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A STUDY OF CLINICO-HAEMATOLOGICAL PROFILE & ETIOLOGY OF PANCYTOPENIA / BICYTOPENIA IN PEDIATRIC AGE GROUP FROM 6 MONTHS TO 18 YEARS

Paediatrics

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ABSTRACT

Background and Aims: Pancytopenia and bicytopenia are significant hematological abnormalities in children, characterized by reductions in one or more blood cell lines. Their etiological spectrum in the pediatric age group is diverse and differs significantly from adults. This study aimed to evaluate the clinico-haematological profile and underlying etiologies of pancytopenia and bicytopenia in children aged 6 months to 18 years in an urban Tier II Indian setting. **Methods:** This prospective observational study was conducted over one year in the Department of Paediatrics, Varun Arjun Medical College & Rohilkhand Hospital, with Institutional Ethics Committee approval. Seventy-five children were enrolled after informed consent. Inclusion criteria defined cytopenias based on hemoglobin (<10 g/dL), WBC (<4000/mm³), and platelets (<1 lakh/mm³). Data on history, clinical signs, investigations (CBC, peripheral smear, B12, folate, malaria, dengue serology, etc.), and socioeconomic status were collected. Statistical analysis was done using SPSS v26 with chi-square and t-tests. **Results:** Pancytopenia was more common (n=46) than bicytopenia (n=29). Icterus (28%, p<0.0001) and petechial rash (16%, p=0.003) were significantly associated with pancytopenia. MCV, MCH, and MCHC were higher in pancytopenia (p<0.0001). Common etiologies in pancytopenia included malaria, enteric fever, and nutritional deficiencies; dengue and co-infections predominated in bicytopenia. Socioeconomic status and dietary intake showed significant associations (p=0.015, p=0.0006 respectively). **Conclusion:** Pancytopenia and bicytopenia differ clinically, etiologically, and hematologically. Identification of these patterns can aid timely diagnosis and targeted management in pediatric practice.

KEYWORDS

Pancytopenia; Bicytopenia; Pediatric Cytopenia; Hematological Profile; Nutritional Deficiency

INTRODUCTION

Pancytopenia and bicytopenia are significant haematological abnormalities, marked by a reduction in all three, or any two, of the major blood cell lines—erythrocytes, leukocytes, and platelets. In the paediatric population, these cytopenias present a formidable diagnostic challenge due to their broad etiological spectrum and non-specific clinical manifestations. Children often present with fatigue, pallor, recurrent infections, or bleeding tendencies, symptoms that may mimic more common childhood illnesses, thereby delaying critical diagnosis and intervention.[1,2]

The underlying causes of pancytopenia and bicytopenia in children differ notably from those in adults and may include marrow failure syndromes like aplastic anaemia and leukaemia, nutritional deficiencies, severe infections, and autoimmune processes.[3,4] In resource-limited settings, particularly in developing countries such as India, the contribution of infectious diseases like malaria, dengue, tuberculosis, and nutritional deficiencies—especially of vitamin B12 and folic acid—is considerably higher. Bone marrow examination remains a cornerstone in diagnosis, supported by peripheral smear and relevant biochemical and serological investigations, offering crucial insights into marrow pathology ranging from hypoplasia to malignant infiltration.[1,5]

Despite advancements in diagnostic modalities, the scarcity of paediatric-specific studies on these haematological disorders continues to hinder early recognition and standardised treatment approaches. Most existing literature focuses on adult populations, leading to a knowledge gap in understanding paediatric presentations, progression, and outcomes.[6]

This study aims to evaluate the clinico-haematological profile and determine the underlying aetiologies of pancytopenia and bicytopenia in children aged 6 months to 18 years. It focuses on identifying common clinical presentations and regional causes specific to Indian Tier II cities, with the goal of aiding early diagnosis and guiding effective, standardised management protocols in paediatric haematology.

MATERIAL AND METHODS

This prospective observational study was conducted over one year in the Department of Paediatrics at Varun Arjun Medical College & Rohilkhand Hospital. Seventy-five children aged 6 months to 18 years presenting with pancytopenia or bicytopenia were enrolled following informed consent and Institutional Ethics Committee approval. The sample size was calculated using the formula $N = (Z^2 \times p(1-p))/d^2$, considering a 92.3% incidence of bicytopenia, resulting in a final sample of 75.

Inclusion criteria were defined as haemoglobin <10 g/dL, total leukocyte count <4000/mm³, and platelet count <1 lakh/mm³ for pancytopenia, or reduction in any two of these for bicytopenia. Exclusion criteria included age outside the defined range, prior diagnoses of leukaemia or aplastic anaemia, suspected genetic pancytopenia, recent transfusions, or lack of consent.

Each child underwent detailed clinical evaluation, including history, anthropometric data, socioeconomic background, and presenting symptoms. Physical examination assessed pallor, jaundice, lymphadenopathy, hepatosplenomegaly, bleeding, and joint involvement. Under aseptic precautions, venous blood was collected for complete blood counts, red cell indices, and peripheral smear, reviewed by a pathologist.

Further investigations such as serum B12, folate, ferritin, liver and kidney function tests, dengue and malaria serology, ANA profile, blood cultures, TB screening (GeneXpert/Truenat), and viral markers were done based on clinical suspicion. Bone marrow aspiration and biopsy were performed when necessary, with additional diagnostic support from immunohistochemistry and cytogenetics when indicated.

Patients were followed biweekly with clinical assessments and blood counts to monitor recovery, disease progression, or transformation to marrow failure or malignancy. Outcomes noted included recovery, relapse, treatment failure, and mortality.

Data were recorded in Microsoft Excel and analysed using SPSS version 26. Continuous variables were presented as mean ± standard deviation, and categorical variables as frequencies and percentages. Chi-square and Student's t-test were applied, with a p-value <0.05 considered significant. Confidentiality was maintained using patient IDs, and all data were securely stored. Findings are intended for future publication with appropriate approvals.

RESULTS

In our study, Adolescents (12–18 years) showed the highest occurrence of both pancytopenia and bicytopenia, with a slight female predominance in both conditions, as shown in Table 1.

Table 1: Distribution of Pancytopenia and Bicytopenia Across Pediatric Age Groups (6 Months–18 Years) and Gender

		Bicytopenia (n)	Pancytopenia (n)	Total (n)	Total (%)
Age Group	Infant (6–12 months)	2	1	3	4.0%

	Toddler (1–3 years)	3	8	11	14.7%
	Preschool (3–6 years)	5	9	14	18.7%
	School-age (6–12 years)	9	11	20	26.7%
	Adolescent (12–18 years)	10	17	27	36.0%
Gender	Male	14	18	32	42.7%
	Female	15	28	43	57.3%

Pallor was universally present across all cases, while icterus and petechial rash were observed exclusively in pancytopenia cases with statistically significant associations, as shown in Table 2.

Table 2: Distribution of Clinical Signs in Pediatric Patients with Pancytopenia and Bicytopenia

Clinical Feature	Finding	Bicytopenia (n)	Pancytopenia (n)	Total (n)	% of Total
Pallor	Present	29	46	75	100.0%
	Absent	0	0	0	0.0%
Icterus	Present	0	21	21	28.0%
	Absent	29	25	54	72.0%
Petechial Rash	Present	0	12	12	16.0%
	Absent	29	34	63	84.0%

Mean values of MCV, MCH, and MCHC were significantly higher in pancytopenia, suggesting macrocytic anemia as a prominent feature as shown in Table 3.

Table 3: Comparison of Red Blood Cell Indices in Pancytopenia and Bicytopenia

Parameter	Bicytopenia (Mean ± SD)	Pancytopenia (Mean ± SD)
MCV (fL)	71.6 ± 10.84	83.2 ± 9.86
MCH (pg)	21.3 ± 5.3	28.0 ± 3.99
MCHC (g/dL)	29.9 ± 2.8	33.2 ± 2.77

Pancytopenia was more frequently associated with enteric fever, megaloblastic anemia, and nutritional deficiencies, while bicytopenia showed a strong link with dengue and malaria as shown in Table 4.

Table 4: Distribution of Diagnoses, Laboratory Findings, and Dietary Intake in Pancytopenia and Bicytopenia

Category	Bicytopenia (n)	Pancytopenia (n)	Total (n)
Complicated Enteric Fever	0	12	12
Dengue (IgM positive)	5	0	5
Malaria (MP Card – P. Vivax positive)	14	10	24
Malaria + Dengue (Pv + IgM positive)	10	0	10
Megaloblastic Anaemia	0	9	9
Microcytic Hypochromic Anaemia (GBP/LFT normal)	0	15	15
Dimorphic Anaemia (B12 deficiency, abnormal retic count)	0	9	9
Typhoid (IgG positive)	0	12	12
Average Dietary Intake	0	15	15
Decreased Dietary Intake	29	31	60
Total	29	46	75

DISCUSSION

This study aimed to delineate the clinico-haematological profile and etiological spectrum of pancytopenia and bicytopenia in pediatric patients. Among the 75 children evaluated, pancytopenia was observed more frequently than bicytopenia. Although pallor was universally present in both groups, clinical features such as icterus (28%) and petechial rash (16%) were significantly associated with pancytopenia, reflecting a more severe hematological disturbance. These findings are supported by Aher A et al. (2024)[7], who emphasized icterus and petechiae as relevant clinical indicators in pancytopenia, and by Sharma A et al. (2023)[8], who linked petechiae to severe thrombocytopenia in hematologic disorders.

The etiological distribution in this study revealed malaria as a common cause in both groups. However, pancytopenia was notably associated with complicated enteric fever, megaloblastic anemia, and nutritional deficiencies, whereas dengue and dengue-malaria co-infection were exclusive to bicytopenia. These diagnostic distinctions were statistically significant ($p < 0.001$) and are consistent with findings from Pendkur G et al. (2021)[9], who observed that pancytopenia in children often results from systemic infections and nutritional causes, while bicytopenia is more commonly linked to acute viral illnesses. Similarly, Chandra H et al. (2019)[10] identified malaria and enteric fever as leading infectious causes of pancytopenia in endemic regions.

Significant differences were also observed in red cell indices. Mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were significantly elevated in pancytopenia ($p < 0.0001$), suggesting macrocytic anemia, often seen in B12 or folate deficiency. This is in line with observations by Kumar G et al. (2024)[11] and Karamchedu S et al. (2023)[12], who reported similar trends in macrocytic and microcytic patterns across different hematologic disorders. Decreased dietary intake was notably higher in bicytopenia ($p = 0.0006$), possibly due to appetite suppression in acute febrile illnesses like dengue, as noted by Thakur R et al. (2019)[13].

LIMITATIONS

The study was single-centered with a limited sample size, which may affect generalizability. Long-term follow-up and bone marrow correlation were not uniformly done. Some diagnoses relied on clinical suspicion due to resource constraints, potentially limiting definitive etiological categorization of pancytopenia and bicytopenia in all cases.

STRENGTHS

This study is among the few to provide a comparative clinico-haematological analysis of pancytopenia and bicytopenia in the pediatric population. It highlights distinct etiological patterns, integrates nutritional and socioeconomic variables, and applies robust statistical comparisons, offering practical diagnostic insights for clinicians in resource-constrained, pediatric healthcare settings.

CONCLUSION

Pancytopenia and bicytopenia are clinically and etiologically distinct in children. Pancytopenia showed stronger associations with nutritional deficiencies and systemic infections, while bicytopenia was more linked to acute viral illnesses. Red cell indices and socioeconomic factors helped differentiate the two, supporting targeted evaluation and tailored management strategies in pediatric cytopenias.

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