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Research Paper

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MICRONUTRIENT DEFICIENCIES AND CHILD GROWTH

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ABSTRACT

Introduction: Growth retardation is highly prevalent in developing countries and is associated with several adverse outcomes throughout life. However, the role of specific micronutrient deficiencies in the etiology of growth retardation has gained attention more recently. Rationale: To correct the situation of malnutrition among children several intervention programmes are in operation. The assessment of nutritional status of beneficiaries of such interventions in general, and that of micronutrient status in particular has great significance as a feedback. Materials and Methods: The prevalence of undernutrition at dietary, anthropometric and biochemical levels was investigated in a cross sectional study involving 776 school going children aged from 8 to 10 years in Tirupati (A.P). All the children were beneficiaries of the Mid Day Meal (MDM) program. Height, weight and MUAC were measured. Waterlow classification was used to categorize children into different nutritional grades to focus on the growth status. Dietary intakes were assessed using a combination of recall and weighment methods. The serum level of micronutrients vit-A, Iron and Zinc was estimated through standard protocols. Results: The data on anthropometry reveal that a highest percentage of children 31.5 and 36.1 were stunted (S) and stunted and wasted (SW) respectively. About 26.4 percent children were normal (N). ANOVA was conducted for the nutrient intakes and biochemical micronutrient status of children in the three nutritional grades reveled that the differences were signifant (p<0.001) and the normal group registered better values for all parameters compared with the S and SW groups. Conclusion : The general low and inadequate food intake may be the contributing factor for poor growth statusmand poor biochemical profile of the select micronutrients among this group of children. Further, it is thus evident that the intended nutritional benefits of the intervention, the MDM programme are not fully reaching the target group.

KEYWORDS : Micronutrient deficiency, Growth, Nutrition Status, Anthropometry, Dietary intakes, Mid Day Meal Programme (MDM), School children.

INTRODUCTION:

Growth retardation is highly prevalent among children in low-income countries (ACC/SCN, 2000). School children form an important vulnerable segment of population and constitute about 20 per cent of total population of India. School age is a dynamic period of growth and development as children undergo physical, mental, emotional and social changes during this stage. The school age period is nutritionally significant because this is the prime time to build up body stores of nutrients in preparation for rapid growth of adolescence (Kumari and Jain, 2005). The age of 6-10 years is a period of growth and at this stage, the foundation for adulthood is laid down. Hence, the nutritional deprivation during this period may influence the adult size and capabilities of the individual at later stages of life (Rajagopalan, 2003).

Growth and nutritional status of pre-school and school going children are profoundly influenced by the diet consumed by them. Growth failure may be caused by inadequate intakes of one or more nutrients including energy, protein or micronutrients such as iron, zinc and vitamins-D, A or C. For some of these nutrients, such as zinc and phosphorus, the sign of deficiency during childhood is specifically growth retardation (Golden, 1988).

Micronutrient deficiencies are common in many developing countries and are typically due to inadequate food intake, poor dietary quality, poor bioavailability (because of the presence of inhibitors, mode of preparation, and infections), and/or the presence of infections.

Micronutrient malnutrition continues to affect a large number of children. Deficiencies of iron, vit-A, and zinc are even more widespread world wide than PEM (WHO, 2001).Most discussions of micronutrient deficiencies have been limited to the "Big 3", namely vit-A deficiency (VAD), iodine deficiency disorders (IDD), and iron deficiency anemia (IDA). While these problems remain significant public health concerns, it is important to recognize other micronutrient deficiencies such as zinc, folate, and multiple micronutrient malnutrition (ACC/SCN, 2000). The micronutrient interventions most often are focused on pre-schoolers and pregnant and lactating women. In the context of the multi micronutrient deficiencies prevalent among the children in the school age group specific interventions addressing this age group are necessary (Rajagopalan, 2003).

The three main strategies used to control the important micronutrient deficiencies are food diversification, fortification, and medicinal supplementation (Sivakumar et al., 2006 and Walker et al., 2005). Food diversification usually involves actions that increase in particular micronutrients. Fortification consists of adding a nutrient to a food that is widely consumed by those at risk of developing the micronutrient deficiency. Medicinal supplementation is generally achieved by two different methods. The first typically involves daily consumption of a pill or liquid containing a dose of a particular micronutrient. The second method consists of mega doses given at intervals. In all of these interventions the targeted groups are usually infants and pregnant and lactating mothers and below 6 years of ages. The targeting of vulnerable groups and diseased is more frequently done, however the most significant school age groups are very rarely included for examination.

SUBJECTS AND METHODS:

The present study was carried out on 776 children (342 males and 434 females) between the age group of 8 to 10 years from Tirupati urban, Municipal upper primary schools. Which are the beneficiaries of Mid Day Meal Programe. All the subjects were from low income families. Height was measured using portable anthropometric rod and weight by plotform weighing balance with minimum clothing. (Jelliffe, 1966). The measurements were compared with NCHS standards. The quantity and quality of dietary intake are assessed by prospective food records (with weighed or estimated food portions), retrospective 24-hour recalls (previous 24 hours or of a "typical" 24-hour period), or food frequency questionnaires (Gibson, 2005). The daily intake of calories, protein, fat, calcium, iron, retinol, zinc and vit-C was calculated using the food composition tables (ICMR, 2007). Using the percent weight-for-age and weight-for-height the children were classified into different degrees of malnutrition based on Waterlow's classification (Bamji, 2004). The vit-A in serum was estimated using the Antimony tri-chloride method (Carr-Prising reaction-Oser, 1968). Serum zinc and iron were determined by Atomic Absorption Spectroscopy.

RESULTS:

Nutritional status of the children was assessed through Waterlow's classification which is based on wt-for-age and wt-for-ht data. The children were categorized into different degrees/types of malnutrition as normal (N), wasted (W), stunted (S), stunted&wasted (SW). The select nutritional characteristics viz., anthropometric measurement, dietary intakes, serum level of select micronutrients are presented in relation to the N, S, SW status of the children.

Table: 1. Prevalence of undernutrition among school going children as assessed from Waterlow's classification

Nutritional Grades	Boys				Girls				Grand Total %(n)
	8 yrs %(n)	9 yrs %(n)	10 yrs %(n)	Total %(n)	8 yrs %(n)	9 yrs %(n)	10 yrs %(n)	Total %(n)	
Normal	27.1 26	29.3 34	31.5 41	29.5 101	22.5 29	24.4 40	24.8 35	24.0 104	26.4 205
Wasted	-	0.9 1	-	0.3 1	-	-	-	-	0.04 1
Stunted	41.7 40	30.1 35	29.2 38	33.1 113	41.8 54	37.2 61	44.7 63	41.0 178	37.5 291
Stunted&Wasted	31.2 30	39.7 46	39.2 51	37.1 127	35.7 46	38.4 63	30.5 43	35.0 152	36.0 279

Table: 2. Mean anthropometric measurements of school going children according to nutritional grade

Sex	Age yrs	Height (cm)			Weight (kg)			MUAC (cm)		
		N	S	SW	N	S	SW	N	S	SW
B	8	128.9±6.6	117.5±3.8	115.6±4.3	25.8±2.5	19.0±1.4	15.8±1.3	16.1±1.3	14.7±1.0	14.0±0.9
	9	129.7±6.3	122.9±4.5	120.5±6.5	26.4±1.4	21.4±1.8	17.3±2.0	17.4±1.0	16.6±0.9	15.9±0.9
	10	136.4±5.1	126.4±5.4	126.9±7.5	30.3±2.2	23.7±2.2	20.0±2.8	18.1±1.2	16.9±1.0	16.5±1.1
G	8	125.6±7.9	116.2±4.9	114.2±6.2	24.1±2.4	18.1±1.7	14.8±1.9	15.3±1.5	13.9±0.9	13.1±0.9
	9	128.7±6.5	119.8±5.0	119.8±7.0	26.4±0.8	18.7±1.8	16.7±2.4	16.2±1.4	15.7±1.2	14.5±0.9
	10	131.3±3.6	126.1±5.3	122.8±6.4	30.6±1.2	21.7±2.6	17.6±2.7	17.5±1.0	16.6±1.1	15.7±1.0
F-value		144.933			792.216**			85.178**		

** Difference between nutritional status significant at $p<0.01$

Table.1. shows that out of the total of 776 children screened only 26.4 percent were found to be normal and the remaining 74 percent belonged to stunted (31.5

Table: 3. Mean dietary intakes of the children belonging to different nutritional grades

Degrees of Malnutrit-ion	Gender	Age Yrs	Energy (k.cal)	Protein (g)	Fat (g)	Retinol (mcg)	Vit-C (mg)	Ca (mg)	Iron (mg)	Zn^1(mg)
N	B	8	1368.3±83.8	34.1±3.7	21.3±1.6	172.9±11.2	18.9±0.8	274.6±20.8	14.6±1.1	5.3±0.6
		9	1494.0±25.1	39.0±1.3	22.9±1.3	232.8±41.6	21.2±1.4	324.0±30.2	17.3±0.9	5.1±0.6
		10	1741.3±26.5	47.2±1.5	23.7±1.4	297.7±25.5	23.7±1.4	400.5±24.6	19.4±1.8	6.9±0.5
	G	8	1302.2±37.4	32.9±2.2	20.3±0.9	162.2±6.9	18.3±0.6	256.9±22.0	14.3±0.8	5.1±0.3
		9	1378.7±45.9	35.5±2.7	19.7±1.8	232.4±32.1	19.9±1.9	250.3±36.2	13.8±1.5	5.0±0.5
		10	1686.5±11.8	42.8±1.1	20.6±1.0	245.0±11.9	22.1±0.9	336.5±14.0	16.9±0.9	5.6±0.4
S	B	8	1255.0±160.3	27.9±3.1	17.2±1.2	142.5±13.1	17.7±1.0	233.2±14.7	12.5±0.9	3.9±0.6
		9	1376.1±34.1	33.5±1.9	19.1±1.6	168.3±15.3	18.3±0.9	241.0±24.9	14.2±1.4	4.5±0.5
		10	1657.5±42.4	41.9±3.2	20.0±2.1	241.5±36.6	20.0±2.1	331.4±33.4	15.7±1.7	5.4±0.7
	G	8	1191.0±26.7	26.7±1.8	18.1±1.1	135.2±13.7	15.3±1.3	226.2±22.3	12.0±0.4	3.5±0.4
		9	1329.3±23.7	30.3±2.3	18.5±1.7	153.8±12.8	17.0±1.2	246.9±21.0	12.4±1.1	3.5±0.5
		10	1657.0±22.4	39.3±1.9	18.6±16.1	226.8±16.6	20.5±1.5	327.6±16.1	19.9±24.3	5.0±0.6
SW	B	8	1166.5±33.8	26.5±3.8	17.6±1.6	138.9±6.0	16.4±0.6	201.0±24.8	11.6±0.4	3.3±0.4
		9	1241.6±46.8	25.8±2.9	17.6±2.1	152.7±13.9	16.6±2.2	211.4±32.8	12.3±1.5	3.4±0.6
		10	1623.5±43.4	38.0±4.4	18.4±1.6	205.7±24.9	19.0±1.4	298.7±33.0	14.2±1.3	3.9±0.7
	G	8	1154.3±44.3	23.8±1.8	16.2±1.3	124.2±14.9	14.4±1.5	183.4±20.9	11.0±0.7	2.8±0.3
		9	1256.3±21.6	24.8±2.6	16.7±1.8	160.4±9.8	16.4±1.1	161.7±45.6	11.7±1.0	2.9±0.4
		10	1632.6±32.0	36.8±1.9	16.9±1.4	223.2±17.5	19.9±1.6	239.9±44.7	14.6±1.8	4.5±0.6
F-value			39.608**	152.673**	320.474**	179.348**	190.596**	125.317**	172.639**	382.543**

** Difference between nutritional status groups significant at $p<0.01$

Table: 4. Mean biochemical parameters of the children belonging to different degrees of malnutrition

Degree of Malnutrition	Gender	Age (Yrs)	Serum micronutrient levels (mcg/dl)		
			Vitamin-A[1]	Iron[1]	Zinc[1]
N	B	8	38.3±9.4	98.6±18.3	86.8±13.8
		9	39.2±7.5	109.4±9.0	89.0±2.9
		10	43.7±7.2	119.8±6.6	91.8±7.3
	G	8	35.9±3.6	88.6±11.4	85.3±6.2
		9	37.5±5.9	96.6±11.4	87.6±2.8
		10	41.7±8.6	104.3±16.1	88.7±4.3
S	B	8	30.0±10.1	67.0±22.4	66.5±18.9
		9	31.3±11.1	68.5432.1	68.1±19.6
		10	34.0±13.7	71.0±29.8	70.4±18.8
	G	8	28.1±7.5	63.9±23.0	64.6±19.8
		9	29.7±8.7	66.0±26.1	66.8±18.2
		10	30.0±10.7	66.9±25.3	68.1±19.8
SW	B	8	21.8±4.7	46.1±10.7	54.8±12.0
		9	23.2±4.7	48.8±10.7	56.1±12.8
		10	25.5±6.5	50.0±17.6	61.8±12.9
	G	8	20.2±6.7	43.9±7.4	52.2±12.6
		9	21.4±5.7	46.6±7.8	53.7±10.3
		10	23.0±5.9	48.0±9.1	55.6±9.7
F-value			256.555**	312.980**	528.693**

[1] Difference between nutritional status significant at $p<0.01$

percent) and stunted & wasted (36.1 percent) types of malnutrition. The age related distribution reveals that in both boys and girls a high percent of stunted children (41.7 and 41.8 percent respectively) occurred in the 8 y age group. Whereas stunting and wasting was high in the 9 y age group of both boys and girls (39.7 and 38.4 percent respectively). The percent of normal children was comparatively higher in boys than girls. At the age of 8yrs an equal percent of boys and girls were in stunted category. Girls were more stunted than boys at 9 and 10 yrs. The percent of SW children increased in boys with the age.

The data on anthropometric parameters of children belonging to different nutritional grades is presented in table 2. It is evident that children in the SW category showed very low Ht, Wt and MUAC. Stunted children recorded better values than SW category. The N group of children recorded better values than both S and SW groups. There is a significant difference between the N, S and SW groups for all the anthropometric measurements.

The nutrient intake data presented in table.3 reveal that the mean nutrient intakes differ according to the type of malnutrition in particular for the proximate principles – energy, protein and fat. The intakes of these nutrients were lower for the SW children when compared with those of both S and N categories. Consistently the latter two groups recorded highest mean intakes of the above nutrients. With regard to vitamins and minerals also the trends were similar.

The data on biochemical parameters (table.4) also show similar trends observed for anthropometry and dietary intakes. Normal children recorded better mean serum vit-A, iron and zinc values than the S and SW children. There is a significant difference ($P<0.01$) between the biochemical status of micronutrients of N, S and SW type children.

DISCUSSION:

Anthropometry is widely used to assess the nutritional status of an individual or population because of its high sensitivity in detecting undernutrition. (Wang et al., 2006). The height and weight of a child are useful indices of development, reflecting the various influences on growth, including nutrition. Indeed, the monitoring of a child's increase in height and weight by age using growth charts is widely used to identify failure-to-thrive or over nutrition (WHO, 1995; Gibson, 2005).

Malnutrition continues to be a problem of considerable magnitude in most developing countries of the world (Som et al., 2006).In the present study, the overall age and sex combined prevalence of N, W, S and SW were 26.4, 0.0, 37.5 and 36.0 per cent respectively. While wasting reflects a failure of attainment of wt-for-age only; Stunting reflects a failure to reach linear growth potential due to sub optimal health and / or nutritional conditions; SW reveals low body mass relative to chronological age which is influenced by both, a child's ht and wt (WHO, 1995).

One of the largest studies of anthropometric status of rural school children in low income countries (Ghana, Tanzania, Indonesia, Vietnam and India) found the overall prevalence of stunting and underweight to be high in all five countries, ranging from 48 to 56 percent for stunting and from 34 to 62 percent for underweight. Second, in all countries there was trend for Z-scores for height for age and weight for age to decrease with age, thus as children got older they became progressively shorter relative to the reference population. Third, the boys in most countries tended to be more stunted than girls and in all countries boys were more underweight than girls (Partnership for child development, 1998). The findings of the study corroborate with the findings of the present study which shows a similar trend in the prevalence of stunting and wasting as related to age and gender.

Further, ht-for-age reflects achieved linear growth, and its deficits (stunting) indicate long-term cumulative inadequacies of health and nutrition. Stunting of older children is a legacy of nutritional deprivation during early childhood. Present level of prevalence of stunting among school children also points to the high prevalence of nutritional insults during early childhood. In India, prevalence of stunting, underweight was almost 60 percent among rural preschool children and prevalence of wasting was also high (Vijayaraghavan et al., 1998). The present group of school going children who hail from low income families might have been exposed to gross undernutrition during early childhood years, which further is being continued into the school ages, as is evidenced in the present context.

In children suffering from continuous and chronic undernutrition adjustments are made over a period of time to suit their needs of reduced growth and development. The proximate principles are those that decide the calorie intakes. It is suggested that the calorie intake of an individual can be considered as the calorie requirement arrived at to maintain a state of energy balance. Thus, in the present context it may be inferred that the children in SW, S and N states are adjusting their intakes to maintain their respective nutritional state.

In a longitudinal study, comparing preschool stunting to stunting in adolescence, stunted girls exhibited a significant delay in sexual maturation and showed evidence of catch-up growth between the ages of 5 and 17 yrs. The children of both sexes have the possibility of catch-up growth after age 17 yrs. The stunted girls on average had a 1.6 yr delay in menarche compared to the tallest girls (Simondon et al., 1998). In a study from rural Bangladesh, menarche was associated with better nutritional status as indicated by significantly higher mean heights (in menstruating girls ages 11-14 yrs) and weights (in menstruating girls ages 13-15 yrs) compared to non-menstruating girls of the same ages (Chowdhury, et al., 2000). The present group of school age children who are suffering from both stunting and wasting if not intervened, the prognosis pertaining to developments associated with puberty may be judged to be poor.

Stunting is widely believed to occur mainly in early childhood (mostly by three years of age) and through a cumulative process. Children stunted at school-age are likely to have been exposed to poor nutrition since early childhood and that the degree of stunting tends to increase throughout the school-age years. However, children can exhibit catch-up growth if their environment improves. This suggests that interventions in school-age children can supplement efforts in the preschool years to reduce levels of stunting and related effects on children's health and education (Frongillo, 1999). However, it is observed in the present study that the small percent of N children also showed intakes which were lower than the RDA inspite of being beneficiaries of the on-going nutrition intervention programme (MDM). These N children who have shown satisfactory growth performance may also be suffering from sub-clinical/ biochemical micronutrient malnutrition. This may affect their further growth and may result in acute malnutrition (wasting) and faltering in linear growth.

The diet survey clearly brought out the fact that the food and nutrient intakes are inadequate with respect to both macro and micronutrients. Similar trends in intakes are observed with all the three age groups of children in both genders as well. Very small percent of the children had intakes closer to RDA.

Diets of poor income groups were deficient in several nutrients, namely energy, vit-A, calcium, riboflavin, iron. Dietary deficiency of these nutrients occurs more frequently and to a greater degree among children whose requirements of nutrients are higher than others. General deficiency of these nutrients in their diet is reflected in widespread prevalence of deficiency diseases like anemia, PEM, Vit-A and B-complex deficiency (predominantly riboflavin) and goitre (in endemic areas). Although dietary deficiencies of nutrients are the primary cause of these deficiencies, they are aggravated by environmental and personal hygiene. These diets of the poor are predominantly based on cereals which provide 80 per cent of energy and some amount of other nutrients except vit-A and C. Such foods are consumed only in some quantities, that too infrequently by the poor and hence their diets are inadequate with respect to many nutrients, particularly that of vit-A, iron, riboflavin. Only diets of high income and middle income groups in urban areas can be said to be satisfactory (Shepherd, 1999).

Lack of a well balanced diet could adversely affect growth during childhood. Inclusion and increased consumption of food items like pulses, vegetables, fruits, animal products and milk will make the diet more balanced and adequate in all nutrients.

Studies (Clausen and Dorup, 1998 ; John et al., 1999) have also focused on the fact that nutritional deficiency particularly that of micronutrient deficiency also result in alteration in food consumption behavior such as low intake of foods due to lack of appetite. Intervention to correct the situation resulted in improvements in the intake of food. In the present study, also it is observed that though adlibitum food is made available through MDM programme children probably might have not been able to consume adequate quantity of food due to lack of appetite resulting form general undernutrition and or associated clinical and sub-clinical nutritional deficiencies.

In the present study population of children a remarkable observation is that in spite of the nutritional support through the mid day meal (MDM) programme, which provides adlibitum food during lunch the intakes of nutrients were not meeting the recommended dietary allowances. It was observed that the dhal served was rather diluted and the amount of vegetables used was very low in quantity. The buttermilk supplied due to its thinness doesnot mix well with the rice and hence, was preferred less by a majority of children. On Saturdays under the MDM programme the children were provided with only sweet pongal. The meal provided at home; the breakfast and dinner have limitations in terms of quantity and quality. Therefore, the nutritional support offered through MDM is not sufficient to fill this widened food and nutrient gap. Thus, the major objective of MDM to fulfill the nutritional gap existing in the dietaries of school going children has not been achieved. The children were consuming monotonous diets with very less variety.

In a cross-sectional study of indigenous Chilean school children, improved social conditions were related to improved growth, but this was not observed among the non-indigenous school children (Amigo et al., 2000). The problem of malnutrition among children in developing communities thus is not the result of any one single factor and hence, the approach to control the problem also should be multi-pronged approach.

One of the objectives of the current study was to examine the prevalence of deficiency of select micronutrients among school going children. Micronutrient status can affect health outcomes such as child survival, growth and development either directly (e.g. deficiencies of vit-A, I, Fe, Zn or folic acid) or indirectly through interactions with each other (e.g. interactions between vit-A, Zn or Fe), increasing food intake owing to improved appetite and reducing morbidity.

More than 2 billion people world wide suffer from vitamin and mineral deficiencies. Women and children are the groups most severely affected. In addition to deficiencies in Fe, I and vit-A, the Indian diet often lacks essential quantities of folic acid, B vitamins, vit-C and calcium. Micronutrient deficiency is an important fact of the poor nutritional status of the population and is an enormous barrier to the country's socioeconomic development (Marini and Michele, 2003).

Furthermore, several researchers suggest that VAD in early adolescence antecedes and predicts chronic maternal VAD and its apparent health consequences (Christian et al., 1995, 1998, 2000a, b, 2001). This focuses on the need to quantify the prevalence and severity, and understand the epidemiology of VAD in early adolescence in terms of prevalence; both clinical and sub-clinical among children of 5-15 yrs of age.

A prevalence of 34 percent was reported among school attending adolescents in Nigeria (Ene-Obong et al., 2003). These data and data of the present study suggest that VAD could be a significant public health problem. In the present study the data is pertaining to those children hailing from low income families; thus the high prevalence may be attributed to this aspect. This also points out to the need for data from a representative population.

An assessment of the vit-A status of school children in Tanzania, Ghana, Indonesia and Vietnam found that VAD was a severe public health problem in Tanzania (30% deficient in vit-A), a moderate problem in Ghana and a mild problem in Indonesia and Vietnam according to WHO criteria (Friis et al., 1997). A study of the effect of providing fortified soup to school children in South Africa found that between 23.7 and 46.7 percent of children were marginally vit-A deficient (<30μg/dL) (Venberg et al., 1997).

In addition to the existence of a positive relationship between VAD and malnutrition, as evidenced through a relation between plasma vit-A levels and inadequate nutritional status, the problem also may be precipated by helminthes infestations and infections. A study of the relationship between serum retinol concentrations and helminth infection among primary and pre-school children in South Africa found that 23.5 had low serum retinol concentrations. (Vekncia et al., 1999). In the present context there is a positive relation observed between serum vit-A levels and malnutrition state; the SW group recorded low serum vit-A levels than the S group children. It is possible that the children being from poor environments may have helminth burden contributing partly to VAD.

Ferraz et al., (2005) reported that VAD is common among populations of low socioeconomic status, and appears that it is not only to be associated with low levels of consumption of foods containing vit-A, but also with lack of information on healthy nutrition. In these circumstances, prevention by means of supplementation with vit-A could reduce the rates of this deficiency over the short term, while guidance on choosing a healthy diet, including sources of carotenoids and vit-A, could bring results over the medium and long term. Working together to improve awareness of the issue, the teachers of infant and primary schools can play an important role promoting a wide-ranging, informative and explanatory compaign to achieve safe and healthy nutrition. In the current study the school children are from low income group and not only low inclusion of vit-A rich foods, but also ignorance might have contributed to the magnitude of VAD.

Adequate Zn status is essential for optimal growth. Assessment of mild Zn deficiency is difficult, however because of the absence of a single sensitive and specific index of Zn status, currently the serum or plasma Zn concentration is the most widely used biochemical indicator of Zn status for which adequate reference data are available.

Urusual et al., (1993) studied Zn status in 124 adolescents from Southern Ontario, Canada aged 14 to 19 yrs. The distribution of serum Zn below 10.71 µmol/l, indicated mild Zn deficiency using cut off value in NHANES II. The current study showed a high percent of children below cut off level of Zn. All the children were coming from low socioeconomic back ground. They consume plant based foods rich in dietary fibre and phytate, which are known to interfere with Fe and Zn absorption. Meat poultry and sea food are readily available sources of Fe and Zn which are consumed occasionally in the diets. Low intake of zinc rich foods along with low bioavailability might have precipitated the situation leading to low serum zinc concentrations. The greater the severity of malnutrition the lower was the serum Zn levels. The SW children had lower Zn levels when compared to the S children. Though the mean values recorded by the N children were within normal cut off values a few of them were in borderline deficiency.

A majority of the children were in the latent zinc deficiency, which finding is in accordance with those of Silva et al., (2006); Dijkhuizen et al., (2001) who detected a high prevalence of Zn deficiency, in communities with high prevalence of vit-A deficiency and also of iron deficiency among pre-school children (Ferraz et al., 2004; Ferraz et al., 2005). The findings focus on the fact that zinc deficiency is no more a rare condition but is a common occurrence among children from low socio-economic background.

Any attempts to examine the role of diet in the aetiology of ID must take into account the factors that inhibit or enhance Fe absorption. The consumption of heme Fe having better bioavailability is observed to be low among these children of low socioeconomic classes. Meat products such as red meat, poultry and fish represent excellent sources of heme iron. However, the cost of these products often restricts access to the poorest in developing countries (Bhargava et al., 2001). The limited economic potentiality of Low SES households could probably explain why boys and girls of poor families were found to have lower consumption of red meat and fish and hence lower intake of highly bioavailable iron.

Citrus fruits have a high content of vit-C, which is a dietary constituent other than animal tissue that has been reported to augment the absorption of nonheme Fe in humans (Cook and Reddy, 2001). The findings of the current study showed that the mean consumption of food items rich in iron and vit-C is low. This consumption pattern in conjunction with high prices of fresh citrus fruit outside the harvest season, as well as poor nutritional knowledge and practices of the underprivileged population groups, indicates that the promotional effects of vit-C on iron bioavailability may be more applicable to the wealthier socio-economic groups and not to those most likely to be ID. It is evident that in the current study children from poor families were found to have lower consumption of bodybuilding and protective foods like meat & poultry and vegetables & GLV intake resulting in lower access to bioavailable Fe.

ID was probably the most common cause of anemia. However, anemia could also be due to other factors such as deficiencies of folate, vit-B_{12} or vit-A, chronic infections and inflammations and hemorrhages (WHO, 2001). Low intake of Fe, poor bioavailability of Fe from the Indian diet and rising trend of consumption of "empty calorie" foods were suggested to be the main causes of anemia in the school going children (Verma et al., 1998).

In the present study the Fe levels were different for the different nutritional grades. The Fe levels of N group were in the normal range and that of the S and SW children recorded values below the cut offs. It is evident that better nutrition status maintains better the micronutrient levels of the children.

Further more, the higher incidence of ID reported for adolescent school girls, compared to boys shows that female gender exerts an extra effect on the prevalence of this medical condition, probably due to accessional iron losses gender might need closer surveillance (Tatala et al., 1998; Abalkhail and Shawky, 2002; Musaiger, 2002; Hashizume et al., 2004). There is a need to understand the factors associated with the high prevalence of ID among urban schoolchildren, which may predispose these children to risk of anemia during adolescence.

Among school going children low intakes of Fe, poor bioavailability of Fe from the Indian diet were suggested to be the main cause of anemia (Verma et al., 1998). Iron deficiency was probably the most common cause of anemia (WHO, 2001). The prevalence of anemia corroborates to an extent with dietary intakes of Fe. Children from Baroda and Delhi had better intakes of iron and lower prevalence of anemia (Seshadri et al., 1999). The differences in iron intake by region could explain variations in anemia prevalence.

CONCLUSION:

It is thus evident that our children are suffering from different levels and degrees of malnutrition as evidenced from anthropometry, dietary intakes and micronutrient status. Through the children are beneficiaries of MDM Program their daily intakes of food and nutrients are low in a majority. MDM is either becoming a substitute or other operational problems may be contributing factor to the existing status of our children. There is a need to strengthen the program through introduction of food Diversification and plugging the organizational loop holes.

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