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Nutrient adequacy and clinical assessment of rural school children (10-12 years) of Haryana

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Abstract
School children are the most important asset of the country and improving their nutritional status is the best investment in development of the country. Food and nutritional inadequacy is main cause of poor physical growth and mental development of school children that is reflected as low school enrollment, high absenteeism and poor academic performance. The present study was conducted on hundred rural school children of Fatehabad district, Haryana. Nutrient intake of children was assessed using dietary survey 24hr recall method and clinical assessment was done to identify the signs and symptoms of various types of nutrient deficiency in children. The intake of energy, protein, fat, calcium, iron, β-carotene, thiamine, riboflavin, niacin, vitamin C, folic acid and vitamin B_{12} by children were significantly lower than RDA (25.30 to 85.00%). Clinical examination revealed lack of lustre in hair 16 per cent children while pale conjunctiva, diffused pigmentation, angular scars, cheilosis of lips, scarlet and raw tongue, magenta tongue, mottled enamel, dental caries, spongy and bleeding gums, xerosis in the skin and follicular hyperkertosis was observed among 19.0, 13.0, 4.0, 13.0, 7.0, 4.0, 13.0, 11.0, 6.0, 4.0 and 2.0 per cent of school going children, respectively. The findings of this study conclude that there is continuous need of creating awareness on importance of adequate intake of nutrients among school children which would help to improve health and nutritional status of school children.

Keywords: Nutrient adequacy, clinical assessment, school children, Haryana

Introduction
School going children are the most important assets of any nation and they are future workforce. The health and nutritional status of children is an indicator of growth and development of a nation as a whole. The foundation of good health and sound mind is laid in the school age (5-14 years) period [1-3]. Inadequate intake of food and nutrients is main cause of low nutritional status that can be aggravated due to the infections present in the body [4]. Poor physical growth and mental development of school children are result of low intake of food and nutrients and repeated infections reflected as low school enrollment, high absenteeism and poor academic performance by the children [5-6]. The school age period is crucial period for physical growth, cognitive and social development and nutritional deprivation in this period leads to the long way effect on whole life of an individual.

Nutritional deprivation is rampant in children of school age particularly primary school children ranging in magnitude from 20-80% [7]. According to UNICEF data, 90% of developing world's undernourished children lives in Asia and Africa while 40% of the world's malnourished lives in India [8]. India has been ranked at 103th position among 119 countries by Global Hunger Index Report 2018, which represents the serious hunger situation. The Global Hunger Index (GHI) rank is based on four key indicators i.e. undernourishment, child mortality, child wasting and child stunting. India is facing a serious burden of under-nutrition [9] and it has been reported that 38 per cent of children under five years of age are stunted (too short for their age) and about 21 per cent of children under 5 years of age are 'wasted' or 'severely wasted' (do not weigh enough for their height). Moreover, prevalence of underweight is higher in rural areas (50 percent) than in urban areas (38 percent); higher among girls (48.9 percent) than among boys (45.5 percent); higher among scheduled castes (53.2 percent) and scheduled tribes (56.2 percent) than among other castes (44.1 percent).

Protein energy malnutrition, micronutrient deficiencies such as, vitamin A deficiency, iron deficiency, anaemia and iodine deficiencies are the major nutritional problems frequently encountered particularly among the children in rural poor and urban slum communities [10-11]. Micro-nutrients deficiency is a major nutritional problem which severely impairs people's health, work capabilities and income and thus economic development of the nation [12]. Iron deficiency in school children is associated with retardation of growth, decreased immunity and poor cognitive development resulting in poor intelligence quotient and behavioural abnormalities [13]. The high prevalence of anaemia is due to inadequate diet, poor iron and folic

acid intake, poor bio-availability of iron in phytate fibre-rich Indian diet, chronic blood loss due to infection such as malaria and hookworm infestations. Subclinical Vitamin A deficiency is also reported to be common among school children. Malnutrition affects the child's physical and cognitive growth and increases the susceptibility to infections while having an adverse impact on economic growth of the country indirectly [14]. Moreover, there is dearth of national data on nutritional status of rural school going children. Therefore, the assessment of nutritional status of school going children becomes essential which would be helpful to identify the nutritional deficiencies among them and improving their overall health and nutritional status.

Materials and Methods

Hundred children (10-12 years) were selected randomly from schools of two villages (*Khabra Kalan* and *Jandwala Baggar*) of Fatehabad district, Haryana state.

The data was collected with the help of well-structured questionnaire-cum-interview schedule.

Nutrients intake and nutrients adequacy ratio

The information regarding nutrient intake was collected using 24hr recall method for three consecutive days. Nutrients namely energy, protein, fat, calcium, iron, β-carotene, thiamine, riboflavin, niacin, vitamin B_{12}, Vitamin C, folic acid and zinc intake were calculated using Nutriguide software. Average daily nutrient intake of the respondents was compared with Recommended Dietary Allowance (RDA, 2010) [15] and Nutrient adequacy (NAR) was calculated as:

$$NAR\% = \frac{\text{Nutrient Intake}}{\text{RDA}} \times 100$$

Adequacy of nutrient intake

The adequacy of nutrient intake of the respondents was categorized into the following four groups:

Adequacy of nutrient intake (% RDA)	Score
100% and above	I
75-99.9%	II
50-74.9%	III
Below 50%	IV

Clinical assessment

Clinical examination of an individual is the least sensitive method used to evaluate individual's nutritional status. In this study, observations related to general appearance of child's health, hair, eyes, skin, nails, face, lips and gums were taken with the help of doctor of Primary Health Centre of the selected villages using criteria described by Jelliffe, 1966 [16].

Results

Mean daily nutrient intake of rural school going children

The results on mean daily nutrient intake of rural school children (10-12 years) are presented in Table 1.

Mean daily intake of energy by boys and girls were 1637.36 Kcal (74.76% of RDA) and 1393.79 Kcal (69.34% of RDA), respectively, which was significantly ($p \leq 0.01$) lower than RDA. The mean daily intake of protein by boys and girls were 27.25g and 24.26g, respectively, which were also significantly ($p \leq 0.01$) lower than RDA i.e. 68.29 per cent and 60.05 per cent of RDA, respectively.

Table 1: Mean daily intake of nutrients by rural school going children (n=100)

Nutrients	Mean daily nutrient intake					
	RDA	Boys (n=57)	t-value	RDA	Girls (n=43)	t-value
Energy (Kcal)	2190	1637.36 ±284.48 (74.76)	-14.66**	2010	1393.79 ± 254.03 (69.34)	-15.19**
Protein (g)	39.9	27.25 ± 4.77 (68.29)	-20.01**	40.4	24.26 ± 4.09 (60.05)	-25.90**
Fat (g)	35	22.11 ± 7.44 (63.17)	-13.08**	35	17.41 ± 6.17 (49.74)	-18.69**
Calcium (mg)	800	418.21 ± 106.30 (52.28)	-27.12**	800	369.68 ± 90.78 (46.21)	-31.08**
Iron (mg)	21	14.44 ± 2.60 (68.76)	-19.02**	27	12.45 ± 2.11 (46.11)	-45.29**
β-carotene (µg)	4800	1640.98 ± 577.02 (34.18)	-41.33**	4800	1305.79 ± 425.30 (27.20)	-53.88**
Thiamine (mg)	1.1	0.92 ± 0.17 (83.63)	-7.99**	1.0	0.80 ± 0.14 (80.00)	-9.37**
Riboflavin (mg)	1.3	0.60 ± 0.14 (46.15)	-37.75**	1.2	0.50 ± 0.11 (41.67)	-41.74**
Niacin (mg)	15	8.91 ± 1.95 (59.40)	-23.56**	13	7.49 ± 1.69 (57.61)	-21.31**
Vitamin C (mg)	40	26.13 ± 6.68 (65.32)	-15.67**	40	22.61 ± 5.66 (56.52)	-20.13**
Folic acid (µg)	140	101.69 ± 19.19 (72.63)	-15.07**	140	89.22 ± 18.20 (63.73)	-18.29**
Vitamin B_{12} (µg)	0.2-1.0	0.18 ± 0.13 (18.00)	-47.62**	0.2-1.0	0.15 ± 0.12 (15.00)	-46.47**

Values are mean ±SD **Significant at 1% level
Figures in parentheses indicate percent RDA
RDI- Recommended Dietary Intake (ICMR 2010)
^{NS} = Non-significant

The mean daily intake of fat among boys and girls was 22.11 and 17.41 g, respectively, which was 63.17 and 49.79 per cent of RDA. The mean daily calcium consumption of boys (418.21 mg) and girls (369.68 mg) was also significantly ($p \leq 0.01$) lower than RDA. Similarly, the intake of iron by rural school going children was 68.76 to 46.11 per cent of RDA and significantly ($p \leq 0.01$) lower than RDA. The mean daily intake of β-carotene by boys and girls was 1640.98 µg and 1305.79 µg, respectively i.e. only 34.18 and 27.20 per cent of RDA, respectively, which was significantly ($p \leq 0.01$) lower than RDA. The mean daily intake of thiamine, riboflavin, niacin, vitamin C and folic acid was also significantly ($p \leq 0.01$) lower than RDA. The mean daily intake of vitamin B_{12} by rural school going children was only 15.00 to 18.00 per cent of RDA and significantly ($p \leq 0.01$) lower than RDA.

Adequacy of nutrient intake of rural school going children

The energy intake by 36 per cent of the school children was 50 to 74.9 per cent of RDA and only 13 per cent of the children were taking energy 100 per cent and above of RDA (Table 2). Adequacy of protein revealed that the majority of the respondents (67%) were taking protein in the range of 50 to 74.9 per cent of RDA and 21, 8 and 4 per cent of the

respondents consumed protein in range of 75 to 99.9 per cent, less than 50 per cent and 100 per cent and above of the RDA, respectively. As many as 42 per cent of the respondents consumed fat, 50 to 74.9 per cent of the RDA while 39, 10 and 9 per cent of respondents were consuming fat 75 to 99.9 per cent, 100 per cent and above of the RDA and less than 50 per cent of the RDA, respectively.

Forty eight per cent of respondents were taking less than 50 per cent of RDA of calcium while fifty five per cent consumed iron less than 50 per cent of RDA. Data related to adequacy of β-carotene intake revealed that 44 per cent of rural school going children consumed β-carotene less than 50 per cent of RDA and only 6 per cent children took β-carotene 100 per cent of RDA.

Table 2: Adequacy of nutrient intake by rural school going children (n=100)

Adequacy of nutrient intake	Energy	Protein	Fat	Calcium	Iron	β-Carotene	Thiamine	Riboflavin	Niacin	Vitamin C	Folic Acid	Vitamin B_{12}
I	13	4	10	16	4	6	32	11	10	14	19	5
II	32	21	39	4	18	19	22	35	41	18	27	9
III	36	67	42	32	23	32	31	25	33	29	26	14
IV	19	8	9	48	55	44	15	29	16	39	28	72

I 100% and above the RDA
II 75 to 99.9% of RDA
III 50 to 74.9% of RDA
IV Less than 50% of RDA

Only 5 to 32 per cent of respondents consumed thiamine, riboflavin, niacin, vitamin C, folic acid and vitamin B_{12} 100 per cent and above of RDA while remaining were consuming these nutrients less than 50 to 99.9 per cent of RDA.

Clinical Assessment of rural school going children

Data regarding the presence of clinical deficiency signs and symptoms in school going children have been presented in Table 3.

The general appearance of 61.0 per cent children was good whereas 34.0 and 5.0 per cent children had fair and poor general appearance, respectively. Sixty per cent children were having good hair whereas 16.0, 8.0, 7.0 and 2.0 per cent children's hair showed lack of luster, easy pluckability, thinness and sparseness and premature whitening, respectively. Diffused pigmentation on face was observed only in 13.0 per cent of rural school going children while rests were found to have normal face.

Table 4.3: Clinical assessment of rural school going children (n=100)

Characteristics	Percentage
General appearance	
Good	61.0
Fair	34.0
Poor	5.0
Very Poor	-
Hair	
Good	67.0
Lack of luster	16.0
Flag sign	-
Thinness and sparseness	7.0
Premature whitening	2.0
Easy pluckability	8.0
Face	
Normal	87.0
Diffused pigmentation	13.0
Moon face	-
Naso-labial seborrhea	-
Naso-labial dyssebecea	-
Eyes	
Normal	81.0
Night blindness	-
Pale conjunctiva	19.0
Conjunctival xerosis	-
Corneal xerosis	-
Xerophthalmia	-
Bitot spot	-
Lips	
Normal	83.0
Angular stomatitis	-

Angular scars	4.0
Cheilosis	13.0
Tongue	
Normal	89.0
Scarlet and raw tongue	7.0
Magenta tongue	4.0
Atrophic papillae	-
Glossitis	-
Teeth	
Normal	76.0
Mottled enamel	13.0
Caries	11.0
Gums	
Normal	94.0
Spongy bleeding gums	6.0
Glands	
Normal	100.0
Thyroid gland	-
Parotid enlargement	-
Skin appearance	
Normal	82.0
Lack of lusture	12.0
Dry and rough	4.0
Follicular hyperkeratosis	2.0
Pellagrous dermatitis	-
Nails	
Normal	100.0
Koilonychia	-
Subcutaneous Tissue	
Oedema	-
Normal	100.0

Nineteen per cent children had pale conjunctiva which may be due to iron deficiency. Majority (83.0%) of the rural school going children were having normal lips while 13.0 and 4.0 per cent children were found to have cheilosis and angular scars, respectively which may be due to deficiency of B-complex vitamins. Seven and 4.0 per cent of rural going children showed the signs of scarlet and raw tongue and magenta tongue while remaining had normal tongue.

Eleven per cent children showed dental caries and 13.0 per cent had mottled enamel and remaining 76.0 per cent children had normal teeth. Majority of the respondents (94.0%) were having normal gums whereas 6.0 per cent were having spongy bleeding gums which may due to Vitamin C deficiency. Eighty two per cent children were having normal skin while skin of 12.00 per cent of children lacked lusture, 4.0 per cent had dry rough skin and 2.0 per cent had follicular hyperkeratosis in the skin. All the children had normal glands, nails and subcutaneous tissues.

Discussions

The energy gap between intake and RDA was mainly due to lower energy density of their diet and inadequate intake of cereals, fats and oils, milk and milk products and roots and tubers. Moreover Children and their mothers were not aware about their RDAs and sources of different nutrients in diet. The low intake of pulses, roots and tubers, fruits and vegetables, milk and milk products and lack of intake of animal foods were basically responsible for low intake of energy, protein, B-complex vitamins, vitamin C and vitamin B_{12} among respondents. The mean daily intake of fat by rural going school children was significantly ($p \leq 0.01$) lower than RDA. This may basically be due to high cost of *desi ghee* and that they sold milk produced at home and hence little butter or ghee could be made at home. Calcium intake was also lower than RDA among boys and girls. It could be due to low consumption of milk and milk products. Iron intake of rural school children was also significantly ($p \leq 0.01$) lower than RDA and this was due to lower consumption of cereals, green leafy vegetables and fruits by majority of children. The average intake of β- carotene, folic acid, Vitamin C and B-complex vitamins namely thiamine, riboflavin, niacin and B_{12} in study population was less than RDA. This might be due to low intake of vegetables green leafy vegetables, other vegetables, roots and tubers, fruits and foods from animal sources.

Regarding clinical examination, pale conjunctiva was found in 19.00 per cent school going children which may be due to iron deficiency which was the result of inadequate consumption of green leafy vegetables, fruits and milk and milk products by them. Diffused pigmentation, angular scars, cheilosis of lips, scarlet raw tongue and magenta tongue were also noticed which may be associated with B- complex vitamin deficiencies. Six per cent children suffered from spongy and bleeding gums which may be due to nutrient deficiencies like vitamin C deficiency or may be due to some infections. These clinical signs are manifestations of poor and inadequate diets of school children based predominately on cereals. The inadequate intake of nutrients was reflected in the clinical assessment of the children.

Conclusion

The mean intake of nutrients of school children was found to be less than the recommended dietary allowances. The most limiting nutrients in the diet of majority of respondents were iron, calcium, β- carotene, vitamin C, folic acid and vitamin B_{12}. One of the reasons for inadequate intake of nutrients by school children was due to their habit of breakfast skipping and depending solely on mid-day meal for their breakfast and lunch. It was also noted that some of them were not even consuming their mid-day meal properly because of disliking

of food cooked in school. The low intake of pulses, roots and tubers, fruits and vegetables, milk and milk products and lack of intake of protein from animal foods were basically responsible for low intake of different nutrients. Other reasons for low intake of the food among children could be lack of purchasing power and lack of knowledge and awareness among children and their parents about the importance of balanced diet in human health. So, there is need to provide nutrition education and creating awareness among school children and their parents. Nutrition education could play a vital role in improving the food and nutrient intake by rural school going children. Creating awareness about role and importance of various nutrients in physical and cognitive development of a human will go a long way in improving the health and nutritional status of school going children who are supreme assets and future manpower of the nation.

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