Nutritional Status of Affluent Indian School Children: What and How Much Do We Know?

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Objective: *This paper reviews available literature on nutritional status of Indian school children 6-18 years from middle and high socio economic status (MHSES).* ***Methods:*** *Literature search was conducted using Medline literature database search, followed by review of full-length journal papers and unpublished materials such as research reports.* ***Results:*** *Studies showed that anemia prevalence (hemoglobin concentration <120 g/L) ranged from 19-88% across five different cities in India. Other micronutrient deficiencies including, folate, riboflavin, niacin, vitamin C, vitamin A, and vitamin B12 were also present based on biochemical parameters in one study and clinical signs of deficiency in three other studies. Overweight and obesity were prevalent among 8.5-29.0% and 1.5-7.4% respectively among school children, as indicated by 11 studies. Predominant components in children's diet were cereals and pulses, followed by milk and milk products; the fruits and vegetables component was comparatively lower.* ***Conclusion:*** *Nutritional status of MHSES children in India needs attention especially with respect to the high prevalence of anemia, overweight and obesity. There are indications that micronutrient deficiencies exist, but sufficient data are lacking, in particular biochemical data. A current estimate, using well designed methodologies, of prevalence of micronutrient deficiencies and information on the etiology of anemia among children of MHSES groups would be valuable to help understand the nutritional status and extent of micronutrient malnutrition.*

Key words: *Affluent, Nutritional status, School children.*

DEVELOPING countries are undergoing nutrition transition due to increased economic development and market globalization leading to rapid changes in lifestyle and dietary habits(1). Poor dietary habits combined with decreased physical activity have led to an increase in overweight and obesity among adults and children(1). Overweight and obese children are not only at risk for insulin resistance syndrome, hypertension, dyslipidemia and hypertryglyceridemia(2), but also for poor micronutrient status. Reports from countries such as the United States, Israel and Canada have shown that overweight and obese children have a higher prevalence of iron deficiency than normal weight children(3,4) and intakes of other micronutrients such as folate, vitamin D, calcium, magnesium and vitamin E are sub-optimal among obese children(5). Moreover, micronutrient deficiencies appear to be prevalent even among non-obese, well nourished, school aged children(6-10), and are likely to be caused by a high intake of energy-dense foods that do not contain vitamins and minerals(11). Inadequate intake of micronutrients can adversely influence growth and development, cognitive performance and increase susceptibility to infections(6,12-13).

In India, approximately 19% (190 million) of the growing population comprises school-aged children of whom 30% (48 million) currently reside in urban India. A significant and increasing number of these children belong to middle and high socio-economic groups(14). As a consequence of the socio-economic and demographic transitions that are affecting developing countries such as India, we hypothesize that the nutritional status of the children in middle and high-income groups could be affected by the changes in dietary habits and lifestyle, leading to an increase in the prevalence of overweight and obesity and

micronutrient deficiencies. Therefore, this paper reviews available literature on the nutritional status of Indian children and adolescents aged 6-18 years from the middle and high socio-economic status (MHSES) groups.

Methodology

A literature search, restricted to English language and to publications from the year 1995 to April 2006, was carried out on the Medline database using the search terms: dietary intake, food intake, anthropometry, nutritional status, micronutrient deficiencies, iron, vitamin A, iodine, school children, India, obesity, overweight, undernutrition. Cross-references from the identified publications were checked. Departments of Food and Nutrition in the Universities of Bangalore, Baroda, Mumbai and Coimbatore in India, known to be working in the area of nutrition of affluent school children, were contacted to obtain information on unpublished studies in the form of research reports. The literature search was carried out during July 2005 - December 2005.

Criteria for inclusion was, studies assessing children between 6-18 years of MHSES. MHSES was defined as at least one or more of the following criteria: (*i*) monthly income ≥Rs. 10,000 for studies where period of data collection was between 0-4 years old and ≥ Rs 6,000 for studies of 8 years old. (*ii*) monthly school tuition fee of Rs 2,000 for studies where data collection was between 0-7 years old; (*iii*) private or public schools defined as affluent by the authors, (*iv*) parent's occupation, such as executives, professionals and businessmen, (*v*) parent's education of a university degree or higher (*vi*) material possessions such as automobiles *etc.* We were aware that there would be some heterogeneity in the socio economic status of children between studies, as the criteria employed were diverse, since all studies did not provide information that was uniform and allowed the same variables to be used to make an assessment.

Results

In contrast to extensive data available for children from low socio-economic backgrounds(15), information on nutritional status of children among middle and high-income groups was limited. The most widely quoted data sources on nutritional status of Indian children included the National Nutrition Monitoring Bureau(16,17), representing mostly rural populations, the National Family Health Survey-II(18) restricting data to children below 3 years of age and, the National Sample Survey Organization(19), not specifying data for children; and could therefore not be used to provide adequate information on the nutritional status of MHSES children.

In total, 12 studies on the nutritional status of MHSES children were selected for inclusion in this report. Characteristics of these studies are summarized in *Table I*.

Nutritional status by anthropometric data

Overweight and obesity

Of the 12 identified studies, eight reported on the prevalence of overweight and obesity(20-27). All eight studies used BMI as a criterion to classify overweight and obesity (*Table II*). The range of prevalence of overweight (8.5-29%) and obesity (1.5-7.4%) was large. Prevalence differed mostly by location, rather than age or gender. A secular trend in the prevalence was not observed, as indicated by data from Chennai where there was no difference in the prevalence of overweight and obesity among children between the years 1981 and 1998(23). High rates of prevalence are reported in two recent studies(22,24).

Deficits in growth

One study indicated that under nutrition in middle-income children aged 6-16 years in Hyderabad was 10-13%(31). Children having a body height and weight < –2 SD of the NCHS growth standards were considered undernourished.

Nutritional status by biochemical indicators

Anemia

Biochemical and clinical parameters are used to detect other specific nutrient deficiencies such as anemia and micronutrient deficiencies. Information on the prevalence of anemia (*Table III*) was

TABLE I–*Characteristics of studies reviewed*

Type of publication (Ref) [year of data collection]	Region	N			Age (years)	SES	Measurements		
		Total	Boys	Girls			Dietary	Anthropometry	Biochemical
Journal article (20) [July-Nov 2000]	Chennai	4700	2382	2312	13-18	MHSES - based on possession of automobiles	–	Height Weight	-
Journal article † (21) [2000]	Delhi	5000			4-18	HSES - children attending private school		Height Weight	
Journal article (22) [2001]	Delhi	870	563	307	10-16	HSES - Tuition fee ‡ >Rs 2000/month		Height Weight MUAC Tricep Skin Fold	
Journal article (23) [I-1981, II-1998]	Chennai	1311	–	1-701 11-610	10-15	HSES - tuition fee > Rs 2000/month		Height Weight	
Journal article (24) [1999]	Punjab	2008	962	1046	9-15	50% HSES 43.2% MSES 6.8% LSES	–	Height Weight	
Letter in journal (25) [2003]	Pune	1228	1228	-	10-15	HSES - boys attending affluent schools	–	Height Weight	
Journal article (26) [2000-2001]	Punjab	640	323	317	10-15	HSES - public and convent schools catering to children from affluent families	–	Height Weight	
Report § (27) [2001-2004]	Baroda	5329	3168	2161	12-18	MHSES-per capita income Rs 1000-Rs 4999	Dietary pattern -24hr recall and food frequency questionnaire.	Height, Weight, Waist-hip ratio	Fasting blood sugar, total cholesterol, triglycerides, HDL-C, LDL-C, VLDL-C
Journal article (37) [Jan 2001]	Hyderabad	272	108	164	12-14	Upper-middle and high income group (Rs 18,454)	Food frequency questionnaire	–	
Journal articles (31,34) [2000]	Hyderabad	869			6-16	MSES - semi-urban children attending residential schools	3 day weighed food record (n = 90)	Height Weight	Biochemical parameters (n = 328) for anemia, vitamin A, B_1, B_2, B_6, B_{12}, C, folate,

(contd...)

TABLE I–*Characteristics of studies reviewed*

Type of publication (Ref) [year of data collection]	Region	N			Age (years)	SES	Measurements		
		Total	Boys	Girls			Dietary	Anthropometry	Biochemical
									iodine, zinc. Clinical signs of vitamin A (Bitot's spots), B-vitamins (angular stomatitis, cheilosis, glossitis), vitamin C (bleeding gums), and iodine (goiter)
Journal article (32) [1993-1994]	Punjab	2000	916	1084	5-15	LSES - HSES as defined by Kuppuswamy socioeconomic scale	–	Weight	Anemia (hemoglobin concentration)
Report § (33) [1998]	Baroda (N=920), Chennai (N=999) & Delhi (N=1002)	2921	1168	1752	6-15	HSES - Monthly income Rs 6000 - 10000 (23%) Rs 10000 - 15000 (17%) Rs 15000-25000 (24%) >25000 - (11%) per capita income = 1500-3000	Sub sample (724) 24 hour recall, 3 day weighed food record (2 wk days, 1 holiday)	–	Anemia (Hemoglobin concentrations)
Journal article (37) [Jan 2001]	Hyderabad	272	108	164	12-14	Upper-middle and high income group (Rs 18,454)	Food frequency questionnaire		

Year in Parenthesis is the actual time of data collection.

* Dietary intake and prevalence of anemia by blood hemoglobin measurement were measured in a subgroup of 30 children in total (7-8 children per region per SES group). Data were not specified per SES group and a sample size of 7-8 children is considered too small to draw any conclusion. Therefore, we have not included these data in our review.

† Study conducted by Nutrition Foundation India and mentioned in article; original publication could not be retrieved

‡ Households in the higher socio economic groups can afford to send their kids to private schools or schools that charge a higher tuition fee (>Rs 1500). Tuition fees in Government schools are not high and fall below Rs 1000.

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TABLE II–*Prevalence of Overweight and Obesity Among Children Aged 6-18 Years from MHSES Groups*

Region, N (Ref) [Year of data collection]	Age in years	Overweight (%)			Obesity (%)		
		Total	Boys	Girls	Total	Boys	Girls
Chennai, N= 4700 (20)* [July-Nov 2000]	13-18	–	17.8	15.8	–	3.6	2.9
Delhi, N=5000 (21) *[2000]	4-18	29.0	–	–	6.0	–	–
Delhi, N=3861 (22)* [2001]	10-16	24.7	23.1	27.7	7.4	8.3	5.5
Chennai, (23)†	10-15						
[1981, N=707]**		9.62	–	–	5.94	–	–
[1998, N=610]		9.67	–	–	6.23	–	–
Punjab, N=2008 (24)‡ [1999]	9-15	14.2	15.7	12.9	–	–	–
Pune, N=1228 (25)* [2003]	10-15	19.9	19.9	–	5.7	5.7	–
Punjab, N=640 (26) ¶ [2000-2001]	10-15	10.9	9.9	12.0	5.6	5.0	6.3
Baroda, N=5329 (27)† [2001-2004]	12-18	8.5	8.0	9.0	1.5	1.4	1.7

* Overweight classified as BMI ≥25-29.9 kg/m^2 Obesity classified as BMI ≥30 kg/m^2

† Overweight classified as age and sex-specific BMI (≥85-95th percentile Obesity as ≥95th percentile as per IOTF standards (28)

‡ Overweight classified as age and sex-specific BMI ≥85-95th percentile Obesity as ≥95th percentile as per WHO standards (29)

¶ Overweight classified as age and sex-specific BMI ≥85-95th percentile Obesity as ≥95th percentile as per Must, *et al*. standards. (30)

** Comparison between two studies one in 1981 (Group I) and the other in 1998 (Group II). No Statistically significant change in prevalence of overweight and obesity between the two groups.

Year in parentheses indicates time of data collection.

available from 3 studies(32-34) conducted between 1993-2000. All studies estimated blood hemoglobin concentration by the cyanmethemoglobin method(35). Overall, the prevalence of anemia among children from MHSES ranged from 14% in the upper class in Punjab to 88% in Chennai. The Punjab study(32) revealed that more than half of the anemic children (55%) had a microcytic, hypochromic blood picture, indicating that anemia was caused by iron deficiency. Furthermore, anemia was mostly prevalent in the milder form (110-119.99 g/L), while severe anemia (<70 g/L) was absent(33). All studies defined anemia in children 6-11 years as hemoglobin concentrations <120 g/L as these studies were carried out earlier to the recently defined WHO cut off for anemia as <115 g/L(36). Therefore, the actual prevalence of anemia in the reported studies is likely to be lower.

Other micronutrient deficiencies

Only one study in India(34) has data on the micronutrient deficiency status, based on biochemical analyses on a sample of a total of 328 middle-income children from a residential school (*Table IV*). Folate deficiency (<550 nmol/L, erythrocyte) was present in almost all children (n = 307), while deficiencies of vitamin B_2 (≥1.40 GR-AC, whole blood) and vitamin B_6 (≥1.80 AAT-AC), vitamin C (<30 μmol/L, plasma), vitamin A (<0.7 μmol/L, plasma) and vitamin B_{12} (<150 pmol/L, plasma) were reported in 44-66% of the children. Vitamin B_1 (≥1.25 TK-AC) (12%) and zinc (<10.7 μmol/L, plasma) (0.7%) deficiency was lower. Assessment of clinical signs of micronutrient deficiencies in the same study population confirmed the presence of micronutrient deficiencies.

Nutrient adequacy by dietary intake data

Among the 17 studies reviewed, four provided information on the dietary pattern of MHSES children(27,31,33,37). All studies employed either the validated and pre-tested 24 hr dietary

TABLE III–*Mean Hemoglobin Concentrations and Prevalence of Anemia among School Children in India*

	N	Age (years)	Hemoglobin concentrations (g/L) (mean ± SD)	Prevalence of anemia (%)
(32) Ludhiana, Punjab				
Upper	57	5-15	133.8 ± 13.3	14.0
Upper middle	1064	5-15	121.5 ± 13.8	39.4
Lower middle	812	5-15	111.3 ± 11.6	69.6
(33)				
Baroda	920	6-15	128 ± 0.4	21
Delhi	1002	6-15	122 ± 0.4	36
Chennai	999	6-15	105 ± 0.4	88
(34)				
Hyderabad	328	6-16	–	55.7

Anemia was defined as hemoglobin concentrations <110 g/L for children <6 years of age and <120 g/L for children ≥ 6 years of age.

recall method or a 3-day food record to obtain daily nutrient intake. In general, studies indicated that the diet of these children was largely cereal and pulse based; milk and milk products were consumed in moderation, whereas, fruit and vegetable intake was inadequate(27,33,37). Total fat and sugar intakes were twice the RD(33). One study(27) indicated that the intake of saturated and invisible fat among overweight (23 g/d and 31 g/d, respectively) and obese children (29 g/d and 33 g/d, respectively) was higher when compared to that of normal-weight children (16 g/d and 24 g/d, respectively). A study among school children in Hyderabad showed that approximately 30% consumed instant foods daily(37).

Two(31,33) studies with data on iron intake showed that mean iron intake was lower (30-50% of RDA) than the daily requirements. Despite inadequate consumption of vegetables and fruits, vitamin C intakes were reported as adequate, 105-159% of RDA(27, 31) except by one study (9-21% of RDA)(33). Intake of calcium was reported as adequate (129-150% of RDA) by one study(31).

One study reported both dietary intake measured by the weighed food method and biochemical data on micronutrient status(31,34). Comparisons drawn between prevalence of deficiencies and average dietary intake revealed that low intakes of iron, vitamin A and vitamin B_1 correspond with the high prevalence of deficiencies of these micronutrients as indicated by biochemical data. On the other hand high intakes of folate and vitamin C contrast strongly with the high prevalence of folate and vitamin C deficiency, as indicated by biochemical data.

Discussion

The rates of overweight and obesity among children worldwide have been increasing dramatically in the last few years(38) with similar trends being observed in recent years among children and adolescents from developing countries(39). Although it is widely believed that prevalence of overweight and obesity among MHSES children in India is high, it is difficult to draw any conclusion on the prevalence trends from the available data. The large range in the reported prevalence of overweight and obesity could be due to regional differences, non-uniformity in the criteria used to classify socio economic status among the studies and, the different age range of the children studied. One author(24) shows that there is a significant age-related decrease in prevalence of obesity from 18.5% at 9 years to 7.6% at 14 years and thereafter, a rise at 15 years to 12.1%. Some amount of variation is also contributed by the fact that different standards have been used to classify

TABLE IV– *Prevalence of Micronutrient Deficiencies (%) and Clinical Signs of Anemia, Vitamin A and B Vitamin Deficiencies (%) among school children 6-16 years in Hyderabad (34)*

Micronutrient	% Prevalence	Clinical signs	% prevalence
Folic acid (RBC folate <550 nmol/L) n = 307	99.0	–	
Vitamin B_1 (≥1.25 TK-AC) n = 307	11.7	Angular	2.4-2.5
Vitamin B_2 (≥1.40 GR-AC) n = 317	66.4	stomatitis,	
Vitamin B_6 (≥1.80 AAT-AC) n = 226	66.9	cheilosis,	3.4-6.2
Plasma vitamin B_{12} (<150 pmol/L) n = 234	43.8	glossitis	1.8-2.0
Plasma zinc (<10.7 μmol/L) n = 325	0.7		–
Plasma vitamin A (<0.7 μmol/L) n = 310	43.9	Bitot's spots	0.0-0.3
Plasma vitamin C (<30 μmol/L) n = 100	59.6	Bleeding gums	2.0-2.9
Iodine (severe IDD: urinary iodine <20 μg/L) n = 310	0	Goitre II	2.9-5.4

RBC, red blood cell; TK-AC, transketolase activation; GR-AC, glutathione reductase activation coefficient; AAT-AC, aspartate aminotransferase activation coefficient; IDD, iodine deficiency disorders; Goiter II - grade II where goiter is both visible and palpable.

overweight and obesity. Most authors are of the opinion that poor dietary habits and lack of exercise are the main causes, although there is not much supporting data available.

Any inference on the prevalence of undernutrition among MHSES children cannot be drawn since there is only one study reporting a prevalence of 10-13% among residential school children(31). While we have included data obtained from residential school or private schools, it is important to consider the possibility that some of these schools might also support children from low SES and hence, may not be representative of children from MHSES.

There is a large range in the prevalence of anemia (19-88%) reported among children from MHSES. The cyanmethemoglobin method used by all studies to estimate hemoglobin is commonly used and is considered to be accurate when compared to the hemocue or hematology counter(40). Iron deficiency was probably the most common cause of anemia(32). However, anemia could also be due to other factors such as, deficiencies of folate, vitamin B_{12} or vitamin A, chronic infections and inflammations and hemorrhages(36). Unfortunately, none of the studies assessed the prevalence of iron deficiency by biochemical parameters such as serum ferritin and/or serum transferrin receptor (not influenced by inflammatory conditions), which are good indicators of iron status and will also help determining iron deficiency without anemia(41). Low intake of iron, poor bioavailability of iron from the Indian diet and rising trend of consumption of 'empty calorie' foods were suggested to be the main causes of anemia in the MHSES groups(32).

Prevalence of anemia corroborates to an extent with dietary intakes of iron. Children in Chennai had very low intakes of iron and ascorbic acid and a high prevalence of anemia. Children from Baroda and Delhi had lower prevalence of anemia and better intakes of iron(33). The differences in iron intake by region could explain variations in anemia prevalence. Data on the micronutrient status of children of MHSES groups were limited to one study(34). The high prevalence of folate and vitamin C deficiency were in contradiction with the high intakes of these vitamins(31,34). Intake of folate and vitamin C can be overestimated, as usually nutrient data are not corrected for losses of vitamins during cooking of foods, and also as the bioavailability of folate is usually estimated at 50%(42). Since there are limitations to assessing nutrient adequacy only by dietary intake data, a comparison between biochemical status and dietary intake on an individual basis would be more helpful in understanding the occurrence of micronutrient deficiencies in an individual.

Other factors such as psychosocial and bio-ecologic environment of children also influence

What this Study Adds

- From available literature there are strong indications that anemia and micronutrient deficiencies are prevalent among children from middle and high socio economic status groups in India.
- A Survey including biochemical parameters to asses anemia and micronutrient status of children from middle and high socioeconomic groups is necessary to better understand the nutritional status.

their development and nutritional status(43). Infections are known to reduce uptake and utilization of micronutrients and affect micronutrient status(44,45). Episodes of diarrhea, cough, cold and fever are common (1.0-5.4 per child per year) amongst children from MHSES(31). *Helicobacter pylori* infection is widely prevalent in the Indian population and is known to reduce iron absorption(46,47).

The prevalence figures for overweight (8.5-29.0%) and obesity (1.5-7.4%) in Indian children are comparable with that for Western nations, 7.9 to 25.4% for over weight and 0.9 to 7.9% for obesity(48), indicating the emergence of the double burden of malnutrition in the young population here. While comparing micronutrient deficiencies, the prevalence of anemia reported is higher among children in India. Iron deficiency was shown in 1.8-18% of children and adolescents, in developed countries, aged 6-18 years (6-8).

Conclusion

The available data show a high prevalence of anemia even among MHSES children. Overweight and obesity are health concerns in this group and there are strong indications that micronutrient deficiencies might well exist among these children. However, adequate and recent information is lacking, especially with respect to micronutrient status, and data are only available from a number of small studies from specific regions that might not be representative for the general Indian population.

There is definitely a need for well-planned, large-scale studies using standardized methodologies to estimate the prevalence of iron deficiency, anemia and other micronutrient deficiencies. When planning these studies it is necessary to ensure that importance is given to accurate evaluation of socio economic status and representation of the different regions of India. A comprehensive study including anthropometric data, biochemical data, clinical signs and dietary intake data among the same group of children will give a better insight into the situation. Furthermore, this information would be valuable to show the way forward for improving the nutritional status of MHSES children by implementation of well designed programs for health and nutrition education, micronutrient supplementation, and food fortification.

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