.0%)	12 (19.4%)	5 (20.0%)
Age groups (months)			
12-24	2 (15.4%)	11 (18.0%)	6 (24.0%)
25-36	5 (38.2%)	24 (39.0%)	7 (28.0%)
37-48	2 (15.4%)	9 (14.0%)	5 (20.0%)
49-60	4 (31.0%)	18 (29.0%)	7 (28.0%)

children of Urban, North East Brazil where a study by Silivia et al revealed the prevalence of low zinc levels as 61.8 % [15].

Many factors can affect hair zinc status including age, gender, dietary intake, systemic illnesses sampling techniques and assessment methodologies. However there was no significant difference between mean hair zinc levels of males and females. Similar results were found in a study carried out in Brazil [15]. In contrast to this, Costa Rican females had a consistently higher mean hair zinc values than males [11].

Hair zinc levels of different age groups revealed no significant difference, similar to the results of Takyi who conducted the study on preschool and school children from a mixed income community in Southern Ghana [10]. However Hambidge reported that mean hair zinc level of preschool children was less than that of the older children [14].

The zinc status of study population was not much influenced by the dietary intake in this study though children with adequate/good diet had better hair zinc levels but some children with adequate/good diet revealed low hair zinc levels which could be due to some confounding factors which need to be identified. However Hambidge established that the incidence of low hair zinc levels was higher in low-income Mexican-American preschool children [14].

In the study population hair zinc levels were not much different in children with ARI and diarrhea from those who did not have these conditions. However a study revealed low zinc status in well nourished Bangladeshi children suffering from acute lower respiratory infections [15].

Other studies carried out by Bhandari et al [16] and Brooks et al [17] revealed that zinc supplementation in respiratory tract infection is significantly associated with reduction in morbidity and mortality. Similar results of low zinc levels were seen in children with diarrheal episodes in studies by Ahmad et al [4] and Baqui et al [18].

Because study was carried out on a selected population, on a limited number of subjects of a specific area, therefore results neither predict the status of the community nor reliability of hair as a sample. Therefore large-scale community based studies are needed to establish the zinc status of our children and its relation with the different factors using other methods of sampling as well.

CONCLUSION

It is concluded that majority of healthy pre-school children in the sampled districts of Punjab did not have zinc deficiency as assessed by hair zinc levels. However, few healthy children were found to have low zinc status inspite of adequate/good diet which could be due to some other confounding factors including sampling technique and assessment methodology etc which need to be identified. However, hair zinc estimation is a noninvasive, convenient and cost effective method for assessing zinc status in the community if proper care is given to sample collection, treatment and assessment technique though its reliability is still doubtful and needs further assessment.

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