



EFFECT OF ANAEMIA IN PRIMARY SCHOOL CHILDREN IN KHURJA BULANDSHAHR

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Abstract:

In India, childhood anemia remains a severe public health problem, affecting all sections of society with varying intensity. According to the WHO classification, India faces a severe public health challenge, with anemia prevalence rates of **67.1% among children under five** (NFHS-5, 2019-21). While numerous studies exist on preschool children and pregnant women, data on anemia among school-aged children (6-14 years) remain scarce, particularly in urban settings like khurja, **bulandshahr, Uttar Pradesh**.

This study aimed to estimate the prevalence of anemia among school children in khurja, assess associated socio-economic and nutritional factors, and evaluate the effectiveness of the **Mid-Day Meal Scheme (MDMS)** in addressing anemia.

A **community-based, cross-sectional study** was conducted among **512 children** (6-14 years) from 10 randomly selected government schools in khurja. Hemoglobin levels were measured using the **HemoCue Hb 301 system**, and anthropometric data (height, weight, BMI) were recorded following WHO protocols. Socio-economic status was assessed using the **modified Kuppuswamy scale (2022)**. Data were analyzed using **SPSS 26.0**, with p-values <0.05 considered significant.

The study revealed an **overall anemia prevalence of 78.3%**, with **42.6% mild, 27.8% moderate, and 7.9% severe anemia**. Significant associations were found with **low socio-economic status (aOR=3.4, p<0.001)**, inadequate dietary diversity (aOR=2.3, p=0.002), and irregular MDMS participation (aOR=1.9, p=0.004). Stunting (height-for-age < -2SD) was observed in **31.2%** of children, while **66.8%** were underweight (BMI-for-age < -2SD).

Anemia remains a **severe public health problem** among school children in khurja, necessitating urgent interventions such as **iron-fortified school meals, enhanced supplementation programs, and community awareness initiatives**.

Keywords: Anemia, school children, hemoglobin, malnutrition, Mid-Day Meal Scheme, public health, India.

Introduction

Anemia remains one of India's most persistent public health challenges, particularly affecting vulnerable pediatric populations. The National Family Health Survey-5 (2019-21) reveals that 67.1% of Indian children under five years suffer from anemia, showing minimal improvement from 58.6% reported in NFHS-4 (2015-16). This stagnation persists despite nationwide implementation of programs like the Mid-Day Meal Scheme and Anemia Mukht Bharat initiative. School-aged children (6-14 years), constituting 25.4% of India's population according to Census 2011 data, represent a critically understudied demographic in anemia research.

Existing research highlights significant gaps in understanding childhood anemia epidemiology. Most studies focus disproportionately on preschool children, with a PubMed analysis indicating 86% of anemia research targets under-fives, while school-aged populations remain neglected. Regional disparities are particularly striking, with Uttar Pradesh demonstrating the highest anemia burden at 66.4% according to NFHS-5, yet lacking district-level granularity. A systematic review identified only three published studies from Western Uttar Pradesh in the past decade. Program effectiveness research shows particular deficiencies, with a 2019 ICMR study revealing that merely 28% of Mid-Day Meal Scheme offerings meet recommended iron requirements. Urbanization creates additional complexities, as evidenced by Sharma et al.'s (2020) finding of 71.3% anemia prevalence in Ghaziabad slums, while peri-urban areas like khurja are main unstudied.

This investigation addresses multiple evidence gaps through three primary objectives. First, it establishes baseline anemia prevalence among 6–14-year-olds in khurja, filling a critical knowledge void. Second, it rigorously evaluates the Mid-Day Meal Scheme's impact using biochemical and anthropometric parameters rather than relying solely on administrative data. Third, the study identifies local determinants through comprehensive household-level data collection, enabling context-specific interventions. The research particularly focuses on the intersection between school-based feeding programs and hemoglobin outcomes, an understudied relationship in public health nutrition.

Methodology Overview

The study employs a school-based cross-sectional design with robust methodological components. A representative sample of 512 children was selected through stratified random sampling from ten government schools in khurja. Biochemical analysis utilized the HemoCue Hb 301 system for hemoglobin estimation, following WHO protocols for capillary blood sampling. Anthropometric measurements applied WHO Growth Reference Standards (2007) for all indices, with trained personnel conducting height and weight assessments using calibrated equipment. Dietary evaluation incorporated both 24-hour recall and food frequency questionnaires to capture nutritional patterns. Advanced statistical analysis employed multivariate regression modeling using STATA 15.0 to identify significant predictors while controlling for confounding variables.

Scientific Contribution

This research makes several novel contributions to public health literature. It represents the first study to correlate Mid-Day Meal Scheme participation with hematological outcomes in Western Uttar Pradesh. The methodology innovatively combines quantitative biochemical analysis with qualitative program evaluation. Furthermore, the application of WHO Growth Reference Standards ensures international comparability of anthropometric findings. The study's household-level socioeconomic data collection provides unprecedented granularity for understanding local determinants of anemia in urbanizing contexts. These elements collectively advance understanding of school-age anemia while providing actionable insights for policymakers.

Results

The comprehensive analysis of 512 school children in khurja revealed critical findings about anemia prevalence and associated factors. The data demonstrates a severe public health challenge requiring immediate intervention.

Table 1: Anemia Prevalence by Severity (n=512)

Hemoglobin Category	Cut-off (g/dL)	Number of Children	Percentage	95% Confidence Interval
Normal	≥ 11.5	111	21.7%	18.2-25.5
Mild Anemia	10.0-11.4	218	42.6%	38.3-46.9
Moderate Anemia	8.0-9.9	142	27.8%	23.9-31.9
Severe Anemia	< 8.0	41	7.9%	5.8-10.6

Figure 1: Bar chart illustrating the distribution of anemia severity categories, showing that 78.3% of children fell below normal hemoglobin thresholds, with nearly 8% experiencing severe anemia.

The age-specific analysis presented in **Table 2** shows consistent anemia prevalence across different age groups:

Table 2: Age-wise Prevalence of Anemia

Age Group (years)	Total children	Anemic Cases	Prevalence	P-Value
6-9	224	176	78.3%	0.92
10-14	288	225	78.6%	

Figure 2: Line graph comparing anemia prevalence between boys (77.1%) and girls (79.5%), demonstrating no statistically significant difference ($p=0.47$).

Nutritional assessment revealed concurrent malnutrition burdens as shown in **Table 3**:

Table 3: Anthropometric Indicators (n=512)

Parameter	Cut-off	Number of Children	Percentage
Stunting	HAZ $< -2SD$	160	31.2%
Underweight	BAZ $< -2SD$	342	66.8%
Sever Underweight	BAZ $< -3SD$	115	22.4%

Figure 3: Pie chart visualization of nutritional status, highlighting that two-thirds of children were underweight and nearly one-third were stunted.

The socioeconomic analysis presented in **Table 4** demonstrates stark disparities:

Table 4: Socioeconomic Gradient in Anemia Prevalence

SES Category	Total Children	Anemic Cases	Prevalence	Adjusted OR (95% CI)
Upper	48	20	42.1%	1.0 (Reference)
Middle	120	70	58.3%	1.9 (1.2-3.1)
Lower	344	284	82.6%	3.4 (2.3-5.1) *

*p<0.001

Figure 4: Scatter plot showing the inverse relationship between socioeconomic status and anemia prevalence ($r = -0.38$, $p < 0.001$).

Dietary assessment findings were particularly concerning:

Table 5: Dietary Patterns and Anemia Association

Dietary Factor	Category	Anemia Prevalence	Adjusted OR (95% CI)
Iron-rich food intake	Daily	52.1%	1.0 (Reference)
	Non-daily	82.4%	2.3 (1.6-3.3) *
Dietary diversity	Adequate (≥ 4 groups)	64.2%	1.0 (Reference)
	Inadequate (< 4 groups)	84.2%	2.1 (1.5-3.0)

*p<0.01

Figure 5: Bar chart comparing anemia prevalence by dietary patterns, showing significantly higher rates among children with inadequate nutrition.

Program coverage data revealed implementation gaps:

Table 6: Program Participation and Anemia Prevalence

Intervention	Coverage	Anemia in Participants	Anemia in non-participants
Regular MDMS	72.6%	70.1%	86.3%
Iron supplementation	58.3%	68.9%	83.7%
Deworming	41.2%	71.4%	82.9%

Figure 6: Comparative bar charts demonstrating significantly lower anemia prevalence among program participants versus non-participants for all interventions.

The multivariate logistic regression model, visualized in **Figure 7** as a forest plot, identified several independent predictors:

- Low socioeconomic status (aOR=3.4, 95% CI:2.3-5.1)
- Inadequate dietary diversity (aOR=2.3, 95% CI:1.6-3.3)
- Irregular MDMS participation (aOR=1.9, 95% CI:1.3-2.8)
- Open defecation practices (aOR=1.7, 95% CI:1.2-2.5)
- Maternal anemia (aOR=1.6, 95% CI:1.1-2.3)

These comprehensive findings demonstrate an alarming anemia burden among khurja school children that substantially exceeds national averages. The data underscores the urgent need for multi-sectoral interventions addressing nutritional, socioeconomic, and environmental determinants of anemia in this vulnerable population.

Discussion

The findings of this study reveal a critical public health situation in khurjar, with anemia affecting 78.3% of school-going children - a prevalence significantly higher than the national average of 67.1% reported in NFHS-5. This alarming rate exceeds even the already high state-level prevalence of 66.4% for Uttar Pradesh, suggesting that urbanizing regions like Ghaziabad may face unique nutritional challenges that demand targeted interventions.

The severity distribution is particularly concerning, with 35.7% of children experiencing moderate-to-severe anemia (Hb <10 g/dL), which carries substantial risks for cognitive impairment and physical development. These findings align with similar studies in peri-urban Maharashtra (Bhise et al., 2013) but show higher prevalence than urban slum reports from Delhi (Srivastava et al., 2012), indicating possible regional variations in anemia determinants.

The socioeconomic gradient observed in our study is striking, with children from lower socioeconomic groups showing 3.4 times higher odds of anemia compared to upper class peers. This disparity persists even after controlling for dietary factors, suggesting that poverty influences anemia risk through multiple pathways beyond nutrition alone - possibly including healthcare access, environmental conditions, and intergenerational nutritional deficits.

Nutritional assessment revealed two major concerns: inadequate dietary diversity (affecting 62.8% of children) and insufficient iron intake (mean 6.8 mg/day vs RDA of 13-20 mg). These findings help explain the high anemia burden and suggest that current dietary patterns fail to meet children's nutritional requirements during critical growth periods. The strong association between dietary diversity and hemoglobin levels (aOR=2.3) emphasizes the need for holistic nutrition interventions rather than iron supplementation alone.

Program implementation gaps emerged as another critical finding. While MDMS reaches 72.6% of children, its limited impact on anemia prevalence (70.1% in participants vs 86.3% in non-participants) suggests the need for quality improvement in meal composition and micronutrient fortification. The low coverage of iron supplementation (58.3%) and deworming (41.2%) represents missed opportunities for anemia prevention that must be addressed through strengthened school health programs.

The multifactorial nature of anemia in this population is evident from the diverse predictors identified - ranging from biological (maternal anemia) to environmental (open defecation) to programmatic (irregular MDMS participation). This complexity underscores the importance of integrated, multi-sectoral approaches to effectively combat childhood anemia.

Conclusion

This study highlights a severe anemia burden (78.3%) among school children in Khurjar, Ghaziabad, driven by multifactorial causes including poor dietary diversity, socioeconomic disparities, and gaps in existing nutrition programs. The findings underscore the urgent need for integrated interventions combining iron-fortified school meals, improved supplementation coverage, and targeted community awareness programs. Addressing these challenges through strengthened policy implementation and multi-sectoral collaboration is critical to reducing anemia prevalence and ensuring better health outcomes for this vulnerable population. The results call for immediate action to align local interventions with national nutrition strategies, particularly in rapidly urbanizing regions facing similar health disparities.

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