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RESEARCH ARTICLE
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EVALUATION OF HEMATOLOGICAL CHANGES AND TYPES OF ANAEMIAS IN MALARIA

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ABSTRACT

Introduction: Malaria continues to pose a significant health challenge in endemic regions, often leading to a range of hematological abnormalities that complicate both diagnosis and clinical management.

Aims & Objectives: To observe, compare, and assess the severity of hematological changes associated with various types of malaria-induced anemias in the adult population.

Methodology: This cross-sectional analytical study was conducted at Rahbar Medical & Dental College Lahore, over a duration of six months (October 2024 till March 2025). Adult patients presenting to the outpatient department with clinical symptoms of malaria specifically fever, chills, and rigors were screened for malaria via peripheral blood smear microscopy. Patients with confirmed malarial parasites were enrolled in the study. Thick and thin blood films were prepared and stained using Leishman's stain for species identification. Hematological parameters, including complete blood count (CBC), hemoglobin concentration, total leukocyte count, and platelet count, were analyzed using an automated hematology analyzer (Sysmex). Hematological indices were recorded and correlated with the identified Plasmodium species to determine the extent and nature of the abnormalities.

Results & Findings: A total of 165 patients were included, comprising 103 males (62.5%) and 62 females (37.5%), with an age range of 15 to 70 years (mean age: 38 ± 15 years). Plasmodium vivax was detected in 133 patients (81%), whereas Plasmodium falciparum was found in 32 patients (19%). Anemia was present in 126 patients (76.4%), while 39 patients (23.6%) had normal hemoglobin levels. Among anemic patients, 77 (61.1%) exhibited hypochromic microcytic anemia and 49 (38.9%) had normochromic normocytic anemia. With respect to white blood cell counts, 118 patients (71.5%) had normal counts, 28 (17%) had leukocytosis, and 19 (11.5%) exhibited leukopenia. Platelet count analysis revealed that 41 patients (25%) had normal platelet levels, while 65 (39%) had mild thrombocytopenia, 44 (27%) moderate thrombocytopenia, and 15 (9%) severe thrombocytopenia.

Conclusion: Both Plasmodium vivax and Plasmodium falciparum are associated with significant hematological abnormalities, primarily anemia and thrombocytopenia. Plasmodium vivax infection was more prevalent and frequently associated with microcytic hypochromic anemia and lower hemoglobin levels. These findings emphasize the importance of early hematological assessment and species-specific management strategies in malaria-endemic settings.

Key Words: Plasmodium vivax, plasmodium falciparum, malarial parasite, hemoglobin

INTRODUCTION

Malaria is the leading cause of mortality & morbidity worldwide [1]. It is transmitted to humans by female Anopheles mosquito. The common associated hematological changes leading to fatal complications are thrombocytopenia, anaemia, leukopenia & monocytosis [2]. Most common species of malarial parasite are Plasmodium vivax (P. Vivax) & Plasmodium falciparum (P. Falciparum) that also causes anemia in malarial endemic areas. The hemolysis of red blood cells or depression of red blood cells in bone marrow leads to anaemia in malarial patients [3]. After hemolysis, the infected red cells release parasite that degrade hemoglobin leading to iron & oxygen deficiency that causes anemia, fever & rigors [4]. The objective of this study is to evaluate hematological changes & to observe types of anaemias in patients with malarial infection.

METHODOLOGY

This study was conducted in pathology department of Rahbar Medical & Dental College Lahore, over a period of six months (October 2024 till March 2025). All patients presenting with clinical signs & symptoms of fever, chills and rigors and having malarial parasite (MP) detected on peripheral blood smear were included in the study. Patients with other causes of fever (tuberculosis, typhoid etc.) as well as chronic liver disease, bleeding disorders, thrombocytopenia and patient already taking anti-malarial drugs were not included in the study. Permission form the hospital ethical review committee was taken. The history, sign & symptoms & demographic data was collected from all patients. Blood for complete blood count (CBC) was drawn and thick and thin smears were prepared and stained with Leishman's stain. Thick smears were examined to confirm the presence of malarial parasite and thin smears were examined for the identification of specific malaria type. Complete blood count was performed on automated counter (Sysmex) machine & values of hemoglobin, white blood cell (WBC) count, platelets and hematological indices were noted and recorded. Thrombocytopenia was defined as mild (Platelet count: 50-150,000/uL), moderate (Platelet count: 20-50,000/uL) and severe (Platelet count: <20,000/uL). Anemia was diagnosed in patients having hemoglobin levels of <13gm/dl in males & <12gm/dl in females as per WHO criteria. Patients having WBC count of $< 4 \times 10^9$/L were labeled as having leukopenia and patients having WBC count of $> 11 \times 10^9$/L were labeled as having leukocytosis. Data was entered & analyzed by using SPSS 20. Mean and standard deviation of quantitative variables such as age was calculated. Percentages of qualitative variables such as type of malaria, anemias, platelet counts (Normal vs thrombocytopenia) and WBC (Normal, leukocytopenia and leukocytosis) were calculated.

RESULTS

A total of 165 patients diagnosed with malaria were included in the study. The results after analysis revealed that out of 165 patients, 103 (62.5%) were males and 62 (37.5%) were females. Mean age of the patients was 38 years (±15) with a minimum of 15 to maximum of 70 years. On peripheral blood examination of thin smears, 133 (81%) patients had P. Vivax and 32 (19%) had P. Falciparum. The frequencies and percentages of these malarias in males and females are summarized in figure 1. On CBC examination, 126 (76.4%) patients had anemia and 39 (23.6%) patients had normal hemoglobin levels.

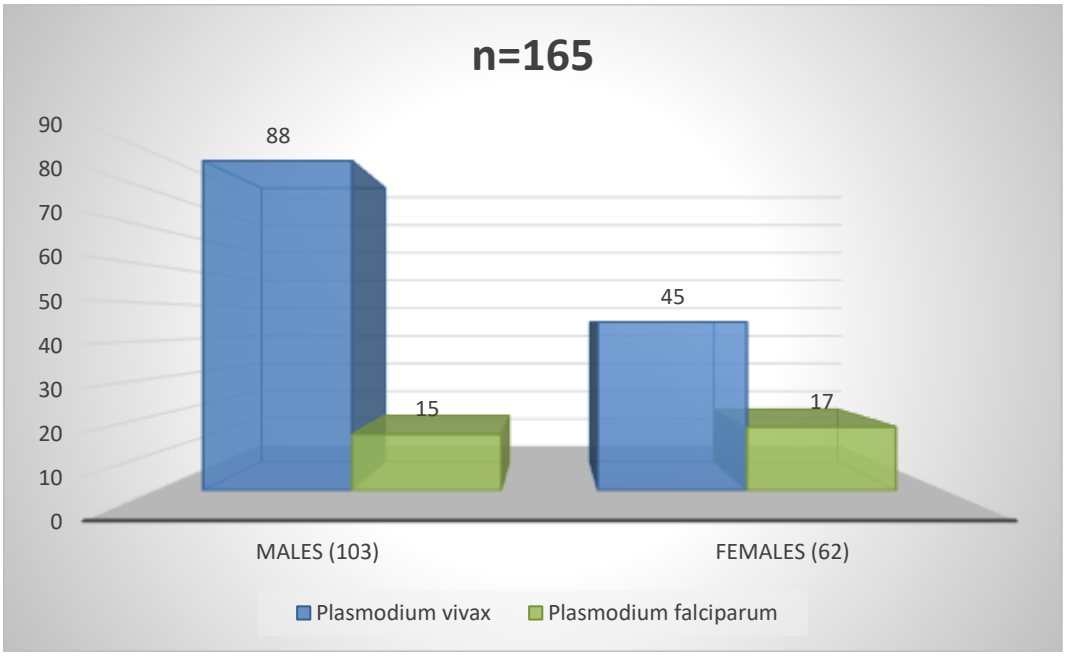

Figure 1. Frequencies of types of malaria in males and females

Type of anemias	Males	Females	Total
Hypochromic microcytic anemia	49	28	77
Normochromic normocytic anemia	29	20	49
Total	78	48	126

Table 1. Frequencies of anemias in males and females

Out of 103 males, 78 (76%) had anemia and 25 (24%) had normal hemoglobin levels whereas in 62 females, 48 (77.5%) were anemic and 14 (22.5%) were having normal hemoglobin levels. The frequencies of hypochromic microcytic anemia and normochromic normocytic anemia in males and females is summarized in table 1. Association of anemias/ normal Hb levels with types of malarias is outlined in table 2.

Table 2. Association of anemia/ normal Hb level with types of malarias

	Anemia/ normal Hb level	Hypochromic microcytic anemia	Normochromic normocytic anemia	Normal hemoglobin level	Total
Type of malaria	**Plasmodium vivax**	63	45	25	**133**
	Plasmodium falciparum	14	04	14	**32**
	Total	**77**	**49**	**39**	**165**

Table 3. Association of WBC count with types of malaria

WBC count	Plasmodium vivax	Plasmodium falciparum	Total
Normal WBC count	96	22	**118**
Leukocytosis	23	05	**28**
Leukopenia	14	05	**19**
Total	**133**	**32**	**165**

Table 4. Frequencies of thrombocytopenia in types of malaria

Platelet count	Plasmodium vivax	Plasmodium falciparum	Total
Normal platelet count	33	08	**41**
Mild thrombocytopenia	53	12	**65**
Moderate thrombocytopenia	35	09	**44**
Severe thrombocytopenia	12	03	**15**
Total	**133**	**32**	**165**

118 (71.5%) out of 165 patients had normal WBC count, 28 (17%) had leukocytosis and 19 (11.5%) were having leukopenia (Table 3). 41 (25%) patients had normal platelets count, 65 (39%) had mild thrombocytopenia, 44 (27%) had moderate thrombocytopenia and 15 (9%) had severe thrombocytopenia. Frequencies of thrombocytopenia in P. Vivax and P. Falciparum are summarized in table 4.

DISCUSSION:

Malaria, a protozoal parasitic infection predominantly caused by Plasmodium vivax and Plasmodium falciparum, remains a significant public health burden in endemic regions of Pakistan [5]. The disease contributes extensively to national morbidity and mortality statistics, particularly in rural and underserved areas where diagnostic delays, therapeutic mismanagement, inadequate health literacy, and limited access to healthcare infrastructure persist as critical challenges [6, 7]. Hematological abnormalities are a hallmark of malarial infections, with anemia representing the most prevalent complication. The pathogenesis of malaria-associated anemia is multifactorial, often attributed primarily to the intravascular hemolysis of parasitized and non-parasitized erythrocytes, leading to decreased hemoglobin levels [8,9]. Secondary etiological factors contributing to anemia include ineffective erythropoiesis stemming from nutritional deficiencies especially iron, vitamin B12, and folate and comorbid helminthic or protozoal infections which exacerbate red cell destruction [10,11].

In the present study, the predominant morphological variant of anemia observed among malaria patients was microcytic hypochromic anemia, with a stronger association noted in P. vivax infections relative to P. falciparum. This subtype is particularly indicative of iron deficiency and is potentiated by chronic dietary insufficiencies, especially among female patients of reproductive age who experience periodic blood loss and are more susceptible to nutritional deficits [12,13]. Thrombocytopenia emerges as another frequent hematologic manifestation of malaria. Our findings revealed that 75% of patients exhibited thrombocytopenia, predominantly among those infected with P. vivax, a pattern concordant with previous literature [14]. Although the precise pathophysiological mechanisms remain to be fully elucidated, proposed hypotheses include enhanced peripheral destruction of platelets, splenic sequestration, immune-mediated clearance via circulating malarial antigen-antibody complexes, and consumptive coagulopathy such as disseminated intravascular coagulation (DIC) [15,16, 17]. Leukocyte abnormalities also serve as indicative biomarkers of disease progression and host immune response. Leukocytosis generally correlates with severe malarial episodes, whereas leucopenia is more commonly observed in acute and uncomplicated cases [18]. In our cohort, lymphopenia was observed in approximately 25% of patients, while monocytosis was reported in 8%. Notably, neutrophil counts remained within normal limits in 90% of cases, and eosinophil and basophil levels were unremarkable in 97% of the population sampled. These findings underscore the complexity of hematological responses in malaria and highlight the necessity for comprehensive differential diagnostics, particularly in endemic regions where coinfections (e.g., bacteremia, helminthiasis) and malnutrition may confound clinical presentation [19,20]. Despite the challenges in disease management, malaria is a preventable and curable disease. Therefore, enhanced clinician awareness, public education, and strengthened diagnostic and treatment frameworks are imperative to mitigate the disease burden and its hematological sequelae in endemic zones of Pakistan.

CONCLUSION:

This study highlights the profound hematological alterations observed in patients infected with Plasmodium vivax and Plasmodium falciparum. Among the most consistent findings were anemia, thrombocytopenia, leucopenia, and monocytosis, reflecting the systemic impact of malarial parasites on hematopoietic function. Notably, a significant relationship is seen between anemias particularly microcytic hypochromic anemia and P. vivax malarial infection, suggesting a diagnostic clue that may assist clinicians in the early recognition and classification of the disease. The comparative analysis further demonstrates that both P. vivax and P. falciparum induce substantial hematological disruptions, albeit with some variation in the degree and pattern of changes. These alterations, when interpreted in conjunction with clinical findings and epidemiological context, can serve as vital indicators in the presumptive diagnosis of malaria, especially in endemic regions where rapid diagnostic tools may be limited. In the presence of the aforementioned hematological abnormalities, the diagnosis and treatment of malarial disease becomes relatively more straightforward. Early detection based on these parameters not only expedites therapeutic intervention but also supports the implementation of targeted preventive strategies. Such approaches are essential in alleviating the disease burden and improving public health outcomes in malaria-endemic countries like ours. In short, routine hematological profiling in suspected cases of malaria holds substantial diagnostic and prognostic value. Integrating these findings into national diagnostic guidelines may enhance early identification, reduce morbidity, and contribute to broader efforts aimed at controlling and ultimately eliminating malaria.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this study

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