ORIGINAL ARTICLE

Clinical presentations and hematological alterations in malaria patients and their association with plasmodium species and disease severity at Ghambat Institute of Medical Sciences

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ABSTRACT

Objective: To identify the prevalence of the clinical manifestations and changes in the hematological parameters of patients with malaria and to study their correlation with the various Plasmodium species to identify species-specific trends associated with severity of disease.

Material and Methods: The study is a descriptive cross-sectional study, which was carried out at the Department of General Medicine, Ghambat Institute of Medical Sciences, from 17th July 2025-17th January 2026. Consecutive sampling was used to enroll 162 patients aged between 18 and 70 years with malaria confirmed by peripheral blood smear. Hematological parameters and clinical characteristics were compared between different species of malaria.

Results: A total of 151 patients with confirmed malaria were included (mean age 32.6 ± 14.1 years; 46.1% males). Plasmodium vivax was the most common species (60.3%), followed by P. falciparum (39.7%). All patients presented with fever with rigors/chills, while headache (81.5%) and nausea/vomiting (75.9%) were the most frequent accompanying symptoms. Thrombocytopenia (79.0%), anemia (57.4%), and high RDW (52.5%) were the most common hematological abnormalities. Anemia and low MCV were more frequently observed in P. falciparum infections and among males, whereas low MCHC was more common in females.

Conclusion: The most common haematological changes in malaria patients are thrombocytopenia and anemia, and the presence of fever, headache, and nausea/vomiting is the most frequent presentation of the illness, especially Plasmodium vivax, which underscores the need to identify it at early stages and then treat the illness.

Keywords: Anemia, Haematological changes, Malaria, Plasmodium vivax, Thrombocytopenia

BACKGROUND

Malaria is a major worldwide social health issue and its prevalence is estimated to be 247 million in 2022, and 619,000 deaths, disproportionately impacting tropical and subtropical regions.[1] Plasmodium vivax and Plasmodium falciparum are the major causes of the disease and the latter has been linked to severe manifestations such as cerebral malaria and acute kidney injury.[2]

Variant surface antigens and resetting mechanisms are the factors that make the disease more severe and fatal.[3] Clinically malaria can be characterized by fever, chills, headache, nausea, and vomiting and, in severe cases, a change in consciousness and dysfunction of organs.[4]

Hematological abnormalities, such as anemia, thrombocytopenia and leukopenia are common occurrences due to hemolysis, splenic sequestration, and immune-mediated processes caused by parasites.[5] Hematological data such as the level of hemoglobin, Platelet count and total white cell count is useful in determining the severity of malaria and can be used to predict other undesirable clinical outcomes.[9] Among them, anemia is the most frequent hematological complication and leads to high morbidity, as it enhances fatigue, weakens immunity, and predisposes to severe outcomes, including organ dysfunction and long-term hospitalization.[10]

Given the ongoing morbidity of malaria in Pakistan and the paucity of recent studies investigating species-specific clinical and hematological phenotypes, the proposed research seeks to assess the spectrum of clinical manifestations and hematologic changes in malaria patients and study their relationship with the different Plasmodium species and the severity of the disease in Ghambat Institute of Medical Sciences. The findings will assist in the early risk stratification, timely

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diagnosis, and the provision of proper therapeutic care in endemic settings by identifying multi-species-related trends and severity-associated hematological changes.

MATERIAL AND METHODS

This was a descriptive cross-sectional study which took place during period of 6 months from 17th July 2025-17th January 2026 in the Department of General Medicine, Gambat Institute of Medical Sciences, Ghambat, Pakistan after the Institutional Ethical Review Committee gave approval (Approval No. PAQSJIMS/79/ERC) on 16th July 2025.

Non-probability consecutive sampling was used to enroll patients between ages 18- 70 years with confirmed diagnosis of malaria.

All the patients who participated in the study were those who presented themselves with a temperature of over 38 ^{0}C taking over 24 hours and had laboratory-proven malaria with a positive peripheral blood smear of the Plasmodium species. Patients were not eligible in the case of coagulopathies, hematological malignancy, autoimmune diseases, kidney or liver failure, active bleeding, pregnant, or taking anticoagulant therapy.

The sample size was determined according to the OpenEpi Version 3.01 by taking the 11.9 percent prevalence of pallor, 95% confidence interval and 5% margin of error based on the previously published data and calculates as 162. [14]

The diagnosis of malaria was done on the basis of a positive peripheral blood smear of Plasmodium species. After the confirmation, the demographic data, history of medical conditions, smoking status and length of symptoms were recorded in a structured pro forma. Clinical manifestations as nausea, vomiting, headache, pallor, jaundice, and changes in the degree of consciousness were noted. A 5 mL sample of venous blood was taken under aseptic conditions in order to examine the hematology, namely hemoglobin, total leukocyte count, neutrophil count, platelet count and absolute neutrophil count (ANC <1500/mm^3). Patients were divided by plasmodium species (P. vivax, P. falciparum, P. ovale). Comparisons were done between clinical and hematological parameters across the species to determine interspecies variation

Statistical Package of Social Sciences (SPSS) 26 was used in analyzing data. The quantitative variables were presented in the form of mean values and standard deviation (SD), whereas categorical variables were in the form of frequencies and percentages. Categorical variables were compared using Chi-square test or Fisher (where applicable) exact test to assess any difference in plasmodium species. The comparison of continuous variables across the groups was compared using the independent sample t-test. The odds ratios (OD) and 95% confidence intervals (CI) were used to determine the correlation between Plasmodium species and the severe clinical or hematological manifestations. A p-value of less than 0. 05 was accepted as statistically significant.

RESULTS

A total of 162 patients with confirmed malaria were included. The mean age was 32.6 ± 14.1 years and the mean BMI was 25.7 ± 3.5 kg/m². There were 70 males (46.1%) and 82 females (53.9%). The most common species was plasmodium vivax, which had an incidence of 91 participants (56.2%), then plasmodium falciparum (60, 37.0%) (Table-I).

Table-II demonstrates the comparison of the clinical manifestations of Plasmodium vivax and Plasmodium falciparum infected patients. All the patients (100% each group) had fever, with rigors and chills. The most common post-fever symptoms were headache and nausea/vomiting (81.3 and 75.8% of P. vivax cases and 81.7 and 76.7% of P. falciparum cases, respectively). Other symptoms like pallor, diarrhea, hypoglycemia, jaundice, prostration and epistaxis were less common. Hypoglycemia, jaundice and prostration were found to be a bit more prevalent in the P. falciparum-infected patients. Nevertheless, the clinical manifestations did not differ statistically between the two species ($p > 0.05$).

Comparing species-wise, it was revealed that anemia was more common among Plasmodium falciparum (63.3%) than P. vivax (54.9%) and P. ovale (45.5%). Thrombocytopenia was very widespread in all species, and similar frequencies in P. falciparum (78.3% and in P. vivax (76.9%), In total, despite the higher prevalence of P. vivax as an infecting species, some hematological abnormalities, specifically anemia were found to be disproportionately more frequent with P. falciparum. (Table-III).

Anaemia was more prevalent in males (55/70, 59.1%) than females (38/82, 40.9%, $p = 0.018$). Low MCV was also more common among males (40/70, 57.1%) than females (30/82, 42.9%, $p = 0.025$). Conversely, low

MCHC was more frequent among females (10/82, 58.8%) than males (7/70, 41.2%, p = 0.018). No statistically significant differences were observed for thrombocytopenia, high RDW, leucopoenia, neutropenia, lymphopenia, neutrophilia, or low MCH (Table-IV).

Table-I: Types of malaria species.

Malaria Type	Frequency (%)
P. vivax	91 (56.2)
P. falciparum	60 (37.0)
Other/Mixed	11 (6.8)

Table-II: Comparison of clinical manifestations with malaria species.

Clinical Manifestations	P. vivax (n/N, %)	P. falciparum (n/N, %)	p-value
Fever with rigors/chills	91/91 (100)	60/60 (100)	–
Headache	74/91 (81.3)	49/60 (81.7)	0.95
Nausea/Vomiting	69/91 (75.8)	46/60 (76.7)	0.89
Pallor	12/91 (13.2)	9/60 (15.0)	0.74
Diarrhea	8/91 (8.8)	6/60 (10.0)	0.80
Hypoglycemia	3/91 (3.3)	5/60 (8.3)	0.18
Jaundice	3/91 (3.3)	4/60 (6.7)	0.32
Prostration	1/91 (1.1)	3/60 (5.0)	0.14
Epistaxis	2/91 (2.2)	1/60 (1.7)	0.84

Table-III: Haematological alterations by plasmodium species (n=162).

Hematological Alteration	P. vivax (n/N, %)	P. falciparum (n/N, %)
Thrombocytopenia	70/91 (76.9%)	47/60 (78.3%)
Anemia	50/91 (54.9%)	38/60 (63.3%)
High RDW	48/91 (52.7%)	32/60 (53.3%)
Leukopenia	38/91 (41.8%)	28/60 (46.7%)
Neutropenia	28/91 (30.8%)	18/60 (30.0%)
Lymphopenia	46/91 (50.5%)	32/60 (53.3%)
Neutrophilia	22/91 (24.2%)	14/60 (23.3%)
Low MCV	38/91 (41.8%)	27/60 (45.0%)
Low MCH	33/91 (36.3%)	18/60 (30.0%)
Low MCHC	10/91 (11.0%)	5/60 (8.3%)

Table-IV: Gender-wise distribution of haematological alterations (n=162).

Hematological Alteration	Male n/N (%)	Female n/N (%)	P-value
Thrombocytopenia	84/128 (65.6%)	44/128 (34.4%)	0.585
Anemia	55/93 (59.1%)	38/93 (40.9%)	0.018*
High RDW	61/85 (71.8%)	24/85 (28.2%)	0.148
Leukopenia	50/74 (67.6%)	24/74 (32.4%)	0.823
Neutropenia	34/50 (68.0%)	16/50 (32.0%)	0.810
Lymphopenia	55/84 (65.5%)	29/84 (34.5%)	0.739
Neutrophilia	25/40 (62.5%)	15/40 (37.5%)	0.519
Low MCV	40/70 (57.1%)	30/70 (42.9%)	0.025*
Low MCH	38/55 (69.1%)	17/55 (30.9%)	0.639
Low MCHC	7/17 (41.2%)	10/17 (58.8%)	0.018*

*p < 0.05 indicates statistical significance

DISCUSSION

Despite extensive clinical and hematological data on malaria, the current study indicates species-specific differences in malaria abnormalities. According to our findings, the infection of Plasmodium falciparum is related to a higher rate of anemia, as well as the development of severe clinical signs, than P. vivax, which may suggest the variability of the disease severity patterns across the species in our area. We found in this study that the malaria patients were mostly characterized by fever, headache, and nausea/vomiting, in line with prior findings that febrile illness is the characteristic of malaria and other systemic infections that see alterations in hematological parameters.[11] Abnormalities of the hematology, especially thrombocytopenia and anemia were frequent in our cohort. The mechanisms by which malaria may cause anemia are diverse: the parasite itself destroys infected red blood cells during its intraerythrocytic cycle, the immune system leads to hemolysis of uninfected

erythrocytes with the help of immunity, and the bone marrow erythropoiesis is inhibited. In Pakistan, nutritional deficiencies, particularly iron deficiency, are already extremely high and thus could increase the severity of the malaria related anemia in this population.[12] Other reports of similar trends observed were by Awoke and Arota who reported anemia and thrombocytopenia as frequent manifestations in both P. vivax and P. falciparum cases of malaria.[12]

Plasmodium vivax predominance in our cohort is in tandem with the regional epidemiological patterns and is linked with milder hematological derangements as compared to P. falciparum.[13]

Aanemia and low MCV were more intense in male population, indicating possible gender influence in the response of hematology to malaria. Other researches have recorded that a greater percentage of male patients with malaria have anemia. In the investigation conducted by Khan *et al*. in Khuzdar, Balochistan, hematological abnormalities such as anemia were more often observed in malaria patients, which indicated the close correlation between malarial infection and low levels of hemoglobin. The increased prevalence of anemia in males as cited in a number of studies could be attributed to biological and environmental factors. In endemic areas, males tend to be more occupationally exposed to the risks of the mosquito-infested environment in agricultural fields, forests, or mines, which makes them more susceptible to getting infected with malaria and the associated hematological complications.[14] The vast majority of our patients were thrombocytopenic regardless of Plasmodium species which is in line with the results of Zafar *et al*. who observed that platelet destruction and splenic sequestration are central processes in the pathogenesis of malaria-induced thrombocytopenia.[15-17]

On the whole, our results indicate that malaria leads to substantial hematological disturbances in inter- and intra-species and that they may be used as diagnostic and prognostic supportive indicators. The trend of cytopenia's in our experiment is also related with other cases of severe viral and parasitic infections, which also support the idea that routine hematological monitoring is useful in acute febrile infections.[16-18] The clinical symptoms of malaria are similar to other febrile diseases hence making it hard to accurately diagnose malaria in endemic regions. Varo *et al*. also noted that a combination of clinical assessment and laboratory verification enhances the accuracy of the diagnosis and assists in making timely treatment decisions. In our research, the use of both clinical manifestation and peripheral blood smear findings provided the necessary identification of the malaria cases that facilitated the management of the disease in this endemic area.[17-20] This species-specific difference can also help clinicians to predict complications early before they arises, especially in an environment where there are no advanced diagnostic facilities.

LIMITATIONS OF STUDY:

This research is limited in a number of ways. First, it was carried out in one center that can reduce the applicability of the results to other geographic areas or populations. Second, the cross-sectional design does not allow assessing the temporal changes in hematological parameters or causation. Third, the possible confounders of the nutritional status, previous antimalarial therapy, coinfections, and the genetic factors on the hematological profiles were not systematically considered. It is proposed that future multicenter longitudinal research is needed in order to confirm these results and investigate mechanistic connections between Plasmodium species, gender, and hematological changes.

CONCLUSION

The most common clinical features among patients having malaria in this tertiary care setting were fever with rigor, headache, and nausea/vomiting. The most common hematological abnormalities were thrombocytopenia, anemia and RDW. Despite the fact that Plasmodium vivax was the most common infecting species, anemia was relatively more common in P. falciparum infections. There was also some gender differences with anemia and low MCV were more common among males, and low MCHC was commoner among females. The identification of species-specific and hematological patterns could help clinicians to assess risk early and respond to malaria at the appropriate time in an endemic area.

CONFLICT OF INTEREST

None

GRANT SUPPORT & FINANCIAL DISCLOSURE

Declared none

AUTHOR CONTRIBUTIO1N

Zeeshan Ahmed: Substantial contributions to study concept and design, acquisition of data, manuscript drafting, critical revision, final approval, accountable for all aspects of publication.

Bakht Ali: Substantial contributions to acquisition of data and supervision of research work, critical review, final approval, accountable for all aspects of publication.

Khalida Parveen: Substantial contributions to analysis and interpretation of data, critical revision, final approval, accountable for all aspects of publication.

Zarnain Riaz: Substantial contributions to acquisition of data, manuscript drafting, final approval, accountable for all aspects of publication.

Waheed Abid: Substantial contributions to data collection, critical review of the manuscript, final approval, accountable for all aspects of publication.

Aftab Hussain Shah: Substantial contributions to concept, study design, critical review and intellectual oversight of the manuscript, final approval, accountable for all aspects of publication.

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