Section: Pediatrics

Original Research Article

NUTRITIONAL STATUS AND MICRONUTRIENT DEFICIENCIES AMONG URBAN SCHOOL-GOING CHILDREN AGED 6–16 YEARS: A CROSS-SECTIONAL STUDY FROM CENTRAL INDIA

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ABSTRACT

Background: As per WHO among children and adolescents aged 5-19 years, 390 million were overweight, including 160 million who were living with obesity. Another 190 million were living with thinness. This study highlights the critical "second chance" for growth in school-aged children to prepare for adolescent life. As urbanization shifts diets toward processed "convenience" foods, children face a "nutrition transition" marked by hidden hunger and significant micronutrient gaps. Despite huge impact of protein-energy malnutrition and anemia on survival and cognitive development, this age group is often overlooked because regular medical visits typically decline after early childhood immunizations. The findings underscore the urgent need for school-based health interventions and reduce the high global burden of malnutrition-linked morbidity and mortality

Materials and Methods: A cross-sectional study was conducted among 318 school children aged 6–16 years in urban Nagpur between July 2017 and December 2019. Height, weight, and body mass index (BMI) were measured and interpreted using Indian Academy of Pediatrics (IAP) 2015 growth charts. Clinical examination was performed to identify micronutrient deficiencies. Data were analyzed using SPSS version 20.

Results: Among 318 children, 189 (59.4%) were boys and 129 (40.6%) were girls. The prevalence of underweight was 32.8% in boys and 26.3% in girls. Stunting was observed in 24.3% of boys and 24.8% of girls. Pallor was present in 47.5% of children. Clinical signs suggestive of vitamin A deficiency were seen in 5–6%, vitamin B-complex deficiency in 6–27%, vitamin C deficiency in 4.4%, vitamin D deficiency in 4.1%, and zinc deficiency in 2.2% children.

Conclusion: A high burden of malnutrition and micronutrient deficiencies exists among urban school-going children, emphasizing the need for strengthened school health programs and nutritional interventions.

Keywords: School children, Malnutrition, Micronutrient deficiency, Urban India, Anthropometry.

INTRODUCTION

The school-aged children (6–16 years) undergo rapid physical and mental changes, this period serves as a critical “second chance” to correct early-life nutritional deficits and build vital nutrient stores. However, rapid urbanization has triggered a “nutrition transition,” replacing traditional balanced diets with energy-dense convenience foods that lead to "hidden hunger" and micronutrient deficiencies. Since medical contact often declines after the age-five immunization milestone, school-based health assessments are vital to prevent malnutrition from

undermining both scholastic performance and long-term health.

Investment in child health, nutrition, and education serves as the essential foundation stone for national development and future economic wealth. The school-going period (ages 6–16) represents a "second chance" for growth, where children acquire up to 18% of their adult height and 35% of their adult weight. Rapid urbanization and migration have led to a "nutrition transition," where traditional balanced diets are replaced by energy-dense, micronutrient-poor convenience foods. While rural health has been prioritized, there is a critical lack of anthropometric and clinical data for school-age children living in the overcrowded urban slums of Central India.

The school-age period (6–16 years) is a vital "second chance" for physical and cognitive recuperation, yet it remains one of the most neglected phases in public health research, which predominantly focuses on the first 1,000 days of life. While India has made strides in rural health, the rapid "nutrition transition" in urban slums has created a complex landscape of malnutrition where traditional diets are replaced by calorie-dense but nutrient-poor convenience foods. Current evidence is particularly thin regarding the prevalence of "hidden hunger"—micronutrient deficiencies such as Vitamin A, Zinc, and Iron—among urban school-goers who no longer have regular contact with health services following their five-year immunization milestone. Consequently, there is an urgent need to generate an updated anthropometric and clinical profile for this demographic to prevent irreversible deficits in scholastic performance and long-term national productivity.

Since children acquire up to 18% of their adult height and 35% of their adult weight between ages 6 and 16, this study targets the final biological "window of opportunity" to reverse early-childhood nutritional deficits. As the health system's traditional focus on rural areas leaves urban slum populations underserved, this research addresses the rising crisis of "nutrition transition" and overcrowding in rapidly expanding city centers. By focusing on children over age five—a group that lacks regular medical surveillance post-immunization—this study fills a critical evidence gap in anthropometric and micronutrient data for school-aged populations Identifying hidden hunger and malnutrition in this demographic is essential to preventing poor scholastic performance and chronic morbidity, thereby securing the "Tomorrow's Wealth" envisioned by global health initiatives.

MATERIALS AND METHODS

1. Study Setting

The study was conducted in urban areas of **Nagpur, Maharashtra, India**. Data collection took place within various urban schools to capture a representative sample of the city's school-going pediatric population.

2. Study Design

A **community-based cross-sectional study** was employed. This design allowed for the assessment of the prevalence of nutritional deficiencies and growth patterns at a single point in time across different age groups.

3. Operational Definitions

Based on the **IAP 2015 Growth Charts**, the following definitions were used:

Underweight: BMI < 3rd percentile for age and sex.

Stunting: Height-for-age < 3rd percentile.

Overweight: BMI for age adult equivalent of 23.

Obesity: BMI for age adult equivalent of 27.

Nutritional Deficiency: The presence of specific clinical signs (e.g., Bitot's spots for Vitamin A, Angular Stomatitis for Vitamin B) as per WHO/Standard criteria.

4. Sampling Strategy & Sample Size

Sampling Strategy: The study targeted school children aged 6 to 16 years. Specific schools in urban Nagpur were visited after obtaining administrative permission.

Sample Size Calculation: The sample size was calculated by using formula: As per study of:

Sunil Pal Singh Chajhlan et al (2017) "Nutritional deficiencies among school
children in urban areas of Hydrabad, Telangana, India."(21)

Formula

N= 3.84 (pq)/L2

Where,

P-prevalence of underweight = 28.9%

q=(1-p)

L- 5% error

5. Study Procedure

Preparation: Permission was obtained from the HOD of Pediatrics and school Principals.

Team Formation: A team consisting of a Pediatrician, intern doctors, and teachers was formed. Female students were examined in the presence of female interns/teachers to ensure comfort.

Data Collection:

Anthropometry: Height was measured using a **stadiometer** (Frankfort plane) and weight via a **bathroom scale** (zero-error checked).

Clinical Examination: A head-to-toe examination was performed using a torch and tongue depressor to identify signs of micronutrient deficiencies (Vitamins A, B, C, D, Iron, and Zinc).

6. Data Management

Recording: Preliminary data (name, age, sex) and clinical findings were recorded on a **structured case report form**.

Processing: Data was cleaned and scrutinized for errors.

Analysis: Data was entered into **MS Excel 2013** and analyzed using **Epi Info 3.5.3** and **IBM SPSS Statistics v20**. Descriptive statistics were used to group data by BMI percentiles.

7. Human Participation Protection (Ethics)

Informed Consent: Written/Verbal consent was obtained from parents or teachers.
Assent: Verbal assent was obtained from the children before any physical examination.

Privacy: Examinations were conducted during school hours in a respectful manner.
Safety: Tongue depressors were sterilized using **2.45% glutaraldehyde (Cidex)** after every use to prevent cross-infection.

RESULTS

A Total of 318 childrens were enrolled in this study. Median age in our study 11.28(10-13 years) with male to female ratio 1.46 (Male-189, Female-129).

Table 1: Prevalence of Underweight, stunting, overweight, Normal BMI of children studied
We found overall

Nutritional Indicator	Boys (n=189)	Girls (n=129)	Total (N=318)	p-value
Underweight	62 (32.80%)	34 (26.35%)	96 (30.18%)	0.84
Stunting	46 (24.33%)	32 (24.80%)	78 (24.52%)	0.71
Overweight	2 (1.05%)	1 (0.77%)	3 (0.94%)	-
Normal BMI	125 (66.15%)	94 (72.88%)	219 (68.86%)	-

BMI and Height-for-age calculated as per Indian Academy of Pediatrics (IAP) 2015 revised growth charts.

Table 2: Prevalence of Micronutrient Deficiencies

Deficiency Type	Clinical Sign	Frequency (n)	Prevalence (%)
Vitamin A	Bitot's Spots / Xerosis	35	11.00%
B-Complex	Knuckle Pigmentation	85	**26.72%**
	Atrophic Papillae	26	8.17%
	Angular Cheilosis	20	6.28%
Vitamin C	Spongy/Bleeding Gums	14	4.40%
Vitamin D	Frontal Bossing	10	3.14%
Zinc	Perioral Dermatitis	7	2.20%
Iron	Pallor (Clinical)	151	**47.48%**

Table 3: Prevalence of Dental caries

Morbidity	Dental Caries	57	17.92%

DISCUSSION

The present study highlights a substantial burden of malnutrition and anaemia among school-going children, indicating an important public health concern. The prevalence of underweight was higher among males (32.80%) compared to females (26.35%), while stunting was observed in 24.33% of male and 24.80% of female children. These findings reflect the presence of both acute and chronic undernutrition among the study population. The absence of a significant association between age and BMI or stunting suggests that undernutrition persists across all age groups, emphasizing the need for early nutritional interventions.

The high prevalence of pallor (47.48%) among school children suggests a considerable burden of anaemia. Although pallor was more commonly observed among children aged 10–13 years, no statistically significant association with age was identified. The high prevalence of anaemia may be attributed to inadequate dietary intake, poor iron consumption, increased nutritional requirements during growth periods, and possible micronutrient deficiencies. These findings are consistent with previous studies conducted in developing countries, which report a high burden of nutritional anaemia among school-aged children.

The study also identified several clinical manifestations of micronutrient deficiencies. Vitamin A deficiency was indicated by night blindness, Bitot's spots, conjunctival xerosis, and a case of keratomalacia. Similarly, vitamin B complex deficiencies were observed in the form of atrophic papillae, angular cheilosis, magenta tongue, alopecia, and knuckle pigmentation suggestive of vitamin B12 and folic acid deficiency. Additional deficiencies included vitamin C deficiency (spongy gums), vitamin D deficiency presenting as wrist widening, frontal bossing, and rachitic rosary, and zinc deficiency manifested as dermatitis. The higher occurrence of nutritional deficiencies among children aged 10–13 years may be attributed to increased nutritional demands during rapid growth and pubertal development. Inadequate dietary intake, poor socioeconomic conditions, and lack of nutritional awareness may further contribute to these deficiencies. The findings underscore the importance of regular nutritional screening, school health programs, iron and micronutrient supplementation, and nutrition education to address the burden of malnutrition and anaemia among school children. Overall, the study emphasizes the need for comprehensive public health strategies targeting protein-energy malnutrition and micronutrient deficiencies in school-going children to improve their growth, development, and overall health outcomes.

Dental caries were identified in 17.92% of children, with a significant association with age, particularly among children aged 10–13 years. Although the prevalence was lower compared to some earlier studies, dental caries continues to be a common preventable morbidity. Scabies was detected in 7.2% of children, with no significant age-wise variation, and the prevalence was comparable to other school-based studies.

CONCLUSION

In conclusion, the study highlights a substantial burden of undernutrition, micronutrient deficiencies, anemia, and preventable morbidities among school-going children. These findings underscore the need for strengthening school health services, regular nutritional screening, and implementation of targeted nutritional and health interventions to improve child health outcomes.

REFERENCES

1. Kumari S, et al. Assessment of school children from rural Bihar. Ind J Nutr Dietct. 2005; 42:326-334.
2. Singh JP, et al. A Study on Health Status of Urban School Children (7-18 Years): A School Based Cross Sectional Study. 2017.
3. UNICEF. State of world's children, 2019. Available from: http://www.unicef.org/sowc2019/.
4. Singh JP, et al. A Study on Health Status of Urban School Children (7-18 Years): A School Based Cross Sectional Study. 2017.
5. Rao KV, et al. An evaluation of the relationship between nutritional status and anthropometric measurements. Am J Clin Nutr. 1970; 23:83-93.
6. Szklo M. Epidemiologic patterns of blood pressure in children. Epidemiol Rev. 1979;1(1):143-69.
7. Mahoney LT, et al. Childhood predictors of high blood pressure. Am J Hyper. 1991;4(11):608S-10.
8. Shear CL, et al. Value of childhood blood pressure measurements and family history in predicting future blood pressure status. Pediatr. 1986;77(6):862-9.
9. Gillespie S, et al. Attacking the Double Burden of Malnutrition in Asia and the Pacific. ADB Nutrition Series No 4. 2001.
10. Annual report 2010-11. Dept. of Health and Family Welfare, Govt. of India.
11. Rao KV, et al. An evaluation of the relationship between nutritional status and anthropometric measurements. Am J Clin Nutr. 1970; 23:83-93.
12. Dhir SK, Batta M. Brainstem auditory evoked responses in severely malnourished children. Int J Contemp Pediatr. 2015;2(4):303-6.
13. Nino FS. Hunger and food security. UN Sustainable Development.
14. Hunger Statistics | WFP | United Nations World Food Programme.
15. Disease control priorities project; working paper no 51. March 2003.
16. FAO/WHO. World declaration and plan of action for nutrition. Rome, 1992.
17. Banik Datta, et al. Growth pattern of Indian school children in relation to nutrition and adolescence. Indian J Pediatr. 1973;40(173).
18. WHO. Expert committee on comprehensive school health education and promotion through schools. WHO Technical Series No 87. 1997.
19. WHO Child Growth Standards. Acta Pediatr Supplement. 2006; 450:5-101.
20. Khadilkar V, et al. Revised IAP growth charts for height, weight and body mass index for 5- to 18-year-old Indian children. Indian Pediatr. 2015;52(1):47–55.
21. Pal S, Chajhlana S, Mahabhasyam RN. Nutritional deficiencies among school children in urban areas. 2017;4(2):607–12.
22. WHO. The World Health Report 2002: Reducing Risks Promoting Healthy Life. Geneva, 2002.
23. Raikar KJ, et al. A study of anthropometric parameters of school children: a cross sectional study in Rajasthan. Int J Community Med Public Heal. 2019;6(4):1499.
24. Gahlot A, et al. Evaluation of nutritional status of children aged 5-14 years in rural areas of Kanpur. Int J Community Med Public Heal. 2019;6(6):2519.
25. Seema P, Damayanthi MN. Nutritional status determined by anthropometric measurement among rural school children (6-18 years). 2018;5(4):1424–7.
26. Sharma M, et al. Nutritional Status of Primary School Children through Anthropometric Assessment in Moradabad. Ann Int Med Dent Res. 2017;3(2):2–6.
27. Joseph RB. Nutritional Status of Rural School Going Children (6-12 Years) of Mandya District, Karnataka. 2014;2(2).
28. P NB, et al. A study of adolescent health problems in a rural school. 2017;4(1):100–3.
29. Abraham RR, et al. A study on nutritional status and its determinants in adolescents aged 11 to 17 years in Bangalore. 2017;6(3):213–6.
30. Amruth M, Kulkarni KS. A study on nutritional status and morbidity pattern among primary school children in Sullia town. Indian J Basic Appl Med Res. 2015;100–12.
31. Devi P, Srigiri S. Morbidity profile of children attending Municipal Corporation Primary Schools in Visakhapatnam. 2015;14(11):118–22.
32. Rashmi MR, et al. Prevalence of Malnutrition and Relationship with Scholastic Performance in Bangalore Rural District. Indian J Community Med. 2015;40(2):97–102.
33. Bhargava M, et al. Magnitude of undernutrition in urban and rural school-going children of district Dehradun. Natl J Community Med. 2015;6(4):452–7.
34. Srivastava A, et al. Nutritional status of school-age children - A scenario of urban slums in India. Arch Public Heal. 2012;70(1):8.
35. Banerjee S, et al. Under-nutrition among adolescents: A survey in five secondary schools in rural Goa. 2014.
36. Kamath R, et al. Nutritional status assessment of school children in Mangalore city using WHO 2007 Z-scores. 2012;2(3):1–4.
37. Sambo M, et al. Prevalence of scabies among school-aged children in Katanga rural community in Kaduna state. Ann Niger Med. 2012;6(1):26.
38. Kar K, et al. Morbidity pattern of school children: a study in urban Odisha. Int J Res Med Sci. 2018;6(7):2489.
39. Mhaske M, et al. Morbidity pattern and personal hygiene in children among private primary school in urban area. J Fam Med Prim Care. 2013;2(3):266.
40. Bharati HP, et al. Prevalence of micronutrient deficiencies clinically in rural school going children. Int J Contemp Pediatr. 2017;5(1):234.
41. Batta M, et al. Vitamin deficiency prevalence in primary school children in Punjab, India. Int J Res Med Sci.