

HAEMATOLOGICAL PROFILE AND MENTZER INDEX IN PEDIATRIC PATIENTS PRESENTING WITH ANEMIA

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ABSTRACT

Objective: The objective of this study was to analyze clinical and hematological profile of children with anemia and determine the Mentzer index of all cases presenting with anemia.

Methods: This was a cross-sectional observational study conducted in the Department of pediatrics of a tertiary care medical college. Eighty pediatric age group patients diagnosed to be having anemia on clinical examination were included in this study. Demographic details such as age and gender were noted in all cases. A thorough history was obtained and a clinical examination was done. Presenting complaints were also noted. Complete blood count with peripheral blood smear examination was done in all cases. The Mentzer index was determined from complete blood count reports.

Results: Out of 80 studied cases, there were 57 (71.25%) boys and 23 (28.75%) girls. The mean age for boys was 9.12±3.14 years and for girls, it was slightly higher at 10.24±3.46 years. Fatigue (73.75%), pallor (71.25%), and anorexia (56.25%) were common complaints. About 55% had mild anemia 22.5% had moderate anemia and 22.5% suffered from severe. Mean hemoglobin concentration of studied cases was found to be 8.42±3.98 g/dL. The most prevalent blood picture was the normocytic normochromic blood picture, representing 60% of cases. Mentzer index ranged from a minimum of 10.83 to a maximum of 27.76, with the mean value being 17.40±2.92. Notably, the vast majority of patients (97.5%) had a Mentzer Index >13, suggesting a high prevalence of iron deficiency. Conversely, only 2.5% of the patients had a Mentzer Index at or below 13, indicating a much smaller subset in whom Hb electrophoresis was needed to rule out thalassemia trait.

Conclusion: Although most of the children with anemia are secondary to iron deficiency Mentzer index should be determined in all patients of anemia so as to avoid inadvertently prescribing iron supplementation in cases of thalassemia trait.

Keywords: Anemia, Complete blood count, Mentzer index, Pallor.

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INTRODUCTION

Anemia is defined as hemoglobin (Hb) levels of <13.0 g/dL in men and <12.0 g/dL in women. In the case of children, anemia is defined as a Hb level of less than the 5th percentile for age. It is a significant public health issue affecting millions worldwide. Hb facilitates oxygen transport from the lungs to the body's tissues. Consequently, a deficiency in Hb or red blood cells (RBC) can lead to insufficient oxygen delivery to the body's organs and tissues. This insufficient tissue oxygenation manifests as fatigue as well as weakness. The classification of anemia is typically based on the size of RBC (microcytic, normocytic, and macrocytic). This classification aids in diagnosing the underlying cause of anemia, which can range from nutritional deficiencies and chronic diseases to genetic disorders and infections [1].

Anemia in children is particularly important because of its potential impact on growth and cognitive development. The prevalence and types of anemia in this age group vary widely and are influenced by factors such as age, diet, socioeconomic status, and underlying health conditions. Iron deficiency anemia (IDA) is the most common type among children particularly in those aged below 12 years [2]. Other types of anemia affecting the pediatric age group include anemia of chronic disease, thalassemia, and sickle cell anemia. The risk factors predisposing children to anemia include poor dietary intake of iron, vitamin and mineral deficiencies, chronic infections, genetic predispositions, and exposure to toxins or medications that can affect bone marrow function or RBC lifespan [3].

The clinical presentation of anemia in children can range from asymptomatic to severe signs and symptoms depending on the anemia's severity, cause, and rapidity of onset. Common symptoms include pallor, fatigue, irritability, and decreased physical stamina [4]. In more severe cases children may present with developmental delays, learning difficulties, and increased susceptibility to infections. The hematological profile of anemic children often reveals reduced Hb levels, hematocrit, and changes in RBC indices like mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and MCH concentration. Additional diagnostic tests, including serum iron, ferritin, transferrin saturation, and reticulocyte count, can further give an indication about the type and severity of anemia [5]. The Mentzer index which can be calculated from a complete blood count report also serves as a differentiator between two prevalent forms of anemia in children, that is, IDA and thalassemia trait. This index is calculated by dividing the MCV in femtoliters by the RBC count in millions per microliter. A value of <13 typically suggests IDA, while a value >13 may indicate the presence of thalassemia trait. The utility of the Mentzer Index lies in its simplicity and cost-effectiveness, providing clinicians with a rapid and accessible method to guide further diagnostic evaluations [6].

The management of anemia in children involves addressing the underlying cause. Interventions such as nutritional supplementation for deficiencies (Iron and vitamins), pharmacological treatment for chronic diseases, and specific therapies for genetic conditions may be required depending on the etiology. Iron supplementation is the cornerstone of treatment for IDA [7]. In cases of Vitamin B12 or folate deficiency, appropriate supplementation is the treatment of choice. For anemia

caused by chronic diseases or genetic conditions such as thalassemia medications, blood transfusions, or other specialized therapies aimed at managing the underlying condition may be required [8].

Despite the extensive knowledge on anemia and its impacts on children, there remain significant gaps in understanding the most effective management strategies, especially in resource-limited settings, and the long-term outcomes of children affected by different types of anemia. This study aims to fill these gaps by providing a comprehensive analysis of the clinical and hematological profiles of anemia in children aged 1–12 years.

METHODS

This was a cross-sectional observational study conducted in the Department of pediatrics of a tertiary care medical college. Eighty pediatric age group patients diagnosed to be having anemia on clinical examination were included in this study on the basis of a predefined inclusion and exclusion criteria. The duration of the study was 1 year. Written and informed consent was obtained from parents or guardians of the children enrolled in this study. Confidentiality of the patients was strictly maintained. Sample size calculation was calculated on the basis of pilot studies done for analyzing cases of acute pancreatitis. Keeping power (1-Beta error) at 80% and confidence interval (1-Alpha error) at 95%, the minimum sample size required was 40 patients; therefore, we included 50 cases in this study.

Demographic details such as age, gender, and socioeconomic status of all the patients were noted. A thorough history was obtained from parents with respect to the presence of fatigue, weakness, pallor, shortness of breath, or decreased exercise tolerance. In addition to this other relevant history such as recent infections, chronic illnesses, or medications will also be asked and noted. The presence of anemia in other siblings or other family members will also be asked. A thorough clinical examination was done to look for the presence of pallor, jaundice, or organomegaly. During clinical examination presence of signs of any specific vitamin deficiency was noted. A systemic examination was done and the presence of tachycardia or murmur was noted. A complete blood count was done in all cases.

The clinical findings were analyzed in all cases. The severity of anemia was determined from complete blood count reports. Anemia was defined as per the World Health Organization definition [9]. Accordingly, anemia was diagnosed in the presence of Hb level below 12 g/dL in children. Severe anemia was defined as Hb level below 7 g/dL. Moderate anemia was defined as Hb level 7 g/dL–9.9 g/dL. Mild anemia was defined as Hb level 10 g/dL–11.9 g/dL. In all cases, Mentzer index was determined (by dividing the MCV in femtoliters by the RBC count in millions per microliter) from complete blood count reports.

Statistical analysis was done using SPSS version 21.0 software. Quantitative data were presented as mean and standard deviation. Qualitative data were presented with incidence and percentage tables. For quantitative data, an unpaired t-test was applied and for qualitative data, the Chi-square test was used $p < 0.05$ will be taken as statistically significant.

Inclusion criteria

The following criteria were included in the study:

1. Children having anemia on clinical examination
2. Age between 1 and 12 years
3. Parents or guardians gave written informed consent to be part of the study.

Exclusion criteria

The following criteria were excluded from the study:

1. Age below 1 year or above 12 years
2. Parents/guardians refused consent
3. Anemia secondary to leukemia, lymphoma, autoimmune hemolytic anemia, or aplastic anemia
4. History of blood transfusion in the near past.

RESULTS AND DISCUSSION

Out of 80 studied cases, there were 57 (71.25%) boys and 23 (28.75%) girls. There was a male preponderance in cases with anemia with a M: F ratio of 1:0.40 (Fig. 1).

The majority of boys were found in the 8–10 years age group, accounting for 30% of the total population, whereas girls were more evenly distributed across the age groups. The mean age for boys was 9.12 ± 3.14 years and for girls, it was slightly higher at 10.24 ± 3.46 years. Statistical analysis revealed no significant difference between the ages of boys and girls ($p = 0.164$), with a 95% confidence interval ranging from -0.4702 to 2.7102 , suggesting that the observed age differences between genders were not statistically significant (Table 1).

The analysis of presenting complaints of patients with anemia showed that out of the 80 children, 59 experienced fatigue (73.75%), 57 showed pallor (71.25%), 45 had anorexia (56.25%), 23 suffered from breathlessness (28.75%), 17 exhibited irritability (21.25%), and 14 had PICA (17.5%) (Fig. 2).

The analysis of severity of anemia on the basis of Hb levels showed that 55% had mild anemia with Hb levels between 10 and 11.9 g/dL, 22.5% had moderate anemia with levels from 7 to 9.9 g/dL, and 22.5% suffered from severe anemia with Hb levels below 7 g/dL (Table 2).

The mean Hb concentration of studied cases was found to be 8.42 ± 3.98 g/dL. Other blood indices such as total leukocyte count, differential leukocyte count, platelet count, hematocrit, red cell distribution width, and MCV and RBC count are given below (Table 3).

The analysis of the Mentzer index seen in studied cases showed that it ranged from a minimum of 10.83 to a maximum of 27.76, with the mean

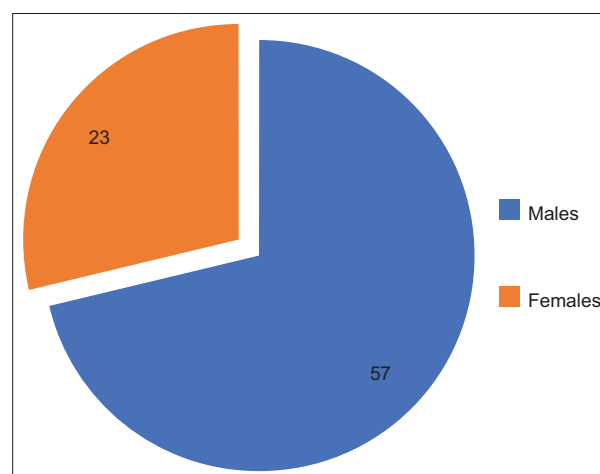


Fig. 1: Gender distribution of studied cases

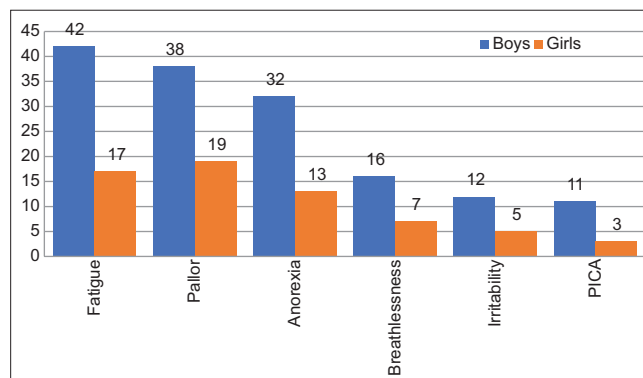


Fig. 2: Presenting complaints in studied cases

Table 1: Gender-wise comparison of age groups in studied cases

Age	Boys		Girls	
	Number	Percentage	Number	Percentage
1-4 years	7	8.75	3	3.75
5-7 years	9	11.25	5	6.25
8-10 years	24	30.00	7	8.75
11-12 years	17	21.25	8	10.00
Total	57	71.25	23	28.75
Mean age (years)	9.12±3.14		10.24±3.46	

p=0.164; 95% CI = -0.4702-2.7102 (not significant)

Table 2: Gender-wise comparison of severity of anemia in studied cases

Severity of Anemia	Boys		Girls	
	Number	Percentage	Number	Percentage
Mild (10-11.9 g/dL)	31	38.75	13	16.25
Moderate (7-9.9 g/dL)	12	15.00	6	7.50
Severe (<7 g/dL)	14	17.50	4	5.00
Total	57	71.25	23	28.75

Table 3: Complete blood count in studied cases

Indices	Values
Mean Hb	8.42±3.98 g/dL
Mean TLC	7645±2232.20/cmm
Mean polymorphonuclear neutrophils	55.95±7.19/cmm
Mean lymphocyte count	38.21±6.87/cmm
Mean eosinophil count	2.46±1.22/cmm
Mean monocyte count	3.36±1.35/cmm
Mean basophil count	0.01±0.11/cmm
Mean platelets count	215387.5±49203.65/cmm
Mean RBC count	4.61±0.51/cmm
Mean hematocrit	36.40±3.89/cmm
Mean MCV	79.52±7.24/cmm
Mean MCH	27.32±2.76/cmm
Mean MCHC	34.40±0.75/cmm
Mean RDW-CV	14.80±1.28/cmm

Hb: Haemoglobin, RBC: Red blood cells, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration

value being 17.40±2.92. Notably, the vast majority of patients (97.5%) had a Mentzer index >13, suggesting a high prevalence of iron deficiency. Conversely, only 2.5% of the patients had a Mentzer index at or below 13, indicating a much smaller subset in which Hb electrophoresis was needed to rule out thalassemia trait (Table 4).

The most prevalent blood picture was the normocytic normochromic blood picture, representing 60% of cases. Microcytic hypochromic anemia was the second most common, affecting 12 (15%) patients. Dimorphic smears were identified in 5 (6.25%) patients and microcytic anemia were found in 4 (5%) patients. A normal blood picture was seen in 2 (2.5%) patients. Less frequent conditions included normocytic normochromic smears with mild neutrophilia, blood pictures with mild lymphocytosis or mild monocytosis, microcytic hypochromic anemia with mild lymphocytosis or leucocytosis, and macrocytic anemia with mild lymphocytosis, each affecting 1-2 patients and contributing to 1.25-2.5% of the cases (Table 5).

Table 4: Analysis of Mentzer index in studied cases

Mentzer index	Values
Minimum Mentzer index	10.83
Maximum Mentzer index	27.76
Mean Mentzer index	17.40±2.92
No of patients with a Mentzer index above 13	78 (97.5%)
No of patients with a Mentzer index above 13	2 (2.5%)

Anemia in children can be multifactorial. It can arise from diverse etiologies such as nutritional deficiencies, inherited disorders, and chronic diseases. The manifestation of anemia varies considerably from one child to another often reflecting underlying pathophysiological processes. Therefore, detailed clinical evaluation and complete hematological profiling are indispensable for accurate diagnosis and appropriate management [10].

Understanding the specific type of anemia, whether microcytic, macrocytic, or normocytic, each associated with varying conditions such as iron deficiency, Vitamin B12 deficiency, or chronic inflammation, respectively, is pre-requisite for appropriate management. For instance, microcytic hypochromic anemia, often caused by iron deficiency, is particularly prevalent in pediatric populations due to rapid growth rates and insufficient dietary intake. Moreover, hematological assessment guides the detection of less common but significant conditions such as thalassemia or bone marrow pathologies which may present with similar clinical features as nutritional anemia but necessitate entirely different treatment approaches [11].

In this study of 80 clinically diagnosed cases of anemia, boys (71.25%) were more commonly affected than girls (28.75%), with a M: F ratio of 1:0.40. Most boys were concentrated in the 8-10 years age group (30%), while girls were more uniformly spread across different ages. The mean ages were 9.12 years for boys and 10.24 years for girls, with no statistically significant age difference between genders (p=0.164). The analysis of symptoms in these patients revealed fatigue as the most common complaint, affecting 73.75% of the children. This was followed by pallor in 71.25%, anorexia in 56.25%, breathlessness in 28.75%, irritability in 21.25%, and PICA in 17.5%. Ramana Sastry conducted a study to analyze the clinical and hematological profile of anemia in children aged 5 years-12 years [12]. For this purpose, the authors undertook a prospective hospital-based study of children presenting with anemia in the. One hundred and ten pediatric cases of anemia were included in the study. The most common affected age group in this study was found to be 7-8 years. Weakness and fatigability were the most common presenting symptoms which were observed in 81.8% of children. On General examination, pallor was seen in 100% of patients. Presenting complaints and mean age of the cases in this study were similar to our study however unlike our study the authors reported a female preponderance (63.3% vs. 36.3%). Similar mean age and presenting complaints in cases of children with anemia were also reported by authors such as Gallagher [13] and Moscheo *et al.* [14]

In this study, 55% had mild anemia with Hb (Hb-10-11.9 g/dL), 22.5% had moderate anemia (Hb- 7-9.9 g/dL), and 22.5% suffered from severe anemia (Hb <7 g/dL). Mean Hb concentration of studied cases was found to be 8.42±3.98 g/dL. The most prevalent blood picture was the normocytic normochromic blood picture, representing 60% of cases. Microcytic hypochromic anemia was the second most common, affecting 12 (15%) patients. Dimorphic smears were identified in 5 (6.25%) patients and microcytic anemia were found in 4 (5%) patients. Choudhary *et al.* conducted a study to analyze the clinical and hematological profile of anemia in children aged 6 months-12 years [15]. In this study out of 96 studied cases having anemia 30 (31.2%) had

Table 5: Peripheral blood smear examination findings in studied cases

Sr. No	Blood picture	Number of patients	Percentage
1	Normocytic normochromic blood picture	48	60.00
2	Microcytic hypochromic anemia	12	15.00
3	Dimorphic smear	5	6.25
4	Microcytic anemia	4	5.00
5	Normal blood picture	2	2.50
6	Normocytic normochromic smear with mild neutrophilia	1	1.25
7	Normocytic normochromic blood picture with mild lymphocytosis	1	1.25
8	Normocytic normochromic blood picture with mild monocytosis	1	1.25
9	Microcytic hypochromic anemia with mild lymphocytosis	1	1.25
10	Normocytic hypochromic anemia with mild lymphocytosis	2	2.50
11	Microcytic hypochromic anemia with leukocytosis	1	1.25
12	Macrocytic anemia with mild lymphocytosis	2	2.50

severe anemia, 43 (44.8%) had moderate anemia and 23 (24%) had mild anemia. The most common type of anemia in this study was found to be IDA. A similar etiological profile of anemia was also reported by the authors such as Meshram [16] and Awasthi *et al.* [17]

One of the most important analyses we made was the determination of the Mentzer index which could be easily determined from complete blood count reports. In our study Mentzer index ranged from a minimum of 10.83 to a maximum of 27.76, with the mean value being 17.40±2.92. Notably, the vast majority of patients (97.5%) had a Mentzer index >13, suggesting a high prevalence of iron deficiency. Conversely, only 2.5% of the patients had a Mentzer Index at or below 13, indicating a much smaller subset in which Hb electrophoresis was needed to rule out thalassemia trait. The importance of determining the Mentzer index from complete blood count cannot be overemphasized. In cases with a Mentzer index <13 iron supplementations should not be started without ruling out thalassemia minor. Gopchade conducted a study to evaluate the reliability of the Mentzer index in the differentiation of IDA and Thalassemia trait [18]. For this purpose, the authors undertook a prospective study of 30 patients each of thalassemia trait and IDA (A total 60 patients). The study found that Mentzer index more than 13 (indicating IDA) and <13 (indicating thalassemia) was a reliable screening tool to differentiate between IDA and thalassemia. Similar findings were also reported by authors such as Tabassum *et al.* [19] and Shah *et al.* [20]

CONCLUSION

Most of the children with anemia were secondary to iron deficiency as evidenced by microcytic hypochromic anemia seen on peripheral smear along with a Mentzer index of more than 13. However, in a minority of cases, the Mentzer index was <13 and hence these patients were advised Hb electrophoresis. Our study emphasizes the importance of determining the Mentzer index in all patients of anemia so as to avoid inadvertently prescribing iron supplementation in cases of thalassemia trait.

CONFLICTS OF INTEREST

None.

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