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Zinc and Other Micronutrient Deficiencies, Under Nutrition and Morbidities in School Children of Desert Area of Rajasthan

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ABSTRACT

Objective: *Estimation of Zinc and other micronutrient deficiencies, under nutrition and morbidities*
Method: According to WHO/UNICEF/ICCIDD, data collected from 465 school children of 6 to 11 years from fifteen schools of Jodhpur district.

Results: *Analysis of serum zinc revealed that 76.1 percent school children were normal whereas 23.9 percent were deficient, more in early age group i.e. 60.1 percent in 6 to 7 years than 11 years age group (12%). Hb estimation revealed that only 26.5 percent children were non anemic. Median urinary iodine value was 150 g/l. Proportion of school children less than 100 g/l were 25.6 percent. 69 percent children consumed salt adequately iodized i.e. 15 ppm or more. Stunting (17.4%), Underweight (24.9%) and Wasting (8.4%) were also observed. The prevalence of these morbidities were 2.2, 1.2, and 0.5 percent in zinc deficient children.*
Conclusion: Nutrition intervention program stressing dietary diversification should be organized to reduce micronutrient deficiencies.

Introduction

Deficiency of essential micronutrients such as vitamin A, iron, iodine, folic acid and zinc, constitutes a major health threat for a large number of children in India. Estimates suggest that every day, more than 6,000 under-fives die in India and more than half of these deaths are caused by malnutrition, mainly due to micronutrient deficiency. Twenty six percent of the country's population is zinc deficient which contributes directly to stunting. The loss on account of micronutrient deficiencies costs the nation 1 percent of GDP which amounts to Rs. 277.2 billion or more in terms of loss of productivity, illness, increased health care costs and death [1]. The average dietary intake of micronutrients estimated by the M. S. Swaminathan Research Foundation suggests that the low-income population in rural areas is able to meet 48 percent of the recommended daily allowance of iron. Iron deficiency anaemia in the country is high because of low dietary intake, poor iron, and other nutrient intake; poor bio-availability of iron; and infections such as malaria and hook-worm infestations. Until recently major focus for preventing micronutrient deficiencies have focused on single micronutrients, that is deficiencies of iron, vitamin A and iodine. The importance of concurrent deficiencies of zinc, folic acid, vitamin B12 other B vitamins in our country is now recognized. Zinc deficiency is high among children, pregnant and lactating women in India, Pakistan, Bangladesh, Sri Lanka and Nepal [2-5].

Despite many years of supplementation approaches [6], deficiencies of iron, vitamin A and iodine are still largely prevalent and could be due to single micronutrient supplementation programs existing in our county. Also sub clinical deficiencies of other micronutrients can reduce the effect of a single micronutrient, when it is not limiting. Multi-centric studies carried out [7-10] showed that the prevalence of anemia, vitamin A deficiency and iodine deficiency disorders continues to be high, though there is a small decline in IDD in India. In terms of disease burden as measured by DALYs, underweight caused almost 10% (9.5%) of the entire global burden of disease, making it the leading risk factor worldwide. In addition, iodine deficiency disorders were estimated to cause another 2.5 million DALYs (0.2% of global disease burden). Iron deficiency caused an estimated 0.8 million deaths (2.4% of global DALYs), with one-third of the burden in South-East Asia. Zinc deficiency [11] accounted for a similar number of deaths, but a much higher share (2.9%) of global disease burden. Collectively, this cluster of under nutrition and micronutrient deficiencies caused about 6 million deaths in 2000 (11% of the global total) and about 17% of the entire global burden of disease. Much of this disease burden occurs among children. Indeed, these estimates suggest that at least half of all child deaths each year could be prevented if under nutrition, associated micronutrient disorders and morbidities could be eliminated. There is a limited scientific data available on the prevalence of Zinc along with other micronutrient deficiencies in schoolchildren of desert area. Therefore, there is a need to identify the Zinc along with other micronutrient deficiencies in school children of desert area.

Material and Methods

According to WHO/UNICEF/ICCIDD, for school based survey, 30 cluster sampling approach have to be adopted keeping in view the operational feasibility. Recently DGHS (2005) gave new guidelines for sampling according to which sample size is calculated on the basis of prevalence of Zinc deficiency as 11 % (collectively cluster of under nutrition and micronutrient deficiencies caused about 6 million deaths in 2000 i.e.11% of the global total has been considered as the basis for sampling, level of confidence - 95 %, relative precision - 20 %. Using formula $(Z\alpha)^2 Q / (L^2) P$, sample size worked out to be 810 children (rounded off) from Jodhpur district or 810 / 30 = 27 or 30 children (rounded off) per cluster. Keeping in view the operational feasibility, 15 clusters/schools were adopted to cover 450 school children i.e. 30 children per cluster for the identification of the problem in this area. At first step, listing of all the government and private schools with children 6-11 years of age from both rural and urban areas were listed from district education office of Jodhpur. Secondly cumulative enrollment was determined. Finally schools were selected using PPS sampling technique as recommended by WHO. In the selected schools, children were selected randomly using Tippets random number table. Equal proportion of boys and girls and proportionate distribution of children from 6-11 years were covered from selected schools.

All children examined for Socio-demographic profile, nutritional deficiency signs, morbidity for last 15 days and anthropometry (Height and Weight) using standard WHO techniques.

Blood samples were collected from school children, for that, collection tubes and cryotubes was labeled. Each child was given a code number that was also same on the collection tube, cryotube and prescribed form. The blood collected in the tube was allowed to clot at room temperature in dark for 15 minutes. After, 15 minutes, tubes with clotted material were kept in the rotor of centrifuge machine and spinned @ 1,500 to 2,000 rpm for 5 minutes. After centrifuging, serum was separated from the clot, and was removed very carefully with the help of a micropipette and immediately transferred to cryotubes. Precaution was taken at the time of separating the serum from the clot, so that the tip of micropipette should not be come in contact with the clot. For each sample, a new micropipette tip was used to avoid contamination. Zn deficiency was assessed by AOAC method using flame mode of Atomic Absorption Spectrophotometer. Standardization of the techniques was done for estimation of Zn by Atomic Absorption Spectrophotometer by flame mode. Internal quality control was done in each assay with known standards. Serum zinc concentration cut off recommended by International Zinc Nutrition Consultative Group (IZiNCG) was used as a marker of zinc deficiency. Anemia was assessed by Hemoglobin levels (Cyanmethaemoglobin technique), and was classified as per WHO classification. Iodine deficiency disorders was assessed by clinical examination of thyroid gland using the standard method as recommended by the joint WHO / UNICEF / ICCIDD consultation. A casual urine sample was also collected for estimation of Urinary Iodine Excretion (UIE) levels to asses the Iodine nutriture status. UIE was determined by Ammonium Persulphate Digestion on Microplate method (APDM) using standard laboratory technique. UIE level less than 10 mcg/dl was considered as indicator of iodine deficient nutriture.

Initially District Education Officer of Jodhpur was contacted and letter of cooperation addressed to all the principles of primary and middle schools of Jodhpur district was obtained for rapport establishment. Data was collected from 465 school children of 6 to 11 years belonging to fifteen schools of Jodhpur district.

Results

Analysis of 465 school children showed age and sex wise distribution of population (241 males and 224 females). Analysis revealed that majority of school children were Hindus (94.4%) followed by Muslims (5.6%). School children suffered from Fever, Acute Respiratory infection, and GIT (Diarrohea, stomach ache) were 4.7, 3.4, and 1.1 percent respectively.

Stunting (Height for age) was 17.4 percent in school age children with the prevalence of severe stunting 4.5 %. It showed inclining trend with age i.e. 10.8% in 7 years age group whereas 26.4% in 10 years age group. Underweight (Weight for age) was observed 24.9 % and wasting 8.4 %. Both Underweight and Wasting showed declining trend with age i.e. 26.8% & 15.5% in 6 years age group whereas 17.6% & 1.1% in 10 years age group respectively. Both stunting and wasting were observed higher in females (17.9% & 11.2%) than males (17.0% & 5.8%) though statistically insignificant (Fig 1-3).

Fig 1. SD classification for Height for Age in School children

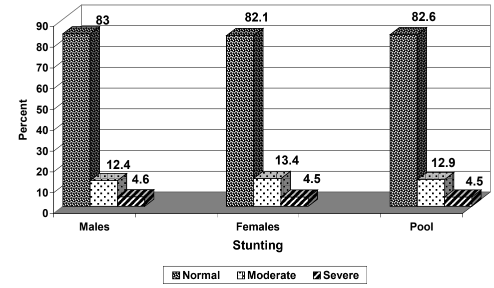


Fig 2. SD classification for Weight for Age in school children

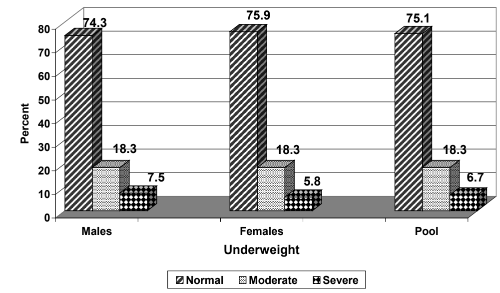
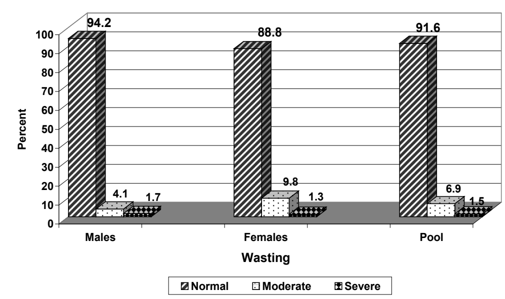


Fig 3. SD classification for Weight for Height in school children



Analysis of the serum zinc of 410 school children revealed that 76.1 percent school children were normal whereas 23.9 percent children were deficient in serum zinc i.e. serum Zn level was less than 0.65 mg/l (Table 1). It was observed that serum zinc deficiency was more in early age group i.e. 60.1 percent in 6 to 7 years age group than 11 years age group (12%). It was observed that serum zinc deficiency was 22.1 percent in boys whereas 25.6 percent in girls (Fig 4). The mean and standard deviation of the Age wise distribution of school children according to Serum Zin**c** were 52, 8.69 and 16.33, 5.78 respectively. The obtained 't' value is 8.36, $p<0.05$ is significant at 0.05 level.

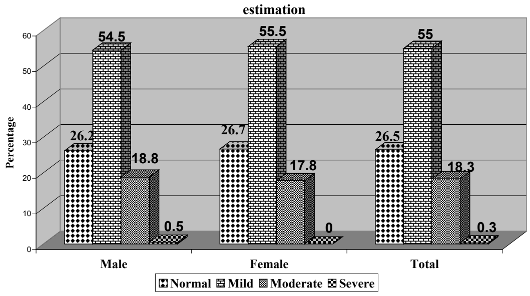
Table 1. Age wise distribution of school children according to Serum Zinc

Age Years	**Normal Serum Zn level ≥ 0.65 mg/l** *(less than 10 years)*		**Deficient Serum Zn level < 0.65 mg/l** *(less than 10 years)*	
	N	%	N	%
6+ N=64	45	70.3	19	29.7
7+ N=69	48	69.6	21	30.4
8+ N=79	59	74.7	20	25.3
9+ N=63	50	79.4	13	20.6
10+ N=85	66	77.6	19	22.4
11+ N=50	44	88.0	6	12.0
Total N=410	312	76.1	98	23.9

Cut offs for 10 years and above: Ref. IZiNCG, 2004
Male- Normal: Serum Zn level ≥ 0.70 mg/l; Deficient: Serum Zn level < 0.70 mg/l
Female- Normal: Serum Zn level ≥ 0.66 mg/l; Deficient: Serum Zn level < 0.66 mg/l

Analysis of 393 school age children according to Hb estimation revealed that only 26.5 percent children were non anemic (Hb≥ 11.5 g/dl) where as 55 percent children belong to mild category (10-11.5 g/dl) and 18.3 percent to moderate category (7-10 g/dl) of anemia whereas severe anemia was 0.3%. It was observed that 26.2% males were non anemic whereas 26.7% in case of females though statistically insignificant. Analysis revealed that overall school children suffering from Moderate category of anemia showed increasing trend i.e. 13.6% in 7 years age group whereas 22.6% in 10 years age group (Fig. 5).

Fig. 4. Distribution of School Children according to Hemoglobin estimation



Epidemiological criteria, as prescribed by WHO, for assessing iodine nutrition is based on median urinary iodine concentrations / levels. Analysis of 289 urine samples was done. Median urinary iodine value was 150 mcg/l. It was observed that proportion of school children less than 100 μg/L were 25.6 percent, whereas, proportion of school children less than 50 μg/L were 5.9 percent. Iodine content of 113 salt samples was estimated using standard iodometric titration method. 69 percent children consumed salt adequately iodized i.e. 15 ppm or more. Overall high proportion of children (31%) consumed salt having inadequate iodine content i.e. less then 15 ppm. 2.7 percent children consumed salt having negligible iodine content (Less than 7 ppm).

Analysis revealed that in zinc deficient children, the prevalence of Fever, Acute Respiratory infection, and GIT (Diarrohea, stomach ache) were 2.2, 1.2, and 0.5 percent whereas in non zinc deficient children, it was 3.2, 2.7 and 0.7 percent in the present study.

Discussion

Deficiency of essential micronutrients such as vitamin A, iron, iodine, folic acid and zinc, constitutes a major health threat for a large number of children in India. Present study revealed that 23.9 percent of children suffered from zinc deficiency in desert area. It was observed that serum zinc deficiency was more in early age group i.e. 60.1 percent in 6 to 7 years age group than 11 years age group (12%). Earlier studies among adolescents in Delhi reported that overall 49.4% children were found to have a deficient zinc nutriture [3] whereas in underfive children, zinc deficiency was highest in Orissa (51.3%), followed by Uttar Pradesh (48.1%), Gujrat (44.2%), Madhya Pradesh (38.9%) and Karnataka (36.2%) [12]. In another study low plasma zinc concentration and poor cognitive performance was observed in 45% of the adolescents girls in India [5, 13]. In another study in Maxican children, zinc deficiency was found higher in infants (34%) than in school age children (19-24%) [4] whereas in Latin America, prevalence of 20 to 30% were reported for deficiencies of iron, iodine, zinc and vitamin A [14].

Present study revealed that high percentage of school children suffered from anemia (73.5%) in desert area which is higher than earlier reported study in Mexican school children i.e. (34-39%) whereas iron deficiency in infants < 2years was 67% [4]. In another study it was observed 79.4 % in school children [15], 90.1% in 16 districts of India [7] whereas 55% to 60.5% in adult population of desert area and 40% to 50% in preschool and primary school children in south Asia [16-17]. In present study, overall school children suffering from Moderate category of anemia showed increasing trend with age i.e. 13.6% in 7 years age group whereas 22.6% in 10 years age group.

Epidemiological criteria, as prescribed by WHO, for assessing iodine nutrition is based on median urinary iodine concentrations / levels. In present study, Median urinary iodine value was 150 mcg/l and proportion of school children less than 100 μg/l were 25.6 percent, whereas, proportion of school children less than 50 μg/l were 5.9 percent which is lower than earlier reported study in school children of Kottayam district i.e. 33.1% and 12.4% respectively [18]. In one of the earlier study, it was observed that Median urinary iodine value was 118 μg/L in Bikaner district [16] whereas 166.2 μg/l in another study [19] similar to the findings of the present study. In another study in Bhubaneswar, Median urinary iodine value was found very low i.e. 50 μg/l and proportion of children having values less than 100 μg/l, indicating biochemical iodine deficiency [20]. In present study, 69 percent children consumed salt adequately iodized i.e. 15 ppm or more, which is stipulated value of salt iodization. In earlier study in school children of Kottayam district, 60.6% of the children were consuming adequately iodized salt [18] whereas 55.4% in case of 15 districts of India [7], 51% in Bhubaneswar and 80.2% in Vadodara [20-21]. Overall high proportion of children (31%) consumed salt having inadequate iodine content i.e. less then 15 ppm.

School children of present study suffering from Fever, Acute Respiratory infection, and GIT (Diarrohea, stomach ache) were 4.7, 3.4, and 1.1 percent respectively. It was observed that in zinc deficient children, the prevalence of Fever, Acute Respiratory infection, and GIT (Diarrohea, stomach ache) were 2.2, 1.2, and 0.5 percent whereas in non zinc deficient children, it was 3.2, 2.7 and 0.7 percent in the present study.

This study showed that school children were malnourished suffering from stunting (17.4%), underweight (24.9%) and wasting (8.4%) along with micronutrient deficiencies. Similar findings being reported from Malaysia where a prevalence of 25% underweight and 35% stunting is reported among young children from poor rural households where iron deficiency anemia affects 40-50% of preschool and primary school children [17]. In East Iran study of school children, where stunting and wasting was 13.2% and 5.5%, recommended supplementation of zinc, especially in stunted students [22]. In one of the study in western Rajasthan, high prevalence of stunting (36.6%), underweight (43.9%) and wasting was reported during drought period [23]. Some studies [24-25] have shown that the effect of Zinc supplementation helps in reduction of under nutrition and some morbidities especially acute lower respiratory infections and diarrhoea. Present study also showed that as zinc deficiency decreases with age in children, underweight, an indicator of short term malnutrition, also decreased with age in the children studied whereas stunting, an indicator of long term malnutrition, increased with age revealing that it might be due to fact that the studied children suffered more from zinc deficiency in early age group leading to more stunting in higher age group.

Conclusion

The study revealed that school children are not only suffering from anemia but also with Zinc deficiency along with stunting, underweight and wasting. Zinc along other micronutrients deficiencies (anemia and iodine) are associated with the under nutrition and some of the morbidities in children. Nutrition intervention program should be done more intensively stressing the role of dietary diversification among school children in order to reduce the micronutrient deficiencies which in turn will help in reducing the under nutrition.

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