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Pattern of Haematological Abnormalities in Malnourished Children Presenting to a Tertiary Care Hospital

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ABSTRACT

Background: Severe Acute Malnutrition (SAM) is a major public health concern and a leading contributor to childhood morbidity and mortality, particularly in low- and middle-income countries like Pakistan. Haematological abnormalities, including anemia, leukocytosis, thrombocytopenia, and pancytopenia, are frequently observed in malnourished children, often compounding clinical outcomes. **Objective:** To evaluate the pattern of haematological abnormalities in children aged 1–5 years with SAM presenting to a tertiary care hospital. **Methods:** A descriptive cross-sectional study was conducted at Lady Reading Hospital, Peshawar, from November 2, 2023, and May 2, 2024. A total of 177 children diagnosed with SAM were enrolled using consecutive non-probability sampling. Demographic data and blood samples were collected. Hematological parameters including hemoglobin levels, white blood cells, and platelets were analyzed. Data were stratified by age, gender, maternal education, and socioeconomic status. **Results:** Anemia was the most prevalent abnormality, affecting 84.2% of participants, with moderate anemia being the most common subtype (36.7%). Thrombocytopenia (26.6%), leukocytosis (22.0%), and pancytopenia (20.3%) were also significantly observed. Stratification analysis revealed a statistically significant association of anemia with younger age ($p = 0.042$), low maternal education ($p = 0.031$), and low socioeconomic status. Thrombocytopenia was significantly more prevalent among children from poorer households ($p = 0.026$). **Conclusion:** A high burden of hematological abnormalities was identified among SAM children, with anemia being most prominent. These findings emphasize the need for routine haematological assessment in the management of malnourished children to enable early intervention and improved clinical outcomes.

INTRODUCTION

The high morbidity and mortality are underscored with malnutrition being the most important public health problem. The malnutrition has been found to cause the deaths of about 60 percent of the over 7 million children below the age of 5 years.1 It is believed that there are around 19 million children under the age of 5 years worldwide who are affected by Severe Acute Malnutrition.2 Malnutrition causes half of the total children under 5 years deaths and about 11 percent of global disability-adjusted-life-years. Geographically, 70-80 percent of children that are undernourished are distributed in lower- and middle-income countries.3Pakistan has the highest prevalence rate of child malnutrition compared to other developing countries.4The rate of child malnutrition in the country has remained sluggish compared to other South Asian countries.[5]

Iron deficiency because of low food intake, consumption of diluted milk, inadequate infant and young child feeding (IYCF) and worm infestation has been regarded as the major cause of anemia in malnutrition[6]. In practice though, there are various other causes of anemia which include low intake and absorption of proteins, erythropoietin deficit as well as low reduced red cell production because of lower lean body mass ratios all leading to anemia[7-9]. Normochromic, normocytic, microcytic hypochromic or macrocytic anemia, Erythropoietin deficiency, deficiency of micronutrients like folic acid, cobalamin B12, copper and zinc are also other reasons of anemia in severe acute malnutrition in children[10,11]. However these can only help in the preventive treatment of these children partially owing to differences in the data[12,13]. The severe acute malnutrition is also accompanied by the leucopenia and leukocytosis. Leucopenia is mainly attributed to shift in circle cell and suppresses cellular immune response. There is also reduction in platelets in SAM as a result of reduced activity of mega karyocytes. But there is an inconsistency in the literature as to the cellular immune response in SAM. Another hematological manifestation that can be studied

in children with severe acute malnutrition is bone marrow hypoplasia[14].

In one study the pattern of haematological abnormalities in malnourished children were; mild anemia (27%), moderate anemia (46%), severe anemia (15%), white blood cells less than normal (50%), red blood cells less than normal (56%) and platelet count less than normal (66%), pancytopenia (48%)[15]. In another study pattern of haematological abnormalities in malnourished children was anemia 53.4%, leukocytosis 26.[16]

Objective of the study is to critically assess the distribution of haematological abnormalities in children with malnutrition that present to a tertiary care facility. In Pakistan, no data exists related to hematological profile of severely malnourished children. Thus, this study was conducted so as to inform the proper management of blood profile irregularities of the SAM children presenting on the care of our nutritional rehabilitation center to enhance positive outcomes in them. Because in our population no such study on the magnitude of haematological abnormalities in malnourished children has ever been done in the past five years, consequently, this study will give us the latest and the updated magnitude of haematological abnormalities in malnourished children in our population Moreover, the results of such a study will be shared with other medical professionals so that they can engage in timely diagnosis and better management of haematological abnormalities in malnourished children.

METHODOLOGY

The study is a descriptive cross-sectional study was conducted in the Department of Pediatrics, Lady Reading Hospital, Peshawar, between November 2, 2023, and May 2, 2024, after the approval of the institutional ethical review committee. The main aim was to determine pattern of haematology abnormalities in children with severe acute malnutrition (SAM) between 1-5 years. An expected frequency of the proportion of thrombocytopenia in SAM was assumed to be 8%, a confidence interval of 95% and absolute precision of 4%. The WHO sample size formula was therefore used to calculate a sample size of 177. Sampling was done by consecutive non-probability sampling.

Children who did not meet the inclusion criteria were excluded: aged above 5 years or less than one year, of any gender as well as with no SAM as per the WHO standards (weight-for-height less than 3SD, mid-upper arm circumference less than 115 mm or bilateral edema). Exclusions of children were a congenital genitourinary anomaly, renal impairment (creatinine >1.4 mg/dl), current steroid treatment (2 mg/kg in the previous month), or recognized immunodeficiency illness, including HIV infection.

Informed written consent was obtained from parents or guardians after explaining the purpose, risks, and benefits of the study. Detailed demographic information including age, gender, duration of malnutrition, socioeconomic status, mother's education level, occupation, and residence was documented using a pre-designed proforma. Each child underwent thorough clinical examination, and a 3cc venous blood sample was collected under aseptic conditions for haematological analysis. All laboratory investigations were performed by an expert pathologist in the hospital's diagnostic laboratory. Haematological abnormalities were defined using standard diagnostic criteria: anemia (hemoglobin <11 g/dL with sub-categorization into mild, moderate, and severe forms), thrombocytopenia (<150,000/mm^3), thrombocytosis (>450,000/mm^3), leukocytosis (>12,000/mm^3), and pancytopenia (Hb <10 g/dL, WBC <4000/µL, and platelets <150,000/µL).

The analysis of data was conducted with SPSS v.24. Mean and standard deviation were written as mean (SD) for quantitative variables including the age of children, duration of malnutrition and frequencies and percentages reported the qualitative variables as gender, social-economic status, maternal education, occupation, residence, and haematological abnormalities, among them. A stratification of haematological abnormalities was done in relation to the demographic and clinical factors, in order to measure effect modification. The post stratification chi-square test was used, and P value of less or equal to 0.05 was deemed as statistically significant. The results could be proven correct due to the strict selection by exclusion criteria that allowed the minimalization of confounding factors.

RESULTS

The study admitted 177 kids aged 1-5 years with severe acute malnutrition (SAM). The average age of the children was 2.78 +/- 1.18 years. Among these, 99 (55.9%) had been males and 78 (44.1%) had been females. Most of the children were of low socioeconomic status/104 (58.8%). The majority of mothers may be described as illiterate (61.6%) and unemployed (67.2%). This demographic distribution can be seen in Table 1.

Table 1

Demographic Characteristics of the Study Population (n = 177)

Variable	Frequency (n)	Percentage (%)
Age (years)		
1 – 2 years	68	38.4%
3 – 4 years	71	40.1%
5 years	38	21.5%
Gender		
Male	99	55.9%
Female	78	44.1%
Socioeconomic Status		
Low	104	58.8%
Middle	52	29.4%
High	21	11.9%
Mother's Education		
Illiterate	109	61.6%
Primary	41	23.2%
Secondary or above	27	15.2%
Mother's Occupation		
Unemployed	119	67.2%
Employed	58	32.8%
Residence		
Urban	73	41.2%
Rural	104	58.8%

Haematological Abnormalities

Anemia was the most common haematological abnormality, observed in 149 (84.2%) children. Among them, 41 (23.2%) had mild anemia, 65 (36.7%) had

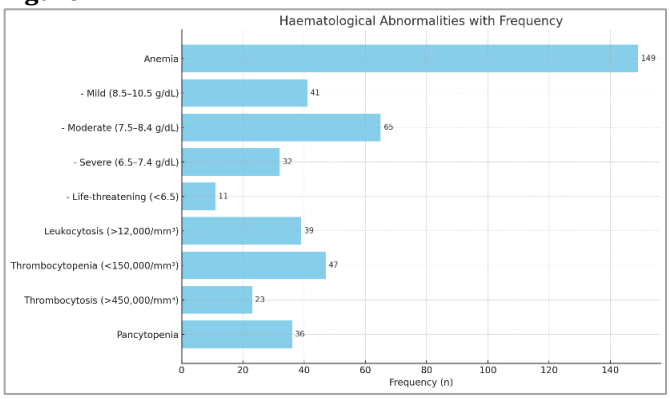
moderate anemia, 32 (18.1%) had severe anemia, and 11 (6.2%) had life-threatening anemia. Leukocytosis was found in 39 (22.0%) children, thrombocytopenia in 47 (26.6%), thrombocytosis in 23 (13.0%), and pancytopenia in 36 (20.3%) children.

Table 2

Frequency of Haematological Abnormalities (n = 177)

Haematological Abnormality	Frequency (n)	Percentage (%)
Anemia	149	84.2%
- Mild (8.5–10.5 g/dL)	41	23.2%
- Moderate (7.5–8.4 g/dL)	65	36.7%
- Severe (6.5–7.4 g/dL)	32	18.1%
- Life-threatening (<6.5)	11	6.2%
Leukocytosis (>12,000/mm^3)	39	22.0%
Thrombocytopenia (<150,000/mm^3)	47	26.6%
Thrombocytosis (>450,000/mm^3)	23	13.0%
Pancytopenia	36	20.3%

Figure 1



Stratification Analysis

Stratification revealed a statistically significant association of anemia with age group (p = 0.042) and mother's education level (p = 0.031). Thrombocytopenia was significantly more common in children from low socioeconomic backgrounds (p = 0.026). The results of stratification are summarized in Table 3.

Table 3

Stratification of Haematological Abnormalities by Demographic Variables

Variable	Anemia (%)	Thrombocytopenia (%)	Pancytopenia (%)	P-value*
Age (years)				0.042
1–2	86.8	27.9	22.1	
3–4	84.5	26.8	18.3	
5	78.9	23.7	15.8	
Gender				0.117
Male	82.8	27.3	19.2	
Female	85.9	25.6	21.8	
Socioeconomic Status				0.026
Low	86.5	31.7	25.0	
Middle + High	80.3	18.0	12.3	
Mother's Education				0.031
Illiterate	89.9	29.4	23.8	
Literate (any level)	76.4	19.1	15.4	

*Chi-square test applied; p ≤ 0.05 considered statistically significant.

The study revealed that anemia is highly prevalent among malnourished children, with nearly one in five children having severe or life-threatening anemia. A significant proportion also showed evidence of thrombocytopenia, leukocytosis, and pancytopenia, highlighting the importance of routine haematological screening in the management of SAM. Socioeconomic and educational factors play a key role in the prevalence of these abnormalities.

DISCUSSION

In this study, the pattern of haematological disorders in children with severe acute malnutrition (SAM) to a tertiary care hospital was determined and showed a large burden of hematological alterations, as already reported in literature. The most common abnormality was anemia with a prevalence of 84.2 percent of the study population. This result is consistent with preliminary studies in comparable low-resource environment, in which anemia among malnourished children varied between 50 and 85 percent [14,15]. Higher rates of moderate anemia in our study (36.7%) explain the importance of early diagnosis and intensive nutritional and hematological treatment, as well as the significant rate of children with severe and life-threatening anemia (24.3%).

The combination of the elevated rates of anemia in SAM children could be explained by several factors that overlap with each other iron deficiency, decreasing of intake, impaired absorption secondary to intestinal mucosal atrophy and chronic inflammation. Also, a lack of other micronutrients such as folate, vitamin B12, and zinc can lead to normocytic or macrocytic anemia patterns, not very rare in this group of people [6,11]. The results point to the fact that anemia in SAM is multifactorial and cannot be attributed only to iron deficiency, which requires both extensive diagnostic and therapeutic measures.

The incidence of leukocytosis was also reported in the study in 22.0 percent of the children, as reported earlier that altered immune responses predispose the malnourished child. SAM results in immune dysregulation with increased as well as decreased immune cells-leukocytosis, frequently as a response to subclinical or manifest infections and leukopenia as a result of suppression of the bone marrow [13]. The prevalence of thrombocytopenia is also quite high in our population (26.6%)- this is also in line with papers which posit that in severe malnutrition, there is reduction in the activity of megakaryocytes, further exacerbated by the presence of co-morbid infections and micronutrient deficiencies [14]. By comparison, thrombocytosis was observed in 13.0 percent of children and could be a reactive phenomenon to inflammation or infection.

The development of pancytopenia, which occurs in 20.3 percent of the children and that is very threatening and indicates a high level of bone marrow suppression which is most likely a consequence of chronic nutritional deficiency and bone marrow hypoplasia is very likely. This supports the necessity of bone marrow assessment in case of specific cases and the significance of diagnosing ahead of time this life-threatening problem during the early stages of hospitalization.

The stratification analysis showed high levels of assurance between anemia with the younger age bracket, poorly educated mothers, and low socioeconomic status. These results are in line with international and regional statistics which associate poverty, low maternal literacy level, and low infant feeding practices to malnutrition and associated morbidities in children [15, 18]. Mothers in low-income families uneducated child children were overrepresented indicating that community specific interventions and maternal education might be important prevention factors.

Notably, thrombocytopenia was much more frequent in the children with low socioeconomic statuses ($p = 0.026$) but pancytopenia also became more prevalent among subjects with low socioeconomic statuses. This facilitates an interpretation of the fact that being undernourished with decreased access to medical care and a late presentation predisposes to severe hematological complications.

The results of the present research highlight the need to include routine haematological screening as a part of a standard management algorithm of children with SAM. The anemia, thrombocytopenia, and pancytopenia can be identified to initiate early blood transfusion, iron and micronutrient supplementation, and other supportive therapies, which could benefit prognosis and survival. It also makes the point that the more comprehensive approach including pediatricians, nutritionists and social workers is required to deal with broader socioeconomic determinants of malnutrition and complication of malnutrition.

In summary, the paper has found that the number of haematological abnormalities in severely acutely malnourished children in our setup is high and anemia constituted the majority. What is suggested in the findings is to be proactive in screening, diagnosing early, and holistically managing haematological derangements that can minimise the morbidity and mortality of SAM. Future studies need to determine the hematological sequelae towards the end of the life and assess whether micronutrient supplementation can be individually tailored in enhancing long-term hematologic improvement on these high-risk individuals.

CONCLUSION

In this study, researchers have identified that the burden of haematological abnormalities is severe among children with Severe Acute Malnutrition (SAM) with anemia identified as the most common problem. Almost a quarter of the children had severe or life-threatening anemia, with other disorders like thrombocytopenia, leukocytosis and pancytopenia also frequent. These results underline the fact that hematological disorders in malnourished children are multifactorial and under the impact of age, maternal education and socioeconomic status. Screening of haematology should be incorporated in SAM treatment regimen and management protocols to facilitate early detection and timely corrections such as through micronutrient supplementation, blood transfusing, and nutritional rehabilitation. Also, any underlying social reasons which can affect prognosis better in such children can be covered like maternal literacy and poverty. Remaining challenges that need further studies are the long-term haematologic recovery and outcome of the structured nutritional support and individualised micronutrient therapies.

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