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Original Research Article

# Clinico-Hematological Profile of Anaemia in Children Aged 6 Months to 12 Years Admitted to a Tertiary Care Hospital in North-East India: A Cross-Sectional Study

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**Abstract**

**Background:** Anaemia remains a major public health problem among children in developing countries, particularly in India. Data from North-East India are limited, especially among hospitalized paediatric populations.

**Objectives:** To estimate the proportion of anaemia among hospitalized children aged 6 months to 12 years along with description of the clinico-hematological profile and to determine the association of nutritional status of the study subjects with severity as well as type of anaemia.

**Methods:** This hospital-based cross-sectional study was conducted in the Department of Paediatrics, Agartala Government Medical College, Tripura, over a two-year period. Children aged 6 months to 12 years admitted with anaemia as per WHO criteria were consecutively enrolled. Clinical features, anthropometry, complete blood counts, peripheral smear examination, iron profile, vitamin B12 levels, haemoglobin electrophoresis, and relevant investigations were performed. Data were analyzed using SPSS version 26.0.

**Results:** Among 2,421 admitted children, 107 were anaemic, giving a proportion of 44.19 cases per 1,000 admissions (4.41%). Males constituted 59.8% (male: female ratio 1.48:1). Moderate anaemia was most common (44.9%), followed by severe anaemia (35.5%). Malnutrition was present in 71% of children and showed a significant association with anaemia severity ($p<0.001$). Microcytic hypochromic anaemia was the predominant morphological type (66.4%). Iron deficiency anaemia was the most common etiology (29.9%), while malaria (10.3%) and haemoglobinopathies were major contributors to haemolytic anaemia.

**Conclusion:** Anaemia among hospitalized children in Tripura is multifactorial, strongly associated with malnutrition, and predominantly nutritional in origin. Early nutritional intervention and region-specific preventive strategies are urgently required.

**Keywords:** Anaemia, Children, Iron deficiency, Malnutrition, Haemoglobinopathies, North-East India.

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## Introduction

Anaemia in childhood is defined as a reduction in haemoglobin concentration below age-specific reference standards and represents one of the most prevalent nutritional disorders worldwide. It affects physical growth, cognitive development, immunity, and overall morbidity in children [1-3]. Globally, anaemia affects nearly one-quarter of the population, with the highest burden observed in preschool-aged children [4].

India contributes substantially to the global anaemia burden. National surveys have consistently demonstrated alarmingly high prevalence rates among children, particularly in socio-economically vulnerable regions. The National Family Health Survey-5 reported anaemia in more than two-thirds of children aged 6–59 months, with higher prevalence in rural areas [5]. Iron deficiency is the most common cause, although haemoglobinopathies, infections, chronic diseases, and nutritional deficiencies such as vitamin B12 deficiency also contribute significantly [1,6-8].

The North-Eastern region of India has unique demographic, ethnic, and nutritional characteristics. Tribal populations in this region exhibit a higher prevalence of haemoglobinopathies such as HbE disease and thalassemia [8]. Despite this, region-

specific hospital-based data describing the clinico-hematological spectrum of anaemia in children remain scarce [9]. Hospitalized children often represent more severe and complex disease patterns, making hospital-based studies essential for understanding disease burden and planning targeted interventions [10-12]. Evaluating the association between anaemia severity, morphological patterns, etiology, and nutritional status is crucial for guiding diagnostic and therapeutic strategies [11-14]. This study was undertaken to estimate the proportion of anaemia among hospitalized children aged 6 months to 12 years in a tertiary care hospital in Tripura and to describe the clinico-hematological profile of anaemia with special emphasis on nutritional status and etiological distribution [14,15].

## Materials and Methods

**Study Design and Setting:** This was an observational cross-sectional study conducted in the Department of Paediatrics, Agartala Government Medical College and GBP Hospital, Tripura, over a period of two years.

**Study Population:** Children aged 6 months to 12 years admitted to the paediatric ward and diagnosed with anaemia according to WHO haemoglobin cut-off values were included.

### Inclusion Criteria

- Children aged 6 months to 12 years
- Diagnosed with anaemia as per WHO criteria
- Admitted to the paediatric ward

### Exclusion Criteria

- Infants below 6 months and children above 12 years
- Outpatient cases
- Children who collapsed due to congestive cardiac failure within 12 hours of admission
- Children with communicable diseases like HIV, tuberculosis, or viral hepatitis

**Sample Size:** Based on an expected prevalence of 47.2% from previous studies and accounting for hospital admission rates, a minimum sample size of 106 was calculated. A total of 107 children were included.

**Data Collection:** After informed consent, detailed clinical history and physical examination were performed. Anthropometric measurements were recorded and nutritional status assessed using WHO growth standards.

### Laboratory Evaluation

All children with anaemia underwent:

- Complete blood count
- Peripheral blood smear examination
- Reticulocyte count
- Iron profile (serum iron, ferritin, TIBC)
- Serum vitamin B12 levels
- Haemoglobin electrophoresis
- Bone marrow examination wherever indicated

Anaemia was classified morphologically (microcytic, normocytic, macrocytic) and etiologically (impaired red cell formation, haemolytic anaemia, blood loss).

**Statistical Analysis:** Data were analyzed using SPSS version 26.0. Categorical variables were expressed as frequencies and percentages. Associations were assessed using the chi-square test, with $p<0.05$ considered statistically significant.

## Results

**Proportion of Anaemia:** Out of 2,421 admitted children, 107 were anaemic, yielding a proportion of 44.19 cases per 1,000 admissions (4.41%).

**Demographic Profile:** Males constituted 59.8% and females 40.2% of cases (male: female ratio 1.48:1). The most affected age group was 60–144 months (40.2%), followed by 24–59 months (36.4%).

The mean age of study subjects was 58.05 months ± 40.308. Greater chunk of the study subjects was hailing from rural and hilly areas of Tripura (71.9%) with 43.9% of the children were from the indigenous tribes of the state.

**Severity of Anaemia:** Moderate anaemia was observed in 44.9% of children, severe anaemia in 35.5%, and mild anaemia in 19.6%. Severity distribution across age groups did not show a statistically significant difference.

**Nutritional Status:** Seventy-one percent of children had some degree of malnutrition. A significant association was observed between nutritional status and anaemia severity ($\chi^2=24.8$, $p<0.001$).

**Clinical Features:** Pallor was present in all children (100%), followed by fever (51.4%), weakness and easy fatigability (47.7%), splenomegaly (43.9%), and hepatomegaly (24.3%).

**Morphological Pattern:** Microcytic hypochromic anaemia was the most common morphological type (66.4%), followed by normocytic anaemia (28.0%) and macrocytic anaemia (5.6%). Morphology was significantly associated with anaemia severity ($p=0.004$).

**Etiology:** Anaemia due to impaired red cell formation accounted for 45.8% of cases, haemolytic anaemia for 42.1%, and blood loss for 12.1% ($p<0.001$). Iron deficiency anaemia (anaemia due to impaired red cell formation) was the most common etiology overall (29.9%), while

malaria (10.3%) was the most common cause of haemolytic anaemia and amongst anaemia due to blood loss immune thrombocytic purpura (4.7%) with history of bleeding from body orifices was the most common cause.

**Figure 1: A child with Eβ thalassemia with severe pallor and grade 3 splenomegaly**

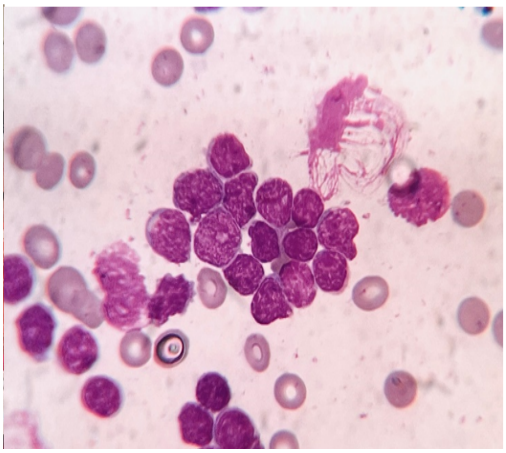

**Figure 2: A case of severe anaemia showing lymphoblasts in peripheral blood smear (100x-Leishman stain)**

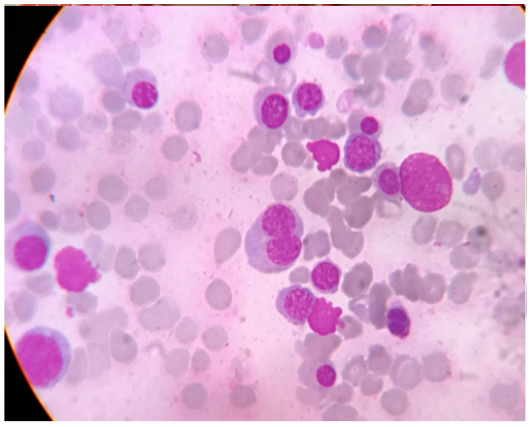

**Figure 3: Bone marrow picture of a case of MDS with moderate anaemia (100x-Leishman stain)**

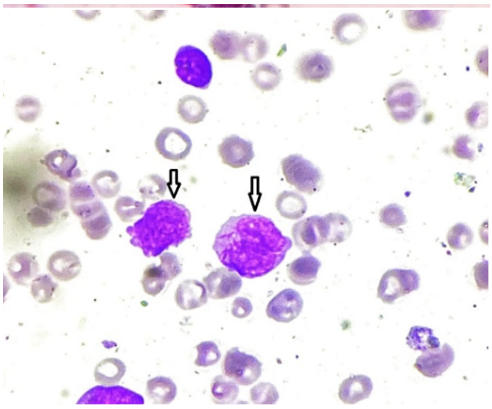

**Figure 4: A case of Juvenile Acute Promyelocytic Leukaemia showing severe hypochromia and Faggot cells in peripheral smear (100x-Leishman stain)**

**Table 1: Demographic characteristics of anaemic children (n = 107)**

| Variable | Frequency (n) | Percentage (%) |
|---|---|---|
| **Age group** | | |
| 6–23 months | 25 | 23.4 |
| 24–59 months | 39 | 36.4 |
| 60–144 months | 43 | 40.2 |
| **Sex** | | |
| Male | 64 | 59.8 |
| Female | 43 | 40.2 |
| **Habitat** | | |
| Rural | 77 | 71.9 |
| Urban | 30 | 28.1 |
| **Ethnicity** | | |
| Tribal | 47 | 43.9 |
| Non-tribal | 60 | 56.1 |

**Table 2: Association between severity of anaemia and nutritional status (n = 107)**

| Severity of anaemia | Well-nourished n (%) | Moderate malnutrition n (%) | Severe malnutrition n (%) | Total | p-value |
|---|---|---|---|---|---|
| Mild | 12 (57.1) | 9 (42.9) | 0 (0) | 21 | <0.001* |
| Moderate | 15 (31.3) | 32 (66.7) | 1 (2.1) | 48 | |
| Severe | 4 (10.5) | 25 (65.8) | 9 (23.7) | 38 | |
| **Total** | 31 | 66 | 10 | 107 | |

**Chi-square test applied**

**Table 3: Morphological pattern of anaemia and its association with severity (n = 107)**

| Morphological type | Mild (n) | Moderate (n) | Severe (n) | Total (n %) | p-value |
|---|---|---|---|---|---|
| Microcytic hypochromic | 18 | 32 | 21 | 71 (66.4) | **0.004*** |
| Normocytic | 3 | 10 | 17 | 30 (28.0) | |
| Macrocytic | 0 | 6 | 2 | 6 (5.6) | |
| **Total** | 21 | 48 | 38 | 107 | |

**Chi-square test applied**

**Table 4: Etiological classification of anaemia among study subjects (n = 107)**

| Etiological category | Frequency (n) | Percentage (%) |
|---|---|---|
| Impaired red cell formation | 49 | 45.8 |
| Haemolytic anaemia | 45 | 42.1 |
| Blood loss | 13 | 12.1 |
| **Total** | 107 | 100 |

## Discussion

**Table 5:**

| | Our study | De M, Halder A, Podder S, Sen R, Chakraborty S, Sengupta B [8] | Alam HS, Hoque MA, Ahsan MR, Al Mamun AMH [16] | Madoori S, Ramya C, Valugula S, Sandeep G, Kotla S (10) | Janjale A, Pande S, Sonawane R, Ahire N, Sonawane S [11] | Mishra G, Dwivedi R [15] | Ramya P, Premalatha P, Tejeswini V, Chitturi IVR [12] | Reddi KS, Mazher N, Khatun H, Saadhana KMBV [14] | Dey S, Goswami S, Dey T [9] | Vaswani ND, Lekhwani S, Swami M [13] |
|---|---|---|---|---|---|---|---|---|---|---|
| **Proportion of anaemia (per 1000 children)** | 44.19 | 570 | 225.75 | | | | | | | |
| **Male to female ratio** | 1.48:1 | | | 1.20:1 | 1.45:1 | 0.97:1 | | | | |
| **Age group with highest number of anaemia cases** | 60-144 months | | | | | 12-59 months | 12-59 months | | | |
| **Commonest grade of anaemia** | Moderate anaemia | | Moderate anaemia | | | Mild anaemia | | Mild anaemia | | |
| **Commonest ethnic group** | Non-tribal | Tribal | | | | | | | | |
| **Habitat Vs Anaemia** | More common in rural | | | | | | | | More common in rural | |
| **Nutrition Vs Anaemia** | 71% of subjects are malnourished | | | | 79.66% of subjects are malnourished | | | | | 76% of subjects are malnourished |
| **Most common ailment of presentation** | Pallor | | Pallor | | Pallor | | | | | |
| **Commonest morphological type of anaemia** | Microcytic Hypochromic | | | | | | Microcytic Hypochromic | Microcytic Hypochromic | | |
| **Most common aetiology of anaemia** | Iron Deficiency Anaemia | | | Iron Deficiency Anaemia | | Iron Deficiency Anaemia | Iron Deficiency Anaemia | | | |

This study highlights that anaemia among hospitalized children in Tripura is multifactorial, with nutritional deficiency remaining the dominant cause. The observed male predominance is consistent with previous hospital-based studies and may reflect healthcare-seeking behavior rather than true biological susceptibility [10,11,14].

The predominance of moderate and severe anaemia underscores the delayed presentation of children to tertiary care centers. The strong association between malnutrition and anaemia severity emphasizes the bidirectional relationship between nutritional deprivation and haematological disorders [6,11,13].

Microcytic hypochromic anaemia being the most common morphological type aligns with studies from other regions of India, reinforcing iron deficiency as the leading cause [1,3,10,12]. The substantial burden of haemolytic anaemia, particularly malaria and haemoglobinopathies, reflects the endemic nature of these conditions in North-East India [8,15].

The high prevalence of haemoglobinopathies among tribal children highlights the need for targeted screening programs and genetic counseling services in this region [8,9].

## Conclusion

Anaemia among hospitalized children in Tripura is common, predominantly nutritional, and significantly associated with malnutrition.

Iron deficiency remains the leading cause, while haemolytic anaemia due to malaria and haemoglobinopathies contributes substantially. Strengthening nutritional interventions, early screening, and region-specific public health strategies are essential.

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