

## Original Research Article

# Prevalence of anemia and its impact on scholastic performance among school-going children in Sangareddy, Telangana: a cross-sectional study

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## ABSTRACT

**Background:** Childhood anemia may impair attention, memory and learning. This study assessed the prevalence of anemia among school-going children in Sangareddy and its association with scholastic performance.

**Methods:** In this cross-sectional observational study, 382 children aged 4-15 years were enrolled from the pediatric outpatient department and participating schools over 18 months (2024 June to 2025 November). Demographic details, clinical findings, hemoglobin levels and annual school marks were recorded. High scholastic performance was defined as annual marks  $\geq 60\%$ . Associations were analysed using chi-square test, Pearson correlation and multivariable logistic regression.

**Results:** Anemia was present in 168/382 children (44.0%): 126 (33.0%) had mild anemia and 42 (11.0%) had moderate anemia. Rural children had higher anemia prevalence than urban children (49.1% vs 37.5%;  $p=0.031$ ). High performance increased from 45.2% in moderate anemia to 72.9% in children with normal hemoglobin (chi-square=16.40,  $p<0.001$ ). Hemoglobin correlated positively with annual marks ( $r=0.205$ ,  $p<0.001$ ). Normal hemoglobin independently predicted high scholastic performance (adjusted OR 2.20; 95% CI 1.43-3.41;  $p=0.001$ ).

**Conclusions:** Anemia was common and significantly associated with poorer scholastic performance. School-based screening, nutrition education, iron supplementation and deworming may improve health and educational outcomes.

**Keywords:** Anemia, School children, Scholastic performance, Hemoglobin, Iron deficiency, India

## INTRODUCTION

Anemia in childhood is not merely a laboratory abnormality; it can influence growth, physical endurance, cognitive maturation and educational potential. Iron deficiency, the commonest nutritional contributor to childhood anemia, affects neuronal myelination, neurotransmitter synthesis and cerebral energy metabolism.<sup>1,2</sup> Deficiency during periods of rapid brain development may therefore manifest as reduced attention span, impaired memory consolidation and slower classroom learning. Although India has implemented school and community-based anemia control programs, the burden remains substantial, particularly in socioeconomically vulnerable and rural populations.<sup>3,4</sup>

The functional effect of anemia on scholastic achievement is particularly important because examination performance is an accessible, real-world marker of learning efficiency in school-going children. The present study was conducted to estimate prevalence of anemia in school-going children in the Sangareddy and to evaluate its association with scholastic performance.

## METHODS

This cross-sectional observational study was conducted in the Department of Paediatrics, MNR Medical College and Hospital, Sangareddy, and participating schools over 18 months (2024 June to 2025 November) after institutional ethics committee approval. Children aged 4-

15 years whose parents or guardians provided consent were included. Children with anemia associated with chronic medical illness, organomegaly, known vitamin deficiencies other than iron, or annual school attendance <25% were excluded. The calculated sample size was 382, based on an expected anemia prevalence of 53%, 5% allowable error and 95% confidence level. Participants were selected by convenience sampling until the target sample was reached.

Age, sex, residence, dietary pattern, family characteristics, socioeconomic variables, history of worm infestation and clinical examination findings were recorded using a structured proforma. Hemoglobin was estimated using standard laboratory methods, and anemia was classified using age-specific pediatric cut-offs. Scholastic performance was assessed from annual examination marks and school attendance records; annual marks  $\geq 60\%$  categorized as high scholastic performance. Data analysed using SPSS version 22. Frequencies and percentages summarized categorical variables. Chi-square test assessed bivariate associations, Pearson correlation assessed relation between hemoglobin and marks, and logistic regression identified factors independently associated with high scholastic performance.

## RESULTS

The study included 382 children, with a near-equal sex

istribution: 195 females (51.0%) and 187 males (49.0%). The largest age group was 11-15 years (41.4%), followed by 7-10 years (31.7%) and 4-6 years (27.0%). Rural participants constituted 214 (56%) of cohort and urban participants 168 (44.0%). Worm infestation was reported in 101 children (26.4%). Anemia was present in 168 children (44%); mild anemia accounted for 126 (33%) and moderate anemia for 42 (11%). No severe anemia category was reported in analysed tables (Table 2).

Anemia was significantly more frequent among rural children than urban children (49.1% vs 37.5%;  $p=0.031$ ). Scholastic performance differed significantly across hemoglobin categories. A graded pattern was observed, with the proportion of high performers increasing from 45.2% in moderate anemia to 72.9% in children with normal hemoglobin. Hb concentration also correlated positively with annual marks ( $r=0.205$ ,  $p<0.001$ ), although the strength of correlation was weak. Key bivariate associations have been depicted in Table 2.

On multivariable logistic regression, normal Hb status remained independently associated with high scholastic performance after adjustment for residence, worm infestation, family income, maternal education, sex, age, diet pattern and family type. Children with normal Hb had more than twice odds of high scholastic performance compared with anemic children (adjusted OR-2.20; 95% CI 1.43-3.41;  $p=0.001$ ) (Table 3).

**Table 1: Baseline characteristics and anemia profile of study participants, (n=382).**

| Characteristic       | Category        | N (%)      |
|----------------------|-----------------|------------|
| Age group (in years) | 4-6             | 103 (27.0) |
|                      | 7-10            | 121 (31.7) |
|                      | 11-15           | 158 (41.4) |
| Sex                  | Female          | 195 (51.0) |
|                      | Male            | 187 (49.0) |
| Residence            | Rural           | 214 (56.0) |
|                      | Urban           | 168 (44.0) |
| Diet pattern         | Mixed diet      | 255 (66.8) |
|                      | Vegetarian      | 127 (33.2) |
| Worm infestation     | Present         | 101 (26.4) |
|                      | Absent          | 281 (73.6) |
| Hemoglobin status    | Normal Hb       | 214 (56.0) |
|                      | Mild anemia     | 126 (33.0) |
|                      | Moderate anemia | 42 (11.0)  |
|                      | Any anemia      | 168 (44.0) |

**Table 2: Key bivariate associations related to anemia and scholastic performance.**

| Analysis                            | Group                | Comparison/outcome               | Test statistic   | P value |
|-------------------------------------|----------------------|----------------------------------|------------------|---------|
| Residence vs anemia                 | Rural                | Anemic 105/214 (49.1%)           | Chi-square=4.65  | 0.031   |
|                                     | Urban                | Anemic 63/168 (37.5%)            |                  |         |
| Hb status vs scholastic performance | Moderate anemia      | High 19 (45.2%); low 23 (54.8%)  | Chi-square=16.40 | <0.001  |
|                                     | Mild anemia          | High 72 (57.1%); low 54 (42.9%)  |                  |         |
|                                     | Normal Hb            | High 156 (72.9%); low 58 (27.1%) |                  |         |
| Hb vs annual marks                  | Continuous variables | Pearson $r=0.205$                | -                | <0.001  |

High scholastic performance was defined as annual examination marks  $\geq 60\%$ .

**Table 3: Multivariable logistic regression for predictors of high scholastic performance.**

| Predictor variables                         | Adjusted OR | 95% CI    | P value |
|---------------------------------------------|-------------|-----------|---------|
| Normal hemoglobin status                    | 2.20        | 1.43-3.41 | 0.001   |
| Urban residence                             | 1.16        | 0.75-1.81 | 0.507   |
| Absence of worm infestation                 | 0.59        | 0.35-0.98 | 0.043   |
| Higher family income                        | 0.74        | 0.48-1.15 | 0.179   |
| Mother educated up to high school and above | 1.28        | 0.79-2.07 | 0.321   |
| Male gender                                 | 1.24        | 0.80-1.92 | 0.338   |
| Age >10 years                               | 0.81        | 0.52-1.27 | 0.360   |
| Vegetarian diet                             | 1.23        | 0.77-1.95 | 0.387   |
| Joint family                                | 0.90        | 0.57-1.43 | 0.666   |

Annual marks  $\geq 60\%$ . Direction of worm-infestation variable should be verified against the original coding before final submission.

## DISCUSSION

This study demonstrates that anemia is common among school-going children in Sangareddy and is associated with measurable academic disadvantage. The observed anemia prevalence of 44.0% indicates a substantial pediatric public health burden. Rural residence was significantly associated with anemia, suggesting the influence of dietary diversity, sanitation, parasite exposure, health access and socioeconomic context.

The principal finding is the graded relationship between hemoglobin category and scholastic performance. Children with normal hemoglobin were more likely to be high academic performers than children with mild or moderate anemia, and this association persisted after multivariable adjustment. The weak but statistically significant correlation between hemoglobin and annual marks indicates that hemoglobin is one contributor to academic outcome, but not the sole determinant.<sup>5,6</sup> This is expected because scholastic performance is also shaped by teaching quality, household support, attendance, sleep, motivation, socioeconomic conditions and other micronutrient deficiencies.<sup>7,8</sup> The biological plausibility of this association is strong. Iron has roles in myelination, dopaminergic neurotransmission, mitochondrial energy generation and cerebral oxygen delivery.<sup>9,10</sup> Deficiency can therefore affect attention, mental stamina, memory consolidation and processing speed, domains that are central to classroom learning and examination performance.<sup>11-13</sup> The findings support integrated school health strategies rather than isolated clinical detection, because early screening, iron-folic acid supplementation, deworming, dietary counseling and teacher awareness may together improve both health and educational outcomes.<sup>14,15</sup>

These results also emphasize that mild anemia should not be dismissed as clinically trivial in school-age children. Most anemic children in this cohort had mild disease, yet the academic gradient across hemoglobin categories was clear. In practical terms, school screening programs should link hemoglobin testing with action: treatment initiation, dietary counseling, deworming where the indicated, parent education and follow-up documentation.

Teachers can also play an important role by recognizing fatigue, inattentiveness and poor task persistence as possible health-related signs rather than purely behavioral problems.

The study does not prove that correction of anemia will automatically improve marks; however, the association is sufficiently consistent and biologically plausible to justify preventive and corrective interventions. A combined health-education model may be especially relevant in rural areas, where anemia prevalence was higher. Future longitudinal studies should examine whether hemoglobin improvement after supplementation or deworming translates into measurable gains in attendance, attention, mathematics performance and overall annual marks.

## Limitations

The cross-sectional design limits causal inference. Convenience sampling may reduce generalizability. Detailed dietary quantification, ferritin or inflammatory markers, stool microscopy, vitamin B12, folate and zinc levels were not included, limiting etiological classification of anemia. Scholastic performance was measured using school examination marks rather than standardized cognitive testing, and grading variability between schools may have influenced the outcome.

## CONCLUSION

Anemia was prevalent among school-going children in Sangareddy and was independently associated with poorer scholastic performance. Children with normal hemoglobin had significantly higher odds of achieving high annual marks. Routine school-based anemia screening, nutritional intervention, iron supplementation, deworming and health education should be strengthened, and future longitudinal studies should evaluate whether correction of anemia improves academic outcomes.

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