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PREVALENCE AND CLINICAL CORRELATES OF ANAEMIA AMONG HOSPITALIZED PEDIATRIC PATIENTS: A RETROSPECTIVE STUDY

[1]UMA MAHESWARI B, [2]YOGALAKSHMI E, [3]DR.V.RAMYA
[1]FINAL YEAR POSTGRADUATE, SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES, CHENNAI
[2]TUTOR, SAVEETHA SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES, CHENNAI
[3]PROFESSOR, DEPARTMENT OF PERIODONTOLOGY, SREE BALAJI DENTAL COLLEGE & HOSPITAL, CHENNAI, INDIA

Abstract
Anaemia remains a significant public health concern among paediatric populations, particularly in hospitalized children presenting with diverse systemic illnesses. This retrospective study aims to evaluate the prevalence of anaemia among paediatric patients admitted to a tertiary care hospital and its distribution across different genders and underlying medical conditions. Data were collected from medical records at Saveetha Hospital, comprising **150 children under 15 years of age** who were hospitalized for various diagnostic and therapeutic interventions. The haemoglobin levels of the participants were analyzed, revealing an **average haemoglobin concentration of 11.78 g%**. Anaemia was defined as per the World Health Organization (WHO) criteria, and the study identified that **23% of the participants exhibited anaemia**, with varying degrees of severity. The prevalence was further examined in relation to gender distribution and the presence of systemic diseases, including respiratory infections, gastrointestinal disorders, and febrile illnesses. The study underscores the need for early screening and intervention strategies to address anaemia in paediatric inpatients, as untreated anaemia can contribute to adverse clinical outcomes, prolonged hospital stays, and increased morbidity. The findings highlight the necessity of incorporating routine haematological assessments in hospitalized children to facilitate timely diagnosis and management. Future research should focus on exploring the etiological factors contributing to anaemia in this demographic, with an emphasis on nutritional deficiencies, chronic infections, and genetic predispositions. A multidisciplinary approach involving paediatricians, haematologists, and nutritionists is essential to mitigate the burden of anaemia in hospitalized children.

Keywords: Paediatric Anaemia, Tertiary Care, Retrospective Study, Nutritional Deficiency, Haematological Evaluation

INTRODUCTION

Anemia is a prevalent hematologic disorder defined by a reduction in red blood cell mass or hemoglobin concentration below age and sex-specific thresholds, thereby compromising the blood's oxygen-carrying capacity [1]. Globally, this condition affects nearly 25% of the population, with a disproportionately high incidence among infants, children, and pregnant women. The etiology of anemia is multifactorial, encompassing nutritional deficiencies most notably iron deficiency—chronic inflammatory states, genetic hemoglobinopathies, and other acquired conditions [2].

During the early stages of life, particularly within the first year, red blood cells undergo significant physiological transformations. These developmental transitions include shifts in globin chain composition, alterations in cell morphology, and modifications in metabolic activity, leading to variations in key hematological indices such as Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC). Consequently, accurate diagnosis necessitates the use of dynamic, age-adjusted reference

ranges, with additional considerations for environmental factors like high-altitude living and genetic predispositions influencing baseline hematologic parameters [3].

This retrospective study examines a cohort of 150 children under 15 years of age admitted to Saveetha Hospital for various diagnostic and therapeutic interventions. Hemoglobin levels, serving as the primary biomarker, were measured and used to stratify the participants into mild (10–10.9 g/dL), moderate (7–9.9 g/dL), and severe (<7 g/dL) anemia categories [4]. The study aims to quantify the prevalence of anemia, evaluate its association with diverse systemic illnesses, and delineate potential gender differences in its manifestation. By integrating comprehensive hematological assessments with clinical outcomes, this investigation seeks to enhance early detection protocols and inform targeted therapeutic strategies, ultimately mitigating the adverse neurocognitive and physical developmental impacts associated with pediatricanemia. Anemia can be classified using several frameworks that aid clinicians in understanding its diverse etiologies, guiding both diagnosis and treatment strategies. One common approach is to distinguish anemia as either congenital or acquired, with the former arising from genetic abnormalities such as hemoglobinopathies or membrane disorders, and the latter resulting from external factors like nutritional deficiencies, chronic diseases, or toxin exposures [5].

Another key classification divides anemia into acute or chronic forms. Acute anemia is typically linked to rapid blood loss or abrupt hemolysis, whereas chronic anemia develops over time due to prolonged nutritional insufficiencies or ongoing systemic conditions. Moreover, anemia may be categorized as hemolytic or nonhemolytic [6]. Hemolyticanemia, defined by the premature destruction of Red Blood Cells (RBCs), can be further sub-classified based on the underlying mechanism. It is essential to determine whether the hemolysis is immune-mediated or nonimmune, as well as whether it is occurring intravascularly or extravascularly. In addition, hemolyticanemias are divided into intrinsic and extrinsic types: intrinsic causes include inherited defects such as enzyme deficiencies or membrane abnormalities, whereas extrinsic causes encompass immune responses, infections, drugs, or toxins. Notably, conditions like paroxysmal nocturnal hemoglobinuria may exhibit overlapping features of both intrinsic and extrinsic hemolysis [7].

A clinically valuable method to refine the diagnostic process involves analyzing the Mean Corpuscular Volume (MCV) and reticulocyte count. This classification stratifies anemias as microcytic, normocytic, or macrocytic based on RBC size [8]. Microcytic anemias, often associated with iron deficiency or thalassemia, typically present with a low MCV, while macrocytic anemias frequently linked to vitamin B12 or folate deficiencies exhibit an elevated MCV. Normocytic anemias can indicate conditions such as acute blood loss or bone marrow suppression. The reticulocyte count further distinguishes between anemias with an appropriate marrow response (suggestive of hemolysis or hemorrhage) and those with inadequate production, thereby refining the differential diagnosis [9]. This multifaceted classification framework, integrating morphological, biochemical, and clinical parameters, is particularly valuable in pediatric populations. In infants and children, where the spectrum of etiologies differs from adults, a systematic approach ensures accurate diagnosis and the implementation of targeted therapeutic interventions.Therefore, this study aims to investigate the prevalence and characteristics of anaemia among children under 15 years of age who are admitted with various illnesses to a tertiary care hospital, with the goal of identifying key factors and informing targeted interventions.

Category	NIPI (2013)	WHO (2016)
Infants (6-23 months)	20 mg iron + 100 µg folic acid	10-12.5 mg iron/kg
	Biweekly	Daily
	Throughout the year	3 months/year
Children (24-59 months)	20 mg iron + 100 µg folic acid	30 mg iron
	Biweekly	Daily
	Throughout the year	3 months/year
Children (5-10 years)	45 mg iron + 400 µg folic acid	30-60 mg iron
	Weekly	Daily
	Throughout the year	3 months/year
Children (10-12 years)	100 mg iron + 500 µg folic acid	30-60 mg iron
	Weekly	Daily
	Throughout the year	3 months/year
Adolescents (12-19 years)	100 mg iron + 500 µg folic acid	30-60 mg iron
	Weekly	Daily
	Throughout the year	3 months/year
Pregnant Women	100 mg iron + 500 µg folic acid	30-60 mg iron + 400 µg folic acid
	Daily	Daily
	From 14-16 weeks for 100 days	Throughout pregnancy
Lactating Women	100 mg iron + 500 µg folic acid	30-60 mg iron + 400 µg folic acid
	Daily	Daily
	100 days postpartum	6-12 weeks postpartum
Women of Reproductive Age	100 mg iron + 500 µg folic acid	30-60 mg iron + 400 µg folic acid
	Weekly	Daily
	Throughout the year	3 months/year

Table.1 Comparison of Iron and Folic Acid Supplementation Guidelines: NIPI (2013) vs. WHO (2016) Across Different Age and Physiological Groups [10].

METHODS AND METHODOLOGY

Study Design and Setting

This study was conducted as a retrospective observational analysis at Saveetha Hospital, a tertiary care center, over a three-month period from July to September 2024. The study focused on children under 15 years of age who were admitted as inpatients for various illnesses. Ethical approval was obtained from the Institutional Ethics Committee (IEC) before data collection, ensuring compliance with ethical research guidelines.

Study Population

The study included 150 pediatric patients aged <15 years, admitted to Saveetha Hospital for various medical conditions. The selection of participants was based on specific inclusion and exclusion criteria to ensure the reliability of findings.

Inclusion Criteria

- Children under 15 years of age admitted to the hospital during the study period
- Patients with available Complete Blood Count (CBC) data
- Patients with no prior history of hematological disorders

Exclusion Criteria

To maintain data accuracy and avoid confounding variables, the following patients were excluded:

- Children receiving iron supplementation or hematinics, as this could alter hemoglobin (Hb) levels
- Patients with pre-existing hematological disorders such as thalassemia, sickle cell disease, bone marrow failure syndromes
- Children with chronic diseases affecting RBC production, such as Chronic Kidney Disease (CKD), liver disease, or malignancies
- Patients with acute blood loss due to trauma, surgery, or gastrointestinal bleeding

Data Collection and Processing

Patient data were retrieved using the Medical Information Archiving Software (MIAS), a secure and efficient electronic health record system. The following variables were collected:

- Demographic data: Age, gender, clinical history
- Hematological parameters: Hemoglobin (Hb) concentration, Red Blood Cell (RBC) count, White Blood Cell (WBC) count, Platelet count, and RBC indices (Mean Corpuscular Volume - MCV, Mean Corpuscular Hemoglobin - MCH, and Mean Corpuscular Hemoglobin Concentration - MCHC)
- Clinical data: Signs and symptoms indicative of anemia, including Pallor, Fatigue, Tachycardia, and Poor Growth Patterns

Hematological Analysis

A Complete Blood Count (CBC) was performed on all patients using the Sysmex XN-1000, a fully automated hematologyanalyzer known for its high precision and reproducibility. The following hematological parameters were analyzed:

1. Hemoglobin Concentration (Hb%): Primary indicator for anemia diagnosis and classification
2. Red Blood Cell (RBC) Parameters: Includes total RBC count, MCV, MCH, and MCHC, which help determine the morphological classification of anemia
3. White Blood Cell (WBC) Count: Evaluated to assess possible underlying infections or hematological disorders
4. Platelet Count: Recorded to rule out associated platelet abnormalities that could indicate bone marrow dysfunction

Anemia was diagnosed based on WHO guidelines, which define anemia as Hb concentration <11.0 g/dL. The severity of anemia was further categorized as:

- Mild anemia: Hb 10.0 – 10.9 g/dL
- Moderate anemia: Hb 7.0 – 9.9 g/dL
- Severe anemia: Hb <7.0 g/dL

Quality Control and Data Integrity

All laboratory analyses were conducted under strict quality control protocols, including regular calibration of the Sysmex XN-1000. The accuracy of results was ensured by implementing daily internal quality checks and participation in external quality assurance programs. Data entry was cross-verified by multiple investigators to minimize transcription errors and maintain consistency in patient records.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics v26.0. Descriptive statistics were employed to summarize the demographic characteristics, clinical findings, and hematological parameters. The following statistical tests were applied:

- Mean ± Standard Deviation (SD): Used for continuous variables such as Hb, RBC, WBC, and platelet count
- Frequency Distribution and Percentage: Used for categorical variables such as gender and anemia severity
- Chi-square test or Fisher's Exact Test: Used to compare categorical variables, such as gender-based differences in anemia prevalence
- ANOVA or Student's t-test: Used to compare mean Hb levels across different age groups and severity classifications
- A p-value < 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Board (IRB) of Saveetha Hospital. In compliance with ethical guidelines, patient data were anonymized to ensure confidentiality. The study adhered to the principles outlined in the Declaration of Helsinki for biomedical research involving human subjects. No invasive procedures were performed as part of this study.

This retrospective study utilized advanced hematological techniques and robust statistical methods to assess anemia among pediatric inpatients. The comprehensive classification approach and quality-controlled data analysis ensure that findings from this study contribute valuable insights into the epidemiology, severity, and morphological patterns of anemia in children [11].

RESULTS

Prevalence of Anemia:

Out of the 150 pediatric patients included in the study, 34 children (23%) were diagnosed with anemia, while 116 children (77%) had normal hemoglobin levels. The severity of anemia among the affected individuals was classified as follows:

- **Mild Anemia:** 8 children (5%)
- **Moderate Anemia:** 22 children (15%)
- **Severe Anemia:** 4 children (3%)

The average hemoglobin (Hb) concentration across all patients was found to be 11.78 g/dL.

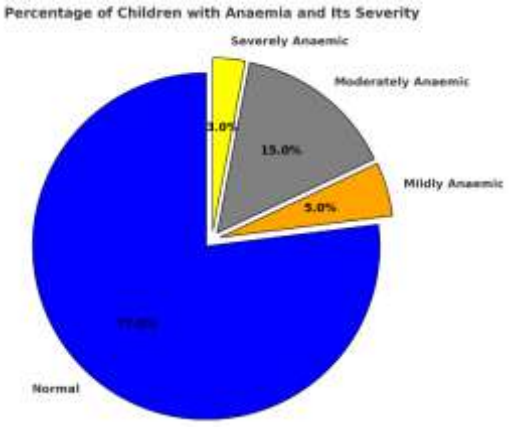

Fig.1 Percentage of Children with Anaemia & Its Severity

Category	Percentage
Normal	77
Mildly Anaemic	5
Moderately Anaemic	15
Severely Anaemic	3

Table.2 Category of Anaemic Vs. Percentile of affected cases

No. of Children studied	Not Anemic	Mild Anemia	Moderate Anemia	Severe Anemia
150	34	8	22	3

Table 3: Distribution of Anemia among Pediatric Patients

Total Anemic Cases (%)	Mild Anemia (%)	Moderate Anemia (%)	Severe Anemia (%)
23%	5%	15%	3%

Table 4: Percentage Distribution of Anemia Severity

Gender-Based Distribution of Anemia

A gender-wise classification of the affected individuals revealed that male children had a higher prevalence of anemia compared to female children. This observation suggests potential gender-related differences in susceptibility to anemia, which may be influenced by nutritional, genetic, or socio-economic factors.

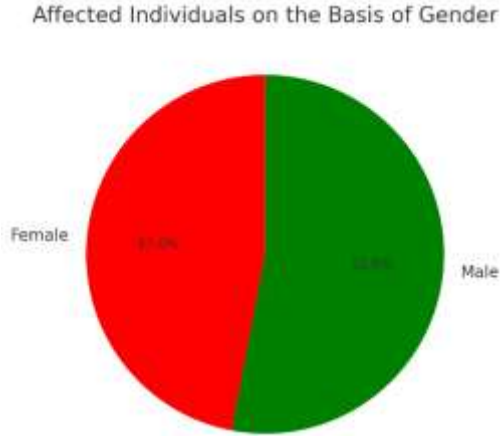

Fig.2 Affected Individuals on the basis of Gender

Gender	Percentage
Male	53%
Female	47%

Table.5 Affected Individuals based on Gender Ratio

- Among the 34 anemic children, the majority (64.7%) had moderate anemia, while 23.5% had mild anemia, and 11.8% had severe anemia.
- The remaining 116 children (77%) had normal hemoglobin levels.
- Male children were more frequently affected by anemia compared to females.

These findings highlight the significance of early detection and intervention to address anemia among pediatric patients and emphasize the need for further investigations into gender-related disparities in anemia prevalence.

Age-Wise Distribution of Anemia

The affected children were classified into three age groups: 1-5 years, 6-10 years, and 11-15 years. The highest prevalence was observed in the 1-5 years age group, accounting for 56% of the total anemic cases, followed by the 11-15 years group (26%) and the 6-10 years group (18%).

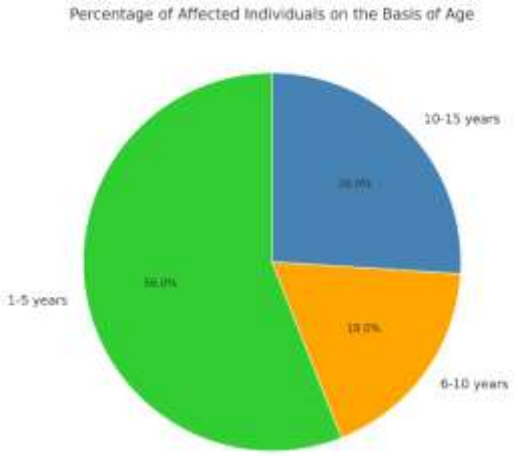

Fig.3 Percentage of Affected Individuals on the basis of Age

Age Group (Years)	Number of Anemic Patients	Percentage (%)
1-5 Years	19	56%
6-10 Years	6	18%
11-15 Years	9	26%

Table 6: Age-Wise Distribution of Anemia

The highest prevalence among younger children (1-5 years) suggests a higher susceptibility to anemia in early childhood, possibly due to inadequate iron intake, rapid growth demands, and increased risk of infections.

Etiological Classification of Anemia

Anemia was further classified based on underlying causes, with the most common contributing factor being acute febrile illness, followed by dehydration-related conditions such as diarrhea and vomiting.

Common Causes of Anemia Observed:

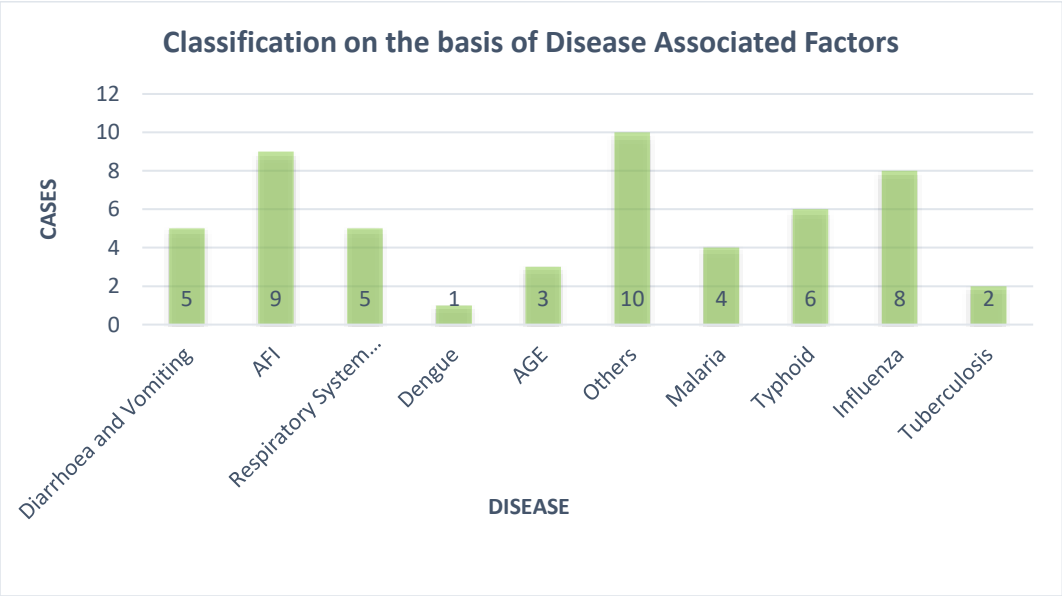

Fig.4 Classification on the basis of Disease Associated Factors

- Acute febrile illness (e.g., viral or bacterial infections) – Most common cause
- Dehydration-related issues (e.g., diarrhea, vomiting) – Second most common cause

- Nutritional deficiencies (iron, vitamin B12, folate deficiency)
- Chronic infections or inflammatory conditions

These findings emphasize the need for early identification and management of infections and dehydration to reduce anemia burden among hospitalized children.

DISCUSSION

This study analyzed 150 pediatric inpatients at Saveetha Hospital, located near Kancheepuram, a region predominantly inhabited by individuals from lower socioeconomic backgrounds. The primary objective was to assess the prevalence and severity of anemia in children under 15 years of age.

- The findings of this study indicate that anemia remains a concern among pediatric inpatients, though the prevalence (23%) was lower than expected compared to similar studies in other regions. The highest burden was observed in younger children (1-5 years), with moderate anemia being the most common severity category. Acute febrile illness and dehydration-related conditions were identified as leading causes of anemia in hospitalized children.
- Future research should focus on longitudinal studies to assess trends in anemia prevalence over time and evaluate the impact of nutritional interventions and public health policies in reducing anemia rates among children.
- This study analyzed 150 pediatric inpatients at Saveetha Hospital, located near Kancheepuram, an area with a predominantly lower socioeconomic population.
- The prevalence of anemia among children under 15 years was found to be 23% (34 out of 150), with 64.7% having moderate anemia, 23.5% mild anemia, and 11.8% severe anemia.
- The average hemoglobin concentration in the study population was 11.78 g/dL, and 77% of children had normal hemoglobin levels.
- Males (53%) were more affected than females (47%), and the highest prevalence was found in the 1-5 years age group (56%), followed by 11-15 years (26%) and 6-10 years (18%).
- The most common cause of anemia was acute febrile illness, followed by dehydration-related conditions like diarrhea and vomiting.
- Iron deficiency anemia is known to impact cognitive function, school performance, immunity, and physical development, making it a public health priority.
- Socioeconomic factors such as maternal education, residence type, and income levels significantly influence the incidence of anemia in children.
- Compared to studies in Tanzania (77.2% anemia prevalence) and Bangalore (72.9% anemia prevalence), our study (23%) reported a lower prevalence, possibly due to improved healthcare, nutrition, and awareness.
- The low prevalence of severe anemia (3%) in our study suggests that nutritional interventions and healthcare accessibility may have contributed to better outcomes.
- Public health measures such as routine anemia screening, iron and folic acid supplementation, nutritional education, and infection management should be strengthened to further reduce anemia prevalence.
- Future studies should focus on longitudinal trends and assess the impact of nutritional interventions and healthcare policies on anemia prevalence in children

CONCLUSION

This study highlights the prevalence of anemia among pediatric inpatients in a tertiary care hospital, with 23% of children affected, raising significant health concerns. Anemia in children can impair growth, cognitive function, and academic performance, making early identification and intervention essential. Nutritional supplementation, iron and folic acid fortification, and dietary awareness are crucial in preventing and managing anemia. As a developing nation, ensuring optimal child health is fundamental to national progress, emphasizing the need for parental education, routine screenings, and effective nutritional strategies to combat anemia and promote overall well-being.

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