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IMPACT OF SOCIO ECONOMIC STATUS AND NUTRITION EDUCATION ON THE PREVALENCE OF ZINC DEFICIENCY AMONG GOVERNMENT SCHOOL GOING CHILDREN

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Zinc deficiency is widespread and a public health concern. Various studies report high prevalence among children of the school going age due to relatively high requirement during growth years. The main objective of this study was to assess the prevalence of zinc deficiency among school going children belonging to low income group. Study subjects were selected from two government schools in urban Bengaluru. Zinc status assessment was done using the Bryce-Smith Zinc Taste Test (BS-ZTT) and 24 hour dietary recall. The study was done in two stages-pre evaluation and post evaluation. A majority of the study subjects (32%) belonged to the 10-11 years age group. A significant association ($p<0.05$) was found between socio-economic status and prevalence of zinc deficiency. Lower income group children found to be more zinc deficient than upper lower income group. A statistically significant correlation($r = +0.050$, $p<0.05$) existed between the pre and post taste test of the study subjects based on age. Likewise, the zinc taste test was well correlated ($r = +0.158$, $p<0.05$) with the dietary zinc intake, and provides a good idea about zinc deficiency. The incidence of under-nutrition was found to be high in this study population, with 100% being underweight in 8-9 and 11-12 years age group.

Keywords: Zinc deficiency, Bryce-Smith Zinc Taste Test (BS-ZTT), Socio economic status, 24-hour dietary recall, Under-nutrition

INTRODUCTION

Zinc deficiency is a health problem in many communities, especially among children because of growth spurt. zinc deficiency during school age can cause growth limitation, delay in sexual maturity, behaviour disorders and abnormal functioning of the immune system, makes the child more vulnerable towards acquiring respiratory and gastrointestinal infections and impairment of taste and smell perception. In a study conducted on the link between zinc deficiency and child development it was seen that a deficiency of this essential trace mineral was associated with a deficit in cognitive activity, attention and motor development. These conditions are usually common in nutritionally deficient children (Black, 1998). Mild zinc deficiency is almost universal and considering the relatively higher requirement of zinc in early infancy and childhood, zinc should be considered as an important limiting factor to growth in children.

The human body contains on an average, 2-3 grams (2000-3000 milligrams) of zinc. Most of it is found in the adrenal glands, brain and eyes. Today, zinc is known to be

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involved in the activity of >200 enzymes in most major metabolic pathways. There is no functional storage reserve for zinc in the body , so an adequate supply of dietary zinc is required on a regular basis.

In recent decades, there has been heightened interest in the role of zinc in human nutrition research. Zinc deficiency may be due to malnutrition, vegetarianism, chronic diarrhoea, nutrient interactions with certain drugs and insufficient levels of zinc in the soil. Zinc deficiency has severe consequences, particularly in children, contributing to stunted growth as well as morbidity related to diarrhoea, pneumonia and malaria and other chronic diseases (Javed *et al.*, 2009).

In addition to this, the potential link between zinc deficiency and cognitive development may be stronger in children at risk for deficits in cognitive and motor functioning, such as premature infants, children who have nutritional problems, and who have chronic diseases that hinder zinc absorption or growth. As it compromises the development of millions of children in developing and industrialised countries, zinc deficiency is rapidly becoming a veritable public health concern.

Mild deficiency can result in impaired growth velocity, suboptimal pregnancy outcomes and impaired immune responses. Severe deficiency can result not only in growth impairment but also alopecia, diarrhoea, delayed sexual development and impotency, eye and skin lesions and impaired appetite (ICMR, 2009).

Various studies, as stated above, show that even a mild deficiency of zinc can have an adverse affect on the clinical, biochemical and immunological functions. The first clinical symptoms of a marginal zinc deficiency are impairment of taste and smell. Certain studies have found that taste acuity may be a good indicator of the functional availability for zinc in the body and have led to the development of the zinc taste test, also called the Bryce-Smith Taste Test, as it was developed by Professor Derek Bryce-Smith, Professor of Biochemistry at Reading University, to assess deficiency in anorexic patients (Schauss, 1987).

For young children, complementary feeding practices should be implemented with zinc-rich foods, such as animal source foods, and zinc-fortified complementary foods. Flesh foods, liver, fish and milk are very good sources of zinc. All food grains are good sources of zinc. Like iron, zinc is lost on milling and processing of the grains. Pulses and nuts are relatively rich sources of Zinc (ICMR,2009). Opportunities to improve zinc status should be considered in the context of ongoing general health and nutrition programme such as growth monitoring programmes, diarrhoea treatment facilities, Integrated Management of Childhood Illnesses (IMCI) interventions and National Fortification programmes.

According to the Micronutrient Initiative and Project Healthy Children, zinc deficiency contributes to as many as 800,000 child deaths annually. Given the important functions of zinc and its consequences on the health and development of children, the aim of this study is to assess the prevalence of zinc deficiency (based on dietary intake and taste test for zinc) among school children belonging to the low income sector. Also, there is very limited data and awareness on the prevalence of zinc deficiency among school children in India which was an influencing factor to conduct this study.

Hence, this study has been undertaken to study the impact of socio economic status on prevalence of zinc deficiency.

MATERIALS AND METHODS

It has been stated in many research studies that zinc deficiency is common in developing countries and can affect the growth of children in the school going age. A cross sectional study using random sampling technique was conducted, where 100 children were assessed for their zinc level using the zinc taste test. The subjects were selected from two Government schools in Bangalore city for a duration of one year .Children in the age group of 8-12 years and belonging to the low income group was the inclusion criteria. The data collection was done in two stages, the pre evaluation phase and the post evaluation phase. There was a gap of four months between the two evaluation stages, during which nutrition education was imparted to the children. The pre designed questionnaire was administered to the study subjects and each question was explained in detail before their response was recorded. They were thoroughly inquired about their food habits and 24-hour recall diet history in order to achieve accurate responses. The Zinc Taste Test was performed as per the protocol in the pre evaluation phase along with the data collection, and in the post evaluation phase after the nutrition education program was completed. A pre structured questionnaire was formulated and was used to elicit relevant information. The questionnaire comprised of all details related to personal information, socio economic status , information on Zinc taste Test and 24 hour dietary recall.

Socioeconomic status of the study population was determined using the Kuppuswamy's classification (2012). In the present study, the parent's education, occupation and income was recorded after confirming with the parents. The socio economic status of the study subjects were categorized into the respective strata.

The 24-hour hour diet recall interview is a quantitative research method used in nutritional assessment, in which individuals were asked to recall foods and beverages they consumed in the twenty-four hours prior to the interview. It may This method records the daily, self-reported consumption of individuals and was administered for three days including one weekend and two weekdays to assess what types of foods were being consumed by individuals in a specific community to avoid errors.The data associated with diet intake of the study population was collected in both the pre evaluation as well as post evaluation phase. Once the raw amounts of the food were quantified, the nutritive value of each item was calculated .The major macronutrients (energy, protein, fat, carbohydrates) and micronutrients (iron, calcium, vitamin A, zinc) levels of all foods consumed in the last three days as recorded in the pre and post evaluation phase was calculated using the Nutritive value of Indian Foods given by National Institute of Nutrition, ICMR (2004).

In Bryce-Smith Zinc Taste Test subjects were clinically tested for zinc deficiency by means of 'Zinc Taste Test' (ZTT). This test was based on the observation that zinc deficiency leads to failure of perception of metallic taste of zinc. The test solution consists of a colourless 1% solution of zinc sulphate in distilled water. Only 2-5 ml of this solution was instilled into the oral cavity of subjects who were asked to retain it for 10 seconds without swallowing. Permission was obtained from the teachers and the parents prior to the test. Clinical grading was done on the basis of the score received (Garg *et al.*, 1993; and Zdilla *et al.*, 2014). The results obtained during the course of study were subjected to statistical analysis by using SPSS software.

RESULTS AND DISCUSSION

The present study reveals that the majority of the children (32%) belonged to the age group of 10-11 years, followed by 30% in 9-10 years and only 18% in the age group of 11-12 years. Multiple studies have been carried out to assess the effect of zinc supplementation on growth of children (Brown, 2002). Zinc deficiency may undermine cognitive development in children through alteration in attention,

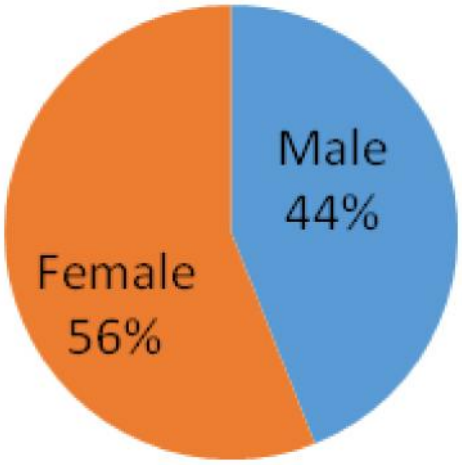
Table 1: Age Wise Distribution of the Study Subjects

Age Group (years)	Study Subjects	
	No.	%
9-Aug	20	20
10-Sep	30	30
11-Oct	32	32
12-Nov	18	18
Total	100	100

activity and other aspects of neuropsychological function. As it compromises the development of millions of children in developing and industrialized countries, zinc deficiency is a veritable public health concern for this age group (Samuel *et al.*, 2010). The findings revealed that age may be important to consider in the link between zinc deficiency and children's cognitive development because children may be particularly vulnerable to zinc deficiency during periods of rapid growth and development, such as infancy and adolescence (Black, 1998).

There exists a gender based difference in the prevalence of zinc deficiency among populations, and the findings for gender-based differences for zinc deficiency were in consent with a study in which only males were selected because they appeared to be more clinically sensitive to suboptimal Zinc nutriture than females, perhaps because of a higher requirement for Zinc (Gibson *et al.*,1989).

Figure 1: Gender Distribution of Study Subjects



The above figure represents the gender wise distribution of the study subjects. The sample size for this study was 100, of which 44% were male while majority (56%) were female. In an earlier Canadian study (Vanderkooy *et al.,* 1987) 21% of the boys studied compared with only 5% of the girls had a low Zinc status, which was indicated by hair Zinc concentrations < 70 g/g.

Similar findings were observed in three zinc supplementation studies in the United States, where male but not female infants and preschool children showed significant increases in linear growth velocity after zinc supplementation (Gibson, 1989). In conclusion it has been proven through several studies conducted on zinc assessment that boys were more likely to have low zinc status (measured by both hair and plasma) than girls.

All community-based studies focus on socio-economic stratification, as this is the key to understanding affordability of health services, amenities, and purchasability. When it is taken as a summation of education, occupation, and income, it reflects the value system expected for that level of education and occupation and the income is parallel to standard of living.

The study subjects were classified into their respective socioeconomic strata based on the Kuppuswamy's socioeconomic status (2012). Socio Economic Status (SES) is an established determinant of health. From the above table it was seen that a majority of study subjects belonged to the upper lower socio economic group (83%), while only 17% were in the lower socio-economic status. This indicates that most of the parents had received education up to primary or high school and had professional qualification as semi skilled or skilled workers.

Table 2: Socio-Economic Status of Study Subjects

Socio-Economic Status	Study Subjects	
	No.	%
Lower	17	17
Upper lower	83	83

Note: * Ref-Kuppuswamy's Socio Economic Status for family (2012).

Socioeconomic status is a factor, which directly influences food consumption and purchasing power of populations. The above table reveals a strong association between the socioeconomic status and prevalence of zinc deficiency ($p<0.05$). It has been observed that the zinc consumption among the upper lower socioeconomic status group was higher than the lower socioeconomic status group. A mean increase of 0.47 mg/d (±0.3) was found in the zinc consumption level of the upper lower socioeconomic strata as compared to 0.43 mg/d in the lower income group.

Zinc deficiency and its interrelation with low income was studied and it was observed that the prevalence of zinc deciency and anemia was high in this population of low-income children, especially among African Americans (Cole *et al.,* 2010).

The findings of the present study (Figure 2) were in consent with a study (Samuel *et al.,* 2010), which indicated

Figure 2: Association Between Socio-Economic Status and Prevalence of Zinc Deficiency (Pre and Post Nutrition Education Intervention)

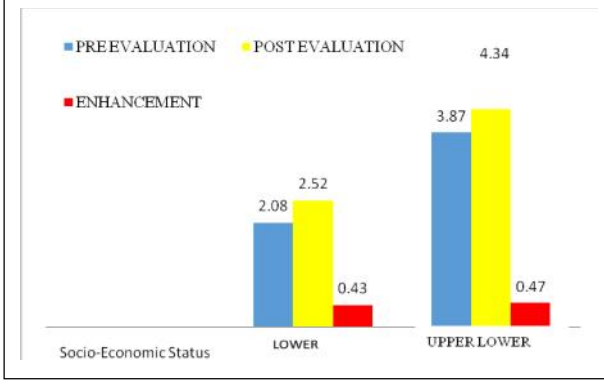


Table 3: Association Between Socioeconomic Status and Prevalence of Zinc Deficiency

Socio-Economic Status	Sample (n)	Zinc Consumption (mg/d)				Difference (Mean Increase in mg/d)		t' Value
		Pre Evaluation		Post Evaluation				
		Mean	SD	Mean	SD	Mean	SD	
Lower	17	2.08	0.4	2.52	0.5	0.43	0.3	5.91*
Upper lower	83	3.87	1	4.34	1	0.47	0.3	14.27*

Table 4: Overall Zinc Taste Test Scores of Study Subjects (Pre and Post Nutrition Education Intervention Program)

Category	Zinc Taste Test Scores	Study Subjects				χ^2 Value
		Pre Evaluation		Post Evaluation		
		No.	%	No.	%	
Severe	1	62	62	14	14	72.79*
Moderate	2	36	36	38	38	
Mild	3	2	2	36	36	
No deficiency	4	0	0	12	12	
Total		100	100	100	100	

Note: * Significant at 5% Level; $\chi^2_{tab}(0.05,3df) = 7.815$.

Table 5: Correlation Between Pre and Post Evaluation of Zinc Taste Test Scores

Category	Sample (n)	Correlation Coefficient (r) Value	
		Pre Test	Post Test
Age	100	-0.028	0.05
Boys	44	0.066	0.099
Girls	56	-0.099	0.03

a high risk of zinc deficiency and suboptimal zinc status for the majority of the study population of children, possibly as a result of low consumption of food sources with high bioavailability of zinc, which invariably was a direct consequence of poverty and food insecurity. It was also observed that in many low income countries, staple diets are predominantly plant based; intake of cellular animal-protein foods such as red meat, poultry, and fish, rich sources of readily available dietary zinc, was often small because of economic, cultural, or religious constraints. As a result, the amount and/or bioavailability of zinc from such diets were found to be low and frequently the primary cause of zinc deficiency (Gibson, 2012).

Alteration in taste associated with zinc deficiency has commonly been used as a measure of the extent of deficiency. Metallic taste of zinc is perceived during its deficiency. On this basis a Zinc Taste Test (ZTT) has been devised to detect zinc deficiency, which has been claimed to reflect the body zinc status (Garg *et al.*, 1993).

It was observed that there was a strong significant difference in the Zinc Taste Test scores of the study subjects before and after the Nutrition Education Intervention program ($\div 2_{cal}$=72.79> $\div 2_{tab}$= 12.59). An increase has been seen in the Zinc taste test scores, with only 14% of study

Table 6: Pre and Post Evaluation of Zinc Consumption of Study Subjects (24 Hour Dietary Recall Method)

Age (years)	RDA* mg/d	Pre Evaluation		Post Evaluation		Difference (Mean Increase)	t' Value
		Mean±SD	%Adq	Mean±SD	%Adq	Mean±SD	
10-Aug	8	3.30± 1.2	41.3	3.75± 1.2	46.9	0.45± 0.3	10.61*
12-Oct	9	3.82± 0.8	42.4	4.30± 0.8	47.8	0.48± 0.3	11.31*

Note: Significant at level 5%; * RDA-Recommended Dietary Allowance.

Table 7-Correlation between Consumption of Zinc and Zinc scores in Pre and Post evaluation

Zinc Scores	Pre Evaluation			Post Evaluation		
	Sample (n)	Consumption of Zinc		Sample (n)	Consumption of Zinc	
		Mean	SD		Mean	SD
1	62	3.39	1.02	14	3.7	0.93
2	36	3.82	1.16	38	4.12	0.91
3	2	4.19	0	36	3.82	1.16
4	0	0	0	12	4.76	0.69
Total	100	3.56	1.05	100	4.03	1.04
Correlation (r)		0.212			0.158	

Note: Significant at level 5%.

subjects being severely zinc deficient (score 1) in the post evaluation, as compared to 62% in the pre evaluation phase. This also reveals the impact of the nutrition education on the study subjects, which included information on dietary modifications, zinc related knowledge and deficiency symptoms. There are a limited number of studies conducted on impact of nutrition education on zinc deficiency among school children. However, it was suggested that an integrated approach employing targeted supplementation; fortification and dietary strategies must be used to maximize the likelihood of eliminating zinc deficiency at a national level. The strategies must also be integrated with ongoing national food, nutrition, and health education programs to enhance their effectiveness and sustainability (Gibson, 1998).

The above table shows the correlations between the zinc taste test scores of the study subjects as observed before and after the Nutrition Education Intervention program. According to the correlation test results, there appears to be a negative correlation (r = -0.028) between the overall age group distribution and the zinc taste test scores before the nutrition education was commenced. However, a linear positive relationship was found to exist in the post evaluation phase ($p<0.05$). Similarly, on the basis of gender the correlation coefficient was found to be negative (r = -0.099) in the pre evaluation phase among girls when compared to boys (r = +0.066). However, both males and females showed a positive correlation between the in the post evaluation phase ($p<0.05$).

The Recommended Dietary Allowance (RDA) for zinc for the age group of 10-12 years is 9 mg/day. The mean intake of zinc of the study subjects was found to be 3.42 mg/d (±0.8) with an adequacy ratio of 42.4% of RDA. A slight increase was observed in the post evaluation where the adequacy was 47.8% of the RDA. A significant difference was found between the pre and post evaluation phases in the mean intakes of micronutrients at $p<0.05$.

The above table represents the correlation between the dietary zinc consumption and the Zinc Taste Test scores of the study subjects as studied in the pre and post evaluation periods.A strong positive correlation was seen between dietary intake and the prevalence of zinc deficiency among the study subjects in the pre evaluation phase, where in it was found that as the zinc intake decreased, the extent of deficiency was also affected. Majority of the children (62%) had a zinc taste test score of 1 and their mean zinc intake was 3.39 mg/d (±1.02), which was the lowest value. This indicated severe deficiency well correlated with the dietary intake values ($p<0.05$). Similarly, in the post evaluation phase 38% of the study subjects reported a zinc taste test score of 2,which indicated moderate zinc deficiency. The mean zinc intake for this group was 4.12 mg/d, and this enhancement could be the result of inclusion of zinc rich foods in the diets. A positive correlation was observed between the zinc intake level and the taste test scores ($p<0.05$) that is, as the mean zinc intake increased, the percentage of study subjects reporting a higher zinc taste test score also increased and lesser number of study subjects reported severe zinc deficiency. The findings of the present study were similar to a study where it was found that the decline and increase in serum zinc and Zinc Taste test Scores were fairly well correlated and stated that the Zinc Taste Test was a sufficiently reliable guide to zinc deficiency (Garg *et al*.,1993).

CONCLUSION

In conclusion the result of the study reveals that the zinc taste test scores were well correlated (r = +0.158, $p<0.05$) with the dietary zinc intake, and provides a good idea about zinc deficiency. Lack of awareness and knowledge about zinc and its role in human health, sources of zinc and consequences of zinc deficiency was seen among the study subjects. Thus, nutrition education related to these topics was imparted and a positive effect was observed with an improvement in knowledge and practice of the study subjects.

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