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Urban-Rural Disparities In Anemia Prevalence Among Primary School Children. A Study Of Bulandshahr District In Context Of Mid-Day Meal Scheme

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Abstract
Background: *Anemia is a persistent public health challenge among school-aged children in India, with rural populations disproportionately affected. Despite national interventions such as the Mid-Day Meal (MDM) Scheme, Anemia prevalence remains high, especially in economically and socially disadvantaged regions.*
Objective: *This paper discusses urban rural inequalities in the prevalence of Anemia in primary school children of Bulandshahr district of Uttar Pradesh. It assesses the effects of the MDM Scheme on the nutritional outcomes and establishes the relationships with such variables as gender and age.*
Methods: *A descriptive cross-sectional research was carried out on groups of 600 children (300 urban and 300 rural) aged 6 to 12 years in government and government-aided schools in four MDM Scheme districts. The structured questionnaires, anthropometric measures and hemoglobin estimation with the help of the HemoCue Hb 301 analyzer were used to collect data. Anemia was classified according to the WHO standards. Associations were tested with statistical analysis, which included chi-square tests ($p < 0.05$).*
Results: *There was a lot of prevalence of Anemia in rural areas than in urban areas. Moderate to severe Anemia was higher among female pupils in addition to older children (11-12 years). The three hypotheses explained by urban-rub rural difference (H1), gender disparity (H2) and age association (H3) all had statistically significant results.*
Conclusion: *Though MDM Scheme has been implemented there still exists Anemia prevalence rate especially in rural and female children. These observations reveal the necessity of regional policy improvements, such as an increased level of nutritional fortification, surveillance, and health care integration within schools and more particularly in rural conditions.*
Keywords: *Anemia; Primary School Children; Urban-Rural Disparities; Mid-Day Meal Scheme; Bulandshahr District.*

1. INTRODUCTION

Anemia is among the commonest public health issues among school-going children in India and in the world at large (Chaudhary, 2020; Manger et al., 2008). According to the World Health Organization (WHO), it can be characterized as an illness when the level of hemoglobin in the blood is lower than the accepted value depending on age and sex, which entails the impairment of the oxygen transportation capacity of the red cells (WHO, 2021). Anemia represents a significant condition in children since it may hinder cognitive development, diminish the attention span, undermine the immune system, and decrease physical growth (UNICEF, 2020). In the recent National Family Health Survey (NFHS-5), it has been found that more than 67 percent of the children age 6 to 12 years in India areemically anemic with rural areas having higher prevalence than metro areas (IIPS & ICF, 2021).

In a bid to counter this challenge, the Government of India has come up with a number of interventions such as the flagship MDM and the provision of free cooked food to the children studying in government and government aided schools (Chaparro & Suchdev, 2019; Union et al., 2023). The MDM Scheme was initiated with a twofold aim of bettering the nutritional intake of children and improving school attendance rates integrating the concepts of iron and folic acid supplementation, deworming, and education on hygiene (Ministry of Education, 2022). It is indicated that daily energy enriched lunchtime meals can raise hemoglobin levels and decrease the prevalence of Anemia in the schoolchildren (Controlled et al., 2018; Didzun et al., 2019).

Nonetheless, the urban-rural differences in the nutritional status and health of children continue to remain large (Abrams et al., 2018). The rural children may experience various disadvantages that may include low level of household income, food insecurity, lack of proper health services, and access to sanitation (Onyeneho et al., 2019; Solon et al., 2003). Yet, the dietary imbalances and eating more of the processed food influences urban children as well (Dutta et al., 2020). It is important to understand these disparities so that the actual extent and effects of the available nutrition programmes such as the MDM Scheme can be analyzed (Fiorentino et al., 2017).

This study is conducted in Bulandshahr district of Uttar Pradesh, which includes a mix of urban and rural areas, making it an appropriate site to examine geographical disparities in Anemia (Salam et al., 2013). The study targets primary school children aged 6–12 years, a vulnerable group during key physical and cognitive development phases. To classify Anemia, the study adopts the WHO hemoglobin threshold values (see Table 1) to distinguish between normal, mild, moderate, and severe Anemia.

The findings of this study are expected to contribute toward refining school-based nutrition policies, particularly the MDM Scheme, and to inform the development of targeted interventions for combating childhood Anemia in both rural and urban settings.

Table 1. WHO Classification of Anemia by Hemoglobin Level

Anemia Severity	**Hemoglobin (g/dL)**
Normal	≥ 11.5
Mild	10.0 – 11.4
Moderate	7.0 – 9.9
Severe	< 7.0

2. REVIEW OF LITERATURE

Childhood Anemia is a major health challenge in both the developed and developing countries (Sazawal et al., 2006; Thankachan et al., 2012). The WHO suggests that more than 40 percent of children worldwide are anaemic and iron deficiency in children is the most dominant reason (Angeles-agdeppa et al., 2008; Anwar et al., 2006). The rate of Anemia in India is very shocking (Dhillon et al., 2017). Based on the NFHS-5 survey, the prevalence of Anemia among children aged 5 and to 11 years with over 67 per cent and 4 to 5 per cent increase of the NFHS-4 survey, the trends are worsening, in spite of continuous effort in the public health intervention (Moretti et al., 2018; Nutrition et al., 2013). Due to Anemia in early childhood, children exhibit low cognitive performance, limited attention span, fatigue, and retardation, which tremendously impact their academic performance and health outcomes in later life (Olson et al., 2021; Stevens et al., 2025). These have been enhanced in resource-poor environments where dietary diversity and poor environment increase malnutrition (Keats et al., 2019). This is worst in low income households especially where foods rich in protein and iron are not taken frequently (Chaparro & Suchdev, 2019). The situation with Anemia is complicated by urban-rural imbalances as well. Living in rural settings, children are usually more vulnerable, as the access to healthcare is poor, infrastructure insufficient, parental literacy is lower, and there is food insecurity (Mengistu et al., 2019; Nieman et al., 2011). But, children, living in cities, are not an exception: they can also have Anemia , connected with a sit-down habit, eating junk food and consuming diet with micronutrient deficiencies (Mantadakis et al., 2020). Government schemes have also been put in place to help fight malnutrition and Anemia cases including the MDM Scheme which provides cooked meals of nutritious value to schoolchildren (Children et al., 2010). As a solution to these deficiencies, such meals are being supplemented with iron and folic acid (Goyal & Bank, 2024; Gupta et al., 2012). It has been established in various studies that MDM scheme has a positive contribution in improvement of hemoglobin and reduction of absenteeism (Arcanjo et al., 2012; Ms et al., 2021). Implementation quality depends on the area, and there is the problem of the urban-rural disparity of program implementation (Goyal & Bank, 2024; Stevens et al., 2025). In spite of the existence of national schemes, literature shows that there has been no localized evaluation of such interventions, especially in places such as Bulandshahr, both urban and rural issues. The study thus fills this gap through a study of prevalence of Anemia in urban rural school children, the effects of some demographic factors which affect Anemia like age and gender and finally the effects of the MDM Scheme on nutrition outcomes.

3. RESEARCH METHODOLOGY

3.1 Objectives of the Study

The study aims to assess urban-rural disparities in Anemia prevalence among primary school children in Bulandshahr district and examine the role of the Mid-Day Meal (MDM) Scheme in addressing nutritional gaps.

Specific Objectives:

1. To estimate the prevalence and severity of Anemia among children in government and government-aided primary schools.
2. To compare Anemia levels between children in urban and rural areas.
3. To analyze gender-based differences in Anemia prevalence.
4. To investigate the association between age and severity of Anemia .

3.2 Hypotheses of the Study

Hypotheses of the study are given as follows;

- H1: There is a significant difference in the prevalence of Anemia between urban and rural primary school children.
- H2: There is a significant difference in the prevalence of Anemia between male and female children.
- H3: There is a significant association between age group and Anemia prevalence among children.

3.2 Research Design

It used a descriptive cross-sectional study design to determine the prevalence rate of Anemia in primary school children in urban and rural parts of Bulandshahr district. The design was appropriate for capturing data at a single point in time, focusing on nutritional and health indicators, and allowing comparisons across demographic categories such as age and gender. The research used a combination of quantitative methods (anthropometric and hemoglobin measurements) and structured questionnaires to generate reliable and generalizable findings.

3.3 Study Area and Population

The research was conducted in Bulandshahr district of Uttar Pradesh, which includes a mix of urban and rural communities. The population of interest comprised primary school children aged 6–12 years enrolled in government and government-aided schools participating in the Mid-Day Meal Scheme (MDM). These schools were chosen because they represent the population most impacted by government nutritional interventions. The study area included schools from multiple blocks to ensure geographic and socio-economic diversity.

3.4 Sampling Design and Sample Size

A stratified random sampling technique was employed to ensure balanced representation of both urban and rural students. From a pool of eligible government schools, a random selection was made within each stratum (urban and rural), followed by the random selection of students from each selected school. The final sample size comprised 600 students, with 300 from urban and 300 from rural schools, ensuring proportional representation across three age groups (6–8, 9–10, and 11–12 years) and both genders for hypothesis testing. Within this sample, 150 male and 150 female children will be selected from government schools, ensuring gender parity and balanced representation across the educational settings.

3.5 Tools and Techniques for Data Collection

Data collection was conducted using a structured questionnaire divided into key sections. general information, anthropometric measurements, and hemoglobin levels. The questionnaire also included items related to socio-economic background, dietary frequency, and evaluation of the MDM scheme (used in broader objectives). Data were collected via face-to-face interviews, direct physical measurements, and school record verification, supported by an observational checklist to assess hygiene and food handling practices during meal distribution.

3.6 Hemoglobin Estimation Method

Hemoglobin levels were measured using a portable HemoCue Hb 301 analyzer, which provides accurate point-of-care readings. A capillary blood sample was obtained via finger prick using sterile lancets, following proper hygiene and safety protocols. The results were classified according to WHO guidelines, categorizing children into normal, mild, moderate, or severe Anemia, as described in Table 1. This method enabled standardized and reliable field-level assessment of Anemia status among the students.

3.7 Data Processing and Statistical Techniques

The collected data were compiled and entered into Microsoft Excel, followed by analysis using SPSS (Version 25). Descriptive statistics such as percentages, means, and frequency distributions were used to summarize the data. Chi-square tests were applied to test associations between Anemia prevalence and categorical variables like area (H1), gender (H2), and age group (H3). A significance level of $p < 0.05$ was used to determine statistical validity.

4. RESULTS AND DISCUSSION

4.1 Demographic Information

Table 2 and Figure 1 present the demographic profile of the 600 respondents included in the study. The sample was evenly distributed across urban (n=300) and rural (n=300) areas, ensuring balanced geographic representation. Gender distribution was also equal, with 300 male and 300 female students. Age-wise, the sample was stratified into three groups—6–8 years, 9–10 years, and 11–12 years—each comprising 200 students (33.3%). This proportional sampling across area, gender, and age categories allowed for reliable comparison in subsequent analyses of Anemia prevalence. Figure 1 visually illustrates this demographic distribution.

Table 2. Demographic Information of Respondents

Variable	Category	Frequency (n)	Percentage (%)
Area	Urban	300	50.0%
	Rural	300	50.0%
Gender	Male	300	50.0%
	Female	300	50.0%
Age Group	6–8 years	200	33.3%
	9–10 years	200	33.3%
	11–12 years	200	33.3%

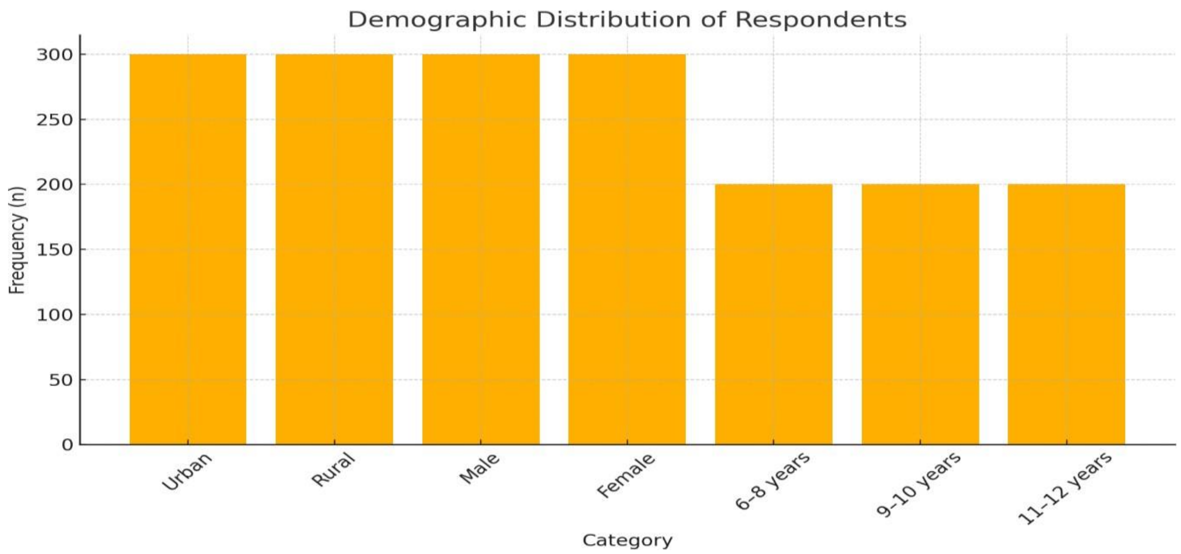

Figure 1. Demographic Information of Respondents

4.2 Descriptive Statics

Table 3 summarizes the descriptive statistics of key health indicators measured among the respondents. The average height of the children was 130.2 cm with a standard deviation of 8.5 cm, ranging from 110 cm to 145 cm. The mean weight was recorded at 28.4 kg (SD = 6.2 kg), with values ranging between 18 kg and 40 kg. The calculated Body Mass Index (BMI) had a mean of 16.8 kg/m2 and ranged from 12.0 to 21.5 kg/m2, indicating varied nutritional status across the sample. The mean hemoglobin level was 10.3 g/dL (SD = 1.5 g/dL), with individual values spanning from 6.5 g/dL to 13.8 g/dL, reflecting the presence of mild to severe Anemia in several students. These baseline statistics provide essential context for interpreting Anemia prevalence in relation to nutritional status.

Table 3. Descriptive Statistics

Variable	Mean	Standard Deviation (SD)	Minimum	Maximum
Height (cm)	130.2	8.5	110	145
Weight (kg)	28.4	6.2	18	40
BMI (kg/m2)	16.8	2.1	12.0	21.5
Hemoglobin (g/dL)	10.3	1.5	6.5	13.8

4.3 Anemia Prevalence by Area (Urban vs Rural)

Table 4 presents the distribution of Anemia prevalence across urban and rural areas. Among urban children, 35.0% were classified as having normal hemoglobin levels, while 40.0% had mild Anemia , 22.0% had moderate Anemia , and 3.0% suffered from severe Anemia . In contrast, rural children showed a notably higher burden of Anemia : only 20.0% had normal levels, whereas 35.0% had mild, 35.0% moderate, and 10.0% severe Anemia . These figures highlight a clear disparity in Anemia severity between urban and rural populations.

Table 4. Anemia Prevalence by Area

Area	Normal (n, %)	Mild (n, %)	Moderate (n, %)	Severe (n, %)	Total (n)
Urban	105 (35.0%)	120 (40.0%)	66 (22.0%)	9 (3.0%)	300
Rural	60 (20.0%)	105 (35.0%)	105 (35.0%)	30 (10.0%)	300

Table 5 shows the results of the chi-square test for Hypothesis H1, which assessed the association between area of residence and Anemia prevalence. The test yielded a chi-square value of 31.67 with 3 degrees of freedom and a p-value of 0.000, indicating a statistically significant difference in Anemia distribution between urban and rural children. This supports Hypothesis H1 and suggests that geographic location is a significant factor influencing Anemia prevalence among primary school children in the Bulandshahr district.

Table 5. Hypothesis H1 – Chi-square Test Results (Urban vs. Rural)

Variable	χ^2 Value	df	p-value	Result
Area vs Anemia	31.67	3	0.000	Significant

4.4 Anemia Prevalence by Gender

Table 6 illustrates the prevalence of Anemia by gender among the 600 primary school children surveyed. Among male students, 32.0% exhibited normal hemoglobin levels, 38.0% had mild Anemia , 25.0% had moderate Anemia , and 5.0% were classified with severe Anemia . In comparison, female students showed a higher burden of Anemia , with only 23.0% having normal hemoglobin, while 37.0% had mild Anemia , 30.0% moderate, and 10.0% severe Anemia . These figures suggest that Anemia is more prevalent and severe among female children than males.

Table 6. Anemia Prevalence by Gender

Gender	Normal (n, %)	Mild (n, %)	Moderate (n, %)	Severe (n, %)	Total (n)
Male	96 (32.0%)	114 (38.0%)	75 (25.0%)	15 (5.0%)	300
Female	69 (23.0%)	111 (37.0%)	90 (30.0%)	30 (10.0%)	300

Table 7 presents results of chi-square test conducted to examine Hypothesis H2, which proposed a significant difference in Anemia prevalence between male and female students. The chi-square value was 10.41 with 3 degrees of freedom, and the p-value was 0.015. Since the p-value is less than 0.05, the result is statistically significant, supporting Hypothesis H2. This indicates that gender plays a meaningful role in the distribution and severity of Anemia among primary school children in the study area.

Table 7. Hypothesis H2 – Chi-square Test Results (Gender)

Variable	χ^2 Value	df	p-value	Result
Gender vs Anemia	10.41	3	0.015	Significant

4.5 Anemia Prevalence by Age Group

Table 8 displays the distribution of Anemia prevalence across different age groups. Among children aged 6–8 years, 34.0% had normal hemoglobin levels, 40.0% had mild Anemia, 22.0% had moderate Anemia, and 4.0% were severely anemic. In the 9–10 years' group, normal and mild Anemia cases dropped slightly to 28.0% and 38.0% respectively, while moderate Anemia increased to 28.0%, and severe Anemia rose to 6.0%. The 11–12 years' age group showed the most concerning pattern, with only 22.0% normal cases, and sharp increases in moderate (35.0%) and severe Anemia (13.0%).

Table 8. Anemia Prevalence by Age Group

Age Group	Normal (n, %)	Mild (n, %)	Moderate (n, %)	Severe (n, %)	Total (n)
6–8 yrs.	68 (34.0%)	80 (40.0%)	44 (22.0%)	8 (4.0%)	200
9–10 yrs.	56 (28.0%)	76 (38.0%)	56 (28.0%)	12 (6.0%)	200
11–12 yrs.	44 (22.0%)	60 (30.0%)	70 (35.0%)	26 (13.0%)	200

Table 9 summarizes the results of the chi-square test conducted to evaluate Hypothesis H3, which examined whether Anemia prevalence is significantly associated with age group. The test yielded a chi-square value of 26.39 with 6 degrees of freedom and a p-value of 0.000, indicating a statistically significant relationship. This supports Hypothesis H3 and suggests that the risk and severity of Anemia increase with age among primary school children in the Bulandshahr district.

Table 9. Hypothesis H3 – Chi-square Test Results (Age Group)

Variable	χ^2 Value	df	p-value	Result
Age vs Anemia	26.39	6	0.000	Significant

5. DISCUSSION

This study examined prevalence of Anemia among primary school children aged 6–12 years in Bulandshahr district, with a specific focus on urban-rural disparities, gender differences, and age-related patterns in the context of the MDM Scheme. The findings reveal a high overall prevalence of Anemia among the study population, consistent with national statistics reported in NFHS-5.

Urban-Rural Disparities

The results clearly indicate that rural children are disproportionately affected by Anemia compared to their urban counterparts. Only 20.0% of rural children had normal hemoglobin levels, while moderate and severe Anemia affected 35.0% and 10.0%, respectively. In contrast, urban children had a relatively better profile, with 35.0% being non-anemic and fewer cases of moderate (22.0%) and severe Anemia (3.0%). This urban-rural divide may stem from multiple interrelated factors such as differences in household income, food security, healthcare access, and sanitation. Although both groups are beneficiaries of the MDM Scheme, variations in meal quality, frequency, and micronutrient fortification at the school level could influence these outcomes. The chi-square test confirmed that this difference was statistically significant (p = 0.000), thus supporting Hypothesis H1.

Gender-Based Differences

Gender analysis revealed that female students are more vulnerable to Anemia than males. Severe Anemia was observed in 10.0% of girls, compared to 5.0% of boys, and a larger proportion of girls (30.0%) also suffered from moderate Anemia. These differences may be linked to cultural dietary practices, differential care at home, and early onset of menstruation among older girls, which increases iron requirements. Despite equal participation in the MDM Scheme, gender-based nutritional needs may not be fully addressed, highlighting the necessity of gender-responsive interventions. The statistical test results confirmed a significant difference (p = 0.015), validating Hypothesis H2.

Age-Related Trends

Age-wise analysis showed a clear increase in Anemia prevalence with age. Children aged 11–12 years exhibited the highest rates of moderate (35.0%) and severe Anemia (13.0%), while the youngest group (6–8 years) had the highest proportion of normal hemoglobin levels (34.0%). This age-related trend may reflect the cumulative impact of inadequate nutrition, increased iron demands due to rapid growth, and possibly a decline in dietary quality as children grow older. It also suggests that current school-based nutritional interventions may not be sufficient to meet the evolving needs of older children. Hypothesis H3 was supported by a statistically significant result (p = 0.000), confirming a strong association between age and Anemia severity.

Implications for the MDMS

While the MDM Scheme plays a vital role in addressing hunger and improving school attendance, the findings suggest that its impact on Anemia reduction is uneven across demographic groups. The persistence of high Anemia rates, especially among rural, older, and female students, points to gaps in micronutrient content, monitoring, and customization of meals to suit specific nutritional needs. This underscores the need for enhanced policy focus on fortification, routine hemoglobin screening, and targeted supplementation.

5. CONCLUSION AND RECOMMENDATIONS

In this study, the researcher looks at the prevalence of Anemia in primary school children of Bulandshahr district by comparing the differences between the urban and rural areas, genders, and ages of these students. The evidence offers assurance to us that there is still a huge health issue in terms of Anemia even though there is a prevalence of introducing the MDM Scheme. The rural school children recorded more moderate and severe Anemia compared to urban school children and girls, as well older students, were more seriously affected. These tendencies prove all three research hypotheses and it is necessary to pay more attention to more specific and flexible nutritional interventions.

Despite the importance of MDM Scheme as a basis upon which school nutrition is founded, it has been implemented now in a manner that does not pay enough attention to micronutrient sufficiency, frequent evaluation and proximity to demographics. The standardisation nature of the scheme might not respond completely to the differentiated aspect of the age, sex and geographical context of children.

Recommendations

To mitigate childhood Anemia more effectively, the MDM Scheme should incorporate enhanced micronutrient fortification and include iron-rich, locally sourced ingredients. Regular health screenings, including hemoglobin checks, must be institutionalized at the school level. Supplementation programs should be customized for higher-risk groups such as girls and older children. Additionally, integrating hygiene education and periodic deworming is essential for improving nutrient absorption. Training school staff and introducing third-party monitoring will help ensure better meal quality, hygiene, and program accountability.

Limitations

This study is subject to several limitations. It focuses on a single district (Bulandshahr), which may restrict the applicability of findings to broader populations. The cross-sectional design limits causal interpretations, offering only a snapshot of Anemia status at one point in time. Some of the data—particularly dietary habits and hygiene practices—were self-reported, which introduces potential bias. Moreover, private schools were excluded from the sample, possibly omitting a segment of children who experience different nutritional contexts.

Future Scope

Future research can expand this study by adopting a longitudinal approach to monitor changes in Anemia status over time and better evaluate intervention outcomes. Including multiple districts or states would enhance the generalizability of the findings and allow for regional comparisons. Qualitative studies involving parents, teachers, and health workers could provide deeper insights into behavioral and cultural drivers of Anemia . Additionally, targeted impact assessments comparing fortified versus non-fortified mid-day meals could inform best practices for policy enhancement.

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