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Original Article

A Comparative Analysis of Nutritional Status Among Children in Rural and Urban Schools: A Cross-Sectional Study

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ABSTRACT

Background: Malnutrition, a major public health issue in developing countries, affects children's growth and development, with varying incidence and prevalence between rural and urban populations. This study aims to assess and compare dietary habits and anthropometric indices among school-aged children (6-12 years) in urban and rural areas. **Objectives:** The primary objective is to assess and compare the nutritional status of children in rural and urban settings. Additionally, the study aims to estimate the prevalence of malnutrition through anthropometric indicators and enhance awareness among parents and children using PILs. **Materials and Methods:** This community-based, cross-sectional comparative study was conducted in rural and urban areas of Bengaluru with a sample size of 800. Anthropometric measurements, such as weight, height, midarm circumference, and age, were collected to assess underweight, wasting, stunting, and overweight prevalence. **Results:** In urban areas, children aged 8-9 years show the highest underweight (20%), stunting (17%), and wasting (16.25%), with the lowest rates in 12-year-olds (3%). In rural areas, underweight peaks in 10-11-year-olds (20.25%), stunting in 6-7-year-olds (10.25%), and wasting in the 10-11 group (15.5%). **Discussion:** Urban children show a sharp decline in underweight and stunting by age 12, while rural children experience persistent underweight and stable stunting. Wasting is generally higher in rural children, especially in older age groups, whereas urban children exhibit a notable decrease by age 12. **Conclusion:** Malnutrition affects both areas, but rural children have higher and more persistent rates, particularly in older groups, indicating the need for targeted nutritional interventions in rural settings.

Keywords: Anthropometric Measurements, Malnutrition, Underweight, Stunting.

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INTRODUCTION

Nutrition status determines the growth in children which in turn is influenced by their dietary intake. However, child's growth is also greatly influenced by other factors such as food security, socio-economic status, environmental factors and available resources (Waghode *et al*., 2017, Kanjilal, *et al*., 2010). child's health and nutritional status has a major role in the overall health and economic development of a country (Prusty *et al*., 2015). The child's nutritional status is a sensitive indicators of community health and nutrition, where the greatest public health problems in the developing countries is attributed to under nutrition (Vincent *et al*., 2016). According to the report of UNICEF around 2300 children die daily and in developing countries, 1 in 7 children die at preschool age because of malnutrition (Emeagi and Apugo, 2022, Raghunathan *et al*., 2021). The extensive diet and nutrition survey carried out by the National Nutrition Monitoring Bureau [NNMB] and the National Institute of Nutrition, Hyderabad [NIN] in 12 states of the country indicates that the diet is inadequate and deficient in nutrition among rural population (Vijayaraghavan and Rao, 1998). India is home to one-third of the world's children who are wasted, with 43% underweight and 48% stunted due to chronic undernutrition. Only 25% of newborns are nursed exclusively during the 5 hr after delivery, and only 46% are exclusively breastfed (Patel *et al*., 2015).

It is important to evaluate and effectively manage nutritional needs at each stage, particularly for school-age children and adolescents (ages 5 to 15) (Sasikala 2016). During this age range, people continue to develop mentally and physically, and they have the opportunity to correct any dietary inadequacies, which helps to avoid growth, development, and cognitive achievement impairments (Khan *et al*., 2022). As per the UNICEF-WHO-World Bank Joint Child Malnutrition Estimates of 2016, there were 155 million stunted and 52 million wasting children

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under the age of five worldwide (De and Chattopadhyay, 2019). Undernourished children are more susceptible to infections and according to statistical reports, these children are more prone to diseases such as diarrhoea, measles, malaria, and LRTI. Undernourishment will reduce physical and cognitive development in children (Khan *et al*., 2022, Verma *et al*., 2021). In LMIC (low-middle-income countries) obesity and overweight are more prevalent in urban areas whereas underweight is higher in rural areas (Nurwanti *et al*., 2019). The most effective way to evaluate a population's nutritional status is by anthropometric measures, which make it possible to determine the type and severity of protein-energy deficiency in each group. Weight and height were converted to nutritional indices: Weight for age (W//A), Weight for Height (W//H), and Height for Age (H//A) (Maiti *et al*., 2011). The prevalence of malnutrition varies greatly between the states and the nation's districts. Numerous studies, particularly at the national and state levels, have been conducted on the nutritional condition of children in India (Banerjee and Rana, 2021).

Growth, food taboos, health state, and dietary preferences are other factors that affect food consumption. Malnutrition can also result from abandonment, irregular meal schedules, a lack of food, and inadequate parental education (Murarkar *et al*., 2020). Other factors include maternal anaemia (haemoglobin <12 g/dL), maternal low Body Mass Index (BMI) (<18.5 kg/m2), and maternal nutrition The primary causes of anthropometric failures (stunting, wasting, and underweight) in children include the child's birth order and weight, the mother's age, place of residence, Antenatal Care (ANC), the and size at birth, the toilet facility, the stool disposal system, the brief period of breastfeeding, and the household income level. Even with significant advancements, there are still issues in tackling undernourishment, especially in children of school age (Katoch, 2021).

On this account, there lies a necessity to assess the nutritional status and to compare nutritional status of children between urban and rural areas.

MATERIALS AND METHODS

Study Design and setting

This school-based, cross-sectional comparative study was conducted in both rural (Devanahalli, Bandi Kodigehalli Palya, Mylanahalli, Hunachur) and urban (Yelahanka, Thirumenahalli) areas of Bengaluru.

Study Population

The study targeted school-aged children (6-12 years), with a total sample size of 800 (400 from rural and 400 from urban areas).

Data Collection and Study Instruments

Data collection involved a structured questionnaire for parents and children, gathering information on dietary intake, socioeconomic status, environmental factors, parental education and employment, family size, medical history, and medication use. Additionally, anthropometric measurements (weight, height, mid-upper arm circumference, triceps skinfold thickness) were recorded to assess wasting, stunting, and overweight prevalence.

The weight and height were converted to nutritional indices: Weight-for-Age *z*-score (WAZ), Height-for-Age *z*-score (HAZ), and body mass Index-for-Age Z-scores (BAZ) which were obtained using Medscape calculators.

A comprehensive nutritional assessment included medical and nutritional history, physical examination, and growth evaluation using age- and gender-specific growth charts. Children were also examined for malnutrition signs, vitamin deficiencies, anaemia, and rickets.

Statistical Analysis

The data were entered into Microsoft Excel, and statistical analysis was performed using Jeffreys's Amazing Statistics Program (JASP) version 0.16.4. Descriptive statistics were used to calculate the frequency and Standard Deviation (SD) of anthropometric measures. Chi-square tests were applied to assess associations between categorical variables, and Student's *t*-test was used to compare mean differences between rural and urban areas. For all tests, statistical significance was set at $p<0.05$.

RESULTS

Among the 800 children studied, underweight (weight-for-age) was identified in varying degrees: 56 (7.0%) were severely underweight (below -3SD), 125 (15.6%) moderately underweight (below-2SD), and 238 (29.8%) mildly underweight (below -1SD), while 347 (43.4%) had normal weight-for-age. Regarding stunting (height-for-age), 12 (1.5%) children were severely stunted, 109 (13.6%) moderately stunted, and 213 (26.6%) mildly stunted, with 466 (58.3%) showing normal height-for-age. In terms of wasting (weight-for-height), 57 (7.1%) were severely wasted, 117 (14.6%) moderately wasted, and 182 (22.8%) mildly wasted, while 405 (50.6%) were within the normal range.

When disaggregated by sex, underweight was more common among boys, with 212 boys below normal compared to 198 girls. Similar trends were observed in stunting and wasting, although the differences were marginal. Age-wise, the 8-9 and 10-11-year age groups exhibited the highest prevalence of mild to moderate malnutrition across all indices. These findings suggest that nearly half of the children experienced some form of undernutrition, with underweight being the most prominent indicator, as shown in Table 1.

In addition to undernutrition, a small proportion of children were found to be overweight. Based on weight-for-age and weight-for-height indicators, 34 (4.25%) and 39 (4.88%) children respectively were categorized as overweight. These cases were

more prominent in the 10-11-year age group, indicating the early emergence of overnutrition alongside persistent undernutrition.

Urban children showed relatively better anthropometric outcomes compared to rural children, with higher mean scores for height, weight, and BMI across all age groups. In contrast, rural children exhibited more negative Z-scores, indicating a greater burden of undernutrition in terms of height-for-age, weight-for-age, and BMI-for-age, as reflected in Table 2.

The Mid-Upper Arm Circumference (MUAC) classification revealed a higher prevalence of malnutrition in rural children compared to their urban counterparts. Among rural children, 12 (3%) were severely malnourished, 18 (4.5%) moderately malnourished, and 94 (23.5%) mildly malnourished. In contrast, only 3 (0.75%) urban children were severely malnourished, 3 (0.75%) moderately malnourished, and 48 (12%) mildly malnourished. The proportion of children falling within the normal MUAC range was notably higher in urban areas (285 children, 71.25%) than in rural areas (337 children, 84.25%), suggesting comparatively better nutritional status in the rural group overall, despite slightly higher mild-to-moderate malnutrition rates in rural settings. This distribution is illustrated in Figure 1.

A chi-square test was conducted to examine the association between nutritional indicators and area of residence among 800 children. The prevalence of wasting was significantly higher in rural children (26.37%) compared to urban children (18.12%), with a statistically significant association (p=0.001). Similarly, underweight status was more common in rural areas (30.37%) than in urban areas (22.0%), showing a significant difference (p=0.004). Stunting affected 23.12% of rural children and 18.62% of urban children, with a borderline significant association (p=0.05). Interestingly, overweight and obesity were more prevalent in urban children (5.6%) compared to rural (3.5%), and this difference was statistically significant (p=0.034).

MUAC-based classification further revealed that mild malnutrition was more prevalent among urban children (11.75%), while moderate and severe malnutrition were significantly higher among rural children (2.62% and 1.87% respectively), indicating a strong association between rural setting and severity of malnutrition (p<0.001). These findings highlight important nutritional disparities between urban and rural populations, as shown in Table 3.

An independent two-sample t-test was used to compare malnutrition indices between the two groups. The mean difference in height was -0.368 (p=0.6484), showing no significant difference. However, weight showed a significant mean difference of -1.980 (p=0.0007), and BMI had a highly significant difference of -0.882 (p<0.0001), indicating notable variations between the groups.

Demographic differences between rural and urban children were assessed using odds ratios. Compared to children aged 12 and above (reference), the odds of being from a rural area were slightly lower in the 6-7 (OR=0.718) and 8-9 (OR=0.974) age groups, and slightly higher in the 10-11 group (OR=1.249). For sex, males had similar odds in both areas compared to females (OR=0.960), indicating no major difference.

Table 1: Percentage on underweight, stunting, and wasting in children from both urban and rural areas.

Demographic characteristics		Underweight (wt/age)				Stunting (ht/age)				Wasting (wt/ht)			
Sex	Age	<-3SD	<-2SD	<-1SD	Normal	<-3SD	<-2SD	<-1SD	Normal	<-3SD	<-2SD	<-1SD	Normal
All	6-7	4	26	55	44	1	20	47	111	21	27	46	79
	8-9	17	43	92	94	6	38	79	131	13	40	65	126
	10-11	19	37	71	110	5	32	51	161	12	33	53	138
	=12	16	19	20	59	0	19	36	63	11	17	18	62
Total		56	125	238	347	12	109	213	466	57	117	182	405
Male	6-7	3	16	29	49	0	12	28	61	14	15	31	37
	8-9	6	19	39	54	2	17	42	60	5	18	25	71
	10-11	5	18	35	41	2	11	27	68	3	17	27	55
	=12	12	14	16	42	0	13	26	47	9	11	15	44
Total		26	67	119	186	4	53	123	236	31	61	98	207
Female	6-7	1	10	26	35	1	8	19	50	7	12	15	42
	8-9	11	24	53	40	4	21	37	71	8	22	40	55
	10-11	14	19	36	69	3	21	24	93	9	16	26	83
	=12	4	5	4	17	0	6	10	16	2	6	3	18
Total		30	58	119	161	8	56	90	230	26	56	84	198

Table 2: Anthropometric parameters and Z-Scores in urban and rural children aged 6 - 12 years.

Urban													
Age	N	Height (cm)				Weight (kg)				BMI (kg/m²)			
		Boys		Girls		Boys		Girls		Boys		Girls	
		Mean +/- SD	Mean HAZ score	Mean +/- SD	Mean HAZ score	Mean +/- SD	Mean WAZ score	Mean +/- SD	Mean WAZ score	Mean +/- SD	Mean BAZ score	Mean +/- SD	Mean BAZ score
6-7	100	111.03 +/- 3.4	-0.44 +/- 1.120	110.2 +/- 3	-0.55 +/- 1.40	18.32 +/- 2	-1.04 +/- 1.13	17.67 +/- 1.36	-0.72 +/- 1.12	13.6 +/- 0.66	-1.22 +/- 1.25	13.1 +/- 0.5	-0.58 +/- 1.09
8-9	212	120.4 +/- 3.57	-0.82 +/- 1.13	120.4 +/- 2.8	-1.29 +/- 1.08	20.89 +/- 2.4	-1.06 +/- 1.211	20.82 +/- 2.13	-1.60 +/- 1.2	13.6 +/- 0.47	-0.92 +/- 1.09	13.6 +/- 0.6	-4.21 +/- 23.3
10-11	118	128.75 +/- 3.8	-0.41 +/- 1.03	127.4 +/- 4.61	-0.62 +/- 1.04	24.75 +/- 2.68	-0.63 +/- 1.33	24.45 +/- 4.11	-0.68 +/- 1.32	14.3 +/- 1.88	-0.61 +/- 1.34	13.3 +/- 0.84	-0.37 +/- 1.28
=12	39	136.6 +/- 3.9	-0.51 +/- 0.78	138.3 +/- 4.12	-1.16 +/- 0.84	29.78 +/- 3.77	-0.26 +/- 1.03	26.9 +/- 2.47	-0.77 +/- 1.16	15.3 +/- 2.4	0.10 +/- 1.16	13.3 +/- 0.15	-0.22 +/- 1.35
Rural													
Age	N	Height (cm)				Weight (kg)				BMI (kg/m²)			
		Boys		Girls		Boys		Girls		Boys		Girls	
		Mean +/- SD	Mean HAZ score	Mean +/- SD	Mean HAZ score	Mean +/- SD	Mean WAZ score	Mean +/- SD	Mean WAZ score	Mean +/- SD	Mean BAZ score	Mean +/- SD	Mean BAZ score
6-7	77	120.6 +/- 9.0	-0.57 +/- 1.41	121.6 +/- 8.7	-0.5 +/- 1.42	20.77 +/- 3.45	-0.80 +/- 1.24	20.66 +/- 4.16	-0.8 +/- 1.17	14.22 +/- 1.5	-1.37 +/- 1.49	13.93 +/- 1.38	-1.40 +/- 1.22
8-9	63	124.9 +/- 6.5	-1.03 +/- 1.08	126.0 +/- 6.36	-0.64 +/- 1.26	23.23 +/- 3.29	-1.2 +/- 1.01	24.09 +/- 5.3	-1.05 +/- 1.25	14.83 +/- 1.40	-0.97 +/- 1.15	15.1 +/- 2.44	-0.92 +/- 1.4
10-11	83	136.25 +/- 8.08	-0.75 +/- 0.96	133.5 +/- 7.71	-0.78 +/- 1.06	29.10 +/- 7.67	-1.30 +/- 1.28	27.9 +/- 4.84	-1.4 +/- 1.07	15.4 +/- 2.6	-1.17 +/- 1.21	15.1 +/- 1.84	-1.2 +/- 1.12
=12	40	142.3 +/- 8.98	-0.87 +/- 1.22	143.8 +/- 8.01	-0.92 +/- 1.10	32.69 +/- 9.61	-1.5 +/- 1.42	36.13 +/- 10.44	-1.17 +/- 1.6	15.91 +/- 3.24	-1.4 +/- 1.55	17.1 +/- 3.6	-0.84 +/- 1.61

Dietary pattern among students

The dietary pattern among students was assessed through a questionnaire completed by parents, covering aspects such as the child's appetite, number of meals, type of diet, intake of raw vegetables, green leafy vegetables, dairy products, junk food consumption, vitamin/mineral supplementation, duration of breastfeeding, and frequency of illness. Most children consumed a mixed diet including both vegetarian and non-vegetarian foods, along with dairy products. In rural areas, data collected from government schools highlighted the positive impact of mid-day meal programs, which provided rice, vegetables, milk, eggs, and fruits, contributing significantly to the children's nutritional intake.

A noticeable difference in junk food consumption patterns was observed between urban and rural children. Urban children reported more frequent intake, especially on a daily basis, whereas rural children predominantly consumed junk food once in two weeks or less. These patterns are illustrated in Figure 2.

DISCUSSION

The cross-sectional comparative study on nutritional assessment among 800 school-going children aged 6-12 years in rural and urban areas of Bengaluru included 400 children from each region. The participants were selected from local schools to ensure equal representation from both settings. Nutritional status of children was assessed through anthropometric measurements including height, weight, and Mid-Upper Arm Circumference (MUAC) (Aydın *et al.*, 2023). Additionally, information on dietary patterns, medical history, and current medication use was collected using structured questionnaires administered to parents or guardians.

Nutritional assessment was based on World Health Organization (WHO) growth standards using three key anthropometric indicators: Weight-for-Age (WAZ), Height-for-Age (HAZ), and Weight-for-Height (WHZ) (World Health Organization, 2017). These parameters helped identify levels of undernutrition-namely underweight, stunting, and wasting-by comparing children's measurements to standardized growth charts. Children were categorized as normal, mildly, moderately, or severely malnourished depending on how far their z-scores deviated from the WHO reference population.

Among the children studied, undernutrition emerged as a significant concern, with many falling below standard growth indicators for weight, height, and BMI. Underweight was the most prominent form, followed by wasting and stunting. Boys appeared to be slightly more affected than girls, and the 8-11-year age group showed higher levels of mild to moderate malnutrition.

In contrast, a smaller proportion of children were identified as overweight, indicating the presence of a dual burden of malnutrition. This trend was more noticeable in older age groups, suggesting the early onset of overnutrition in some segments of the population.

Urban children generally demonstrated better nutritional outcomes, with more favourable anthropometric measurements and Z-scores. Rural children, on the other hand, showed a higher burden of undernutrition across all indicators. These differences

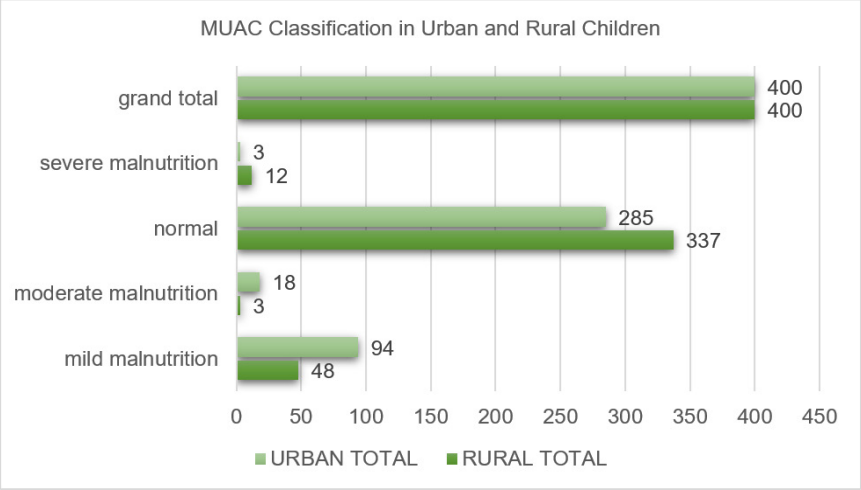

Figure 1: MUAC Classification showing Prevalence of malnutrition categories among Rural and Urban Children.

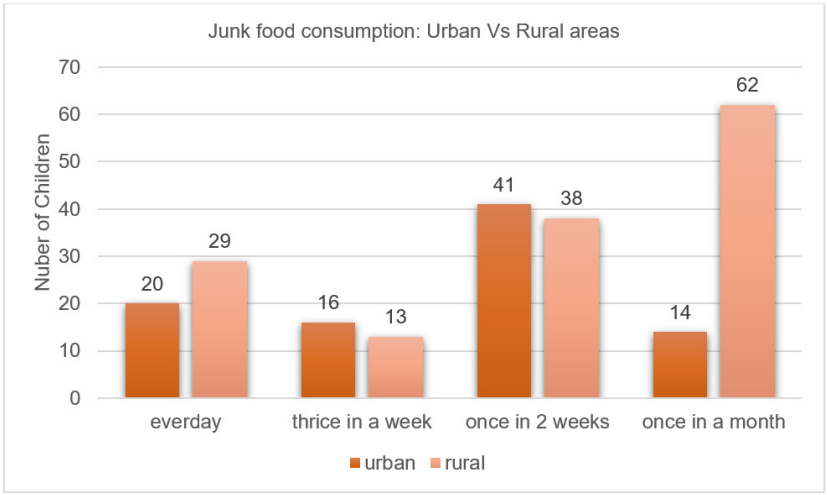

Figure 2: Frequency distribution of junk food consumption among urban and rural children.

Table 3: Prevalence of malnutrition indices and MUAC categories with chi-square analysis among urban and rural children.

Malnutrition Indices	Urban n (%)	Rural n (%)	Total n (%)
Wasting (N=800)	145 (18.12) 211 (26.37) Chi Square=22.0; *p* value=0.001*		356 (44.5)
Stunting (*n*=800)	149 (18.62) 185 (23.12) Chi Square=3.8; *p* value=0.05		334 (41.75)
Underweight (*n*=800)	176 (22.0) 243 (30.37) Chi Square=8.3; *p* value=0.004 *		419 (52.37)
Overweight/obese (*n*=800)	45 (5.6) 28 (3.5) Chi Square=4.5; *p* value=0.034 *		73 (9.1)
MUAC			
Mild malnutrition (800)	94 (11.75) 48 (6.00) Chi Square=18.12; *p* value=0.00002*		142 (17.75)
Moderate malnutrition (800)	18 (2.25) 21 (2.62) Chi Square=10.99; *p* value=0.0009*		39 (4.87)
Severe malnutrition (800)	3 (0.3) 15 (1.87) Chi Square=5.50; *p* value=0.019*		18 (2.25)

were further reflected in MUAC classifications, which indicated a greater proportion of malnourished children in rural areas.

Overall, the findings highlight a substantial prevalence of undernutrition among school-aged children, especially in rural settings, while also pointing to the emergence of overnutrition as a growing public health issue.

A comparative study by Waghode *et al.* conducted in Pune revealed a higher prevalence of severe underweight, stunting, and moderate wasting among preschool children living in urban slums compared to those in rural areas. The study also found that children in urban slums had a greater risk of malnutrition based on MUAC, with some cases of severe malnutrition not seen in rural children. Additionally, urban children had increased consumption of processed foods, sweets, and tea, which may have contributed to their poor nutritional outcomes (Waghode *et al.*, 2017).

In contrast, the present study in Bangalore showed no significant difference in the intake of vegetables, dairy, or meat between urban and rural children. However, undernutrition remained more prevalent in rural children, indicating regional variations in contributing factors and highlighting the importance of tailored nutritional interventions.

CONCLUSION

This study conducted in Bangalore reveals a significant burden of malnutrition among school-aged children, with high rates of underweight, stunting, and wasting, particularly in rural areas. Urban children demonstrated relatively better nutritional status, yet emerging cases of overweight highlight the growing challenge of dual burden malnutrition. The findings underscore the need for area-specific interventions, with a focus on rural communities where undernutrition is more prevalent. At the same time, the rising trend of overnutrition in urban settings warrants early preventive strategies. Strengthening school-based nutrition programs, regular growth monitoring, and parent-child education on balanced diets is essential to improve nutritional outcomes. Timely, targeted actions can help ensure healthier growth and development among children in both rural and urban Bangalore.

LIMITATIONS

Parental illiteracy in rural areas posed a major challenge in obtaining feedback for the questionnaires, leading to their completion by respective class teachers. In some cases, the forms were filled out through direct interaction with the children instead of their parents. Additionally, the study could not evaluate diseases associated with malnutrition. Further research is recommended to explore community-level risk factors contributing to stunting, wasting, and underweight among children.

ABBREVIATIONS

BMI: Body Mass Index; **MUAC:** Mid-Upper Arm Circumference; **PILs:** Patient Information Leaflets; **NNMB:** National Nutrition Monitoring Bureau; **NIN:** National Institute of Nutrition; **WAZ:** Weight-for-Age Z-score; **HAZ:** Height-for-Age Z-score; **BAZ:** Body Mass Index-for-Age Z-score; **SD:** Standard Deviation; **LMIC:** Low- and Middle-Income Countries; **WHO:** World Health Organization; **WHZ:** Weight-for-Height Z-score; **OR:** Odds Ratio.

CONFLICT OF INTEREST

The authors declare that they have no conflicting interests.

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SUMMARY

This cross-sectional comparative study evaluated the nutritional status of 800 school-aged children (6-12 years) in rural and urban Bengaluru using anthropometric measurements (weight, height, MUAC) and WHO growth standards (Weight-for-Age, Height-for-Age, Weight-for-Height Z-scores). Dietary patterns and socioeconomic factors were assessed via structured questionnaires. Results showed higher prevalence of underweight, stunting, and wasting among rural children, while urban children had better anthropometric outcomes but emerging overweight cases. Significant differences were observed in weight (p=0.0007) and BMI (p<0.0001) between groups. These findings underscore the persistent burden of malnutrition, particularly in rural areas, and highlight the need for targeted nutritional interventions, school-based programs, and awareness initiatives to improve child growth and development.

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