National Journal of Life and Health Sciences
Vol: 2(2), 2023
Research Article
ISSN: 3006-5852 & ISSN: 3006-5844

Profiles of Hematological Parameters in *Plasmodium vivax* Malaria Patients attending Lady Reading Hospital, Peshawar

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ABSTRACT

Background: Plasmodium is a type of parasite that causes malaria. Five known species of Plasmodium can cause malaria in humans, *Plasmodium falciparum, plasmodium vivax, Plasmodium ovale, Plasmodium malariae,* and *Plasmodium knowlesi*. This study was designed to assess the effect of *plasmodium vivax infection* on malaria-associated hematological parameters.

Material and Methods: This descriptive cross-sectional study was conducted at Lady Reading Hospital, Peshawar. The duration of the study was four (04) months from June to September 2023. A total of 384 samples possessed positive malarial parasite on peripheral smear both genders having different ages groups were included in the study. Variables such as age frequencies and percentage were reported for gender, hemoglobin, platelets, and white blood cells (WBC). This study was approved by the Ethical Committee of Ahmad Medical Institute, Peshawar. All collected data were analyzed through SPSS-22.

Result: The study findings revealed that 196(51.0%) patients were males and 186(49%) were females. Out of 384 patients, 178 (46.4%) were between 10-30 years, 164(42.7%) were between 31-50 years, and 42(10.9%) were between 51-70 years age. Furthermore, out of 384, 11(2.9%) were normal, 69(18.0%) were anemic, 154(40.1%) were thrombocytopenia, 28(7.3%) were leukocytosis. Overall, distribution of thrombocytopenia, 120(31.3%) were no thrombocytopenia, 113 (29.4%) were mild thrombocytopenia, 104 (27.1%) were moderate thrombocytopenia, 47(12.4) were severe thrombocytopenia.

Conclusion: Gaining further knowledge about these hematological indicators would enable their application in monitoring treatment response and early detection of malaria complications. The two most frequent hematological abnormalities results associated with malaria infection were thrombocytopenia and anemia.

Keywords: Anemia, Thrombocytopenia, Malaria fever, *plasmodium vivax*

HOW TO CITE: Hassan S, Nawaz S, Ahmad B, Haroon M, Ullah MT. Profiles of Hematological Parameters in Plasmodium vivax Malaria Patients attending Lady Reading Hospital, Peshawar. National Journal of Life and Health Sciences. 2023 Dec; 2(2), 42-46.
DOI: https://doi.org/10.62746/njlhs.v2n2.28
Date of Submission: 23/10/2023 Date of Revision: 07/12/2023 Date of Acceptance: 13/12/2023

INTRODUCTION

Plasmodium is the genus of protozoan parasites that cause malaria. *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae*, and *Plasmodium knowlesi* are the five species of Plasmodium that are widely known to cause malaria in humans.[1] It is a tropical and subtropical disease that is mostly seen in Asia and Africa. An estimated 300–500 million cases and 1.6–2.8 million fatalities of malaria occur annually in areas where malaria is prevalent for over 40% of total worldwide.[2] *P. vivax* is the species of malaria that is most common. According to the 2018 Malaria Report, *P. vivax* was the cause of malaria in 74.1% of cases in the United States in 2017.[3]

While malaria affects multiple systems within the body, its fatality rate is heightened by its impact on the nervous, hematological, and renal systems.[4] One important marker for malaria in people with acute febrile diseases is thrombocytopenia. Thrombocytopenia can arise from infections caused by *P. falciparum* or *P. vivax*. It's important to keep in mind that both *P. vivax* and *P. falciparum* malaria can cause extremely low levels of platelets, which might or might not suggest a need for platelet transfusions or have any bearing on prognosis.[5]

Hematological alterations are among the most prevalent malarial consequences, and they are crucial to the disease's pathogenesis.[6] The primary cell lines affected by these alterations are WBCs, thrombocytes, and RBCs.[7] It is commonly known that hematological abnormalities in malaria include anemia, a decrease in platelet, and a decrease in WBCs or Increase in WBCs.[8] WBC count changes are less frequent but can vary depending on factors such as Plasmodium species and treatment response. Complete Blood Count CBC is essential for diagnosing hematological abnormalities, assessing Red Blood cells RBCs, WBCs, and platelets.[9] Hematological alterations, the most common systemic complication of malaria, play a significant role in various serious complications like unconsciousness, convulsions, and organ failure. Prompt treatment based on these alterations, easily detectable through blood tests, can prevent further deterioration and delay in managing the condition.[10] Debates persist regarding the link between hematological parameter changes, immune cytokine

Research Article
ISSN: 3006-5852 & ISSN: 3006-5844

responses, and malaria progression, despite ample research.[11] Anemia and thrombocytopenia are prominent during *P. falciparum* and *P. vivax* infections, yet discussions on hematological changes in malaria remain disputed.[12]

Malaria-related anemia is a significant complication, exacerbated by asymptomatic and submicroscopic infections. The primary cause is the breakdown and loss of parasitized RBCs. Severe anemia in *P. falciparum*, *P. vivax*, or *P. malariae* infections increases mortality risk, as observed in hospitals.[13] Hematological disorders such as anemia, thrombocytopenia, atypical lymphocytosis, and occasionally disseminated intravascular coagulation are consistently present.[14] This study aimed to assess potential hematological alterations in adult populations affected by various forms of malaria. Previously considered mild, *P. vivax* malaria is now associated with severe symptoms and mortality rates comparable to *P. falciparum* infections, as recent research suggests.[15] *Plasmodium vivax* malaria leads to severe complications like organ failure, pulmonary swelling, cerebral malaria, and anemia. While thrombocytopenia is common, bleeding is rare. Recent studies linked *P. vivax* to anemia. Platelet parameters like MPV, PDW, and PCT change in infectious diseases like tuberculosis, indicating platelet activation, but their correlation with malaria outcomes remains uncertain.[16]

Malaria is a tropical disease that is prevalent in countries like Bangladesh, Pakistan, and India. It is a major cause of death worldwide, accounting for 1.5 to 2 million deaths annually. Of the 2.48 million cases of malaria in South-East Asia, 34% occur in India.[17] In India, malaria is a significant public health concern. The African region (88%), followed by Southeast Asia (SEA) (10%), has the highest malaria burden worldwide, according to a 2015 World Health Organization (WHO) report.[18] India bears two-thirds of the load in the Southeast Asian region (66%) and is followed by Indonesia (10%) and Myanmar (18%). In some states and geographic areas, malaria is still a serious issue and is linked to high rates of morbidity and mortality.[14] The World Health Organization (WHO) estimates that 490,000 people died from malaria globally in 2015, out of an estimated 212 million cases that were reported.[19] One of the impacted nations is Pakistan, where 0.9 million suspected and confirmed cases occur each year and 177 million of the 185 million people living there are at danger. Seasonal transmission of malaria occurs during the monsoon season. In Pakistan, *plasmodium vivax* (*P. vivax*) and *Plasmodium falciparum* (*P. falciparum*) coexist, with July through November being the busiest months for transmission.[20]

A clinician may prevent serious problems by establishing an early and successful treatment based on an assessment of hematological alterations associated with malaria. Hematology parameters can aid in the provision of presumptive treatment, particularly in situations where the results of the parasitological examination are uncertain or not immediately available to determine the course of treatment for malaria. They can also aid in the patient's intensive care and help avert death that may arise from such complications. The following variables may affect hematopathological changes linked to malaria infection: malaria immunity, background hemoglobinopathy, level of prevalence, and demographics. This study was conducted to assess potential hematological alterations in adult populations affected by malaria caused by *P. vivax*.

MATERIALS AND METHODS

This was a descriptive cross-sectional study conducted in the Lady Reading Hospital, Peshawar, Khyber Pakhtunkhwa. This study was carried out in four months duration from June to September 2023. The total simple size was 384 which were calculated by Cochrane Formula n =p (1-p) (Z/e) ^{2} n=50% (1-50%) (0.05/1.96)^2 n=50% (1-50%) 1536 n=0.5 (1-0.5) 1536 n=0.5 (0.5) 1536 n= 384 Answer n= simple size p= prevalence z= level of confidence e=range of error. Non-probability convenient sampling technique was applied for patients' recruitment. Patient reported to Lady Reading Hospital for malaria [vivax] were included in the study irrespective of age, gender, and area (Urban and Rural). Individuals with other liver diseases patients and patients infected with other species of malaria were excluded. Ethical approval of research committee formally obtained from Department of Medical Laboratory Technology, Ahmad Medical Institute, Peshawar. Blood samples of 3ml were taken using venipuncture technique ina tube contain ethylene diamine tetra acetic acid (EDTA), for testing under a microscope to look for malaria parasites. Hemoglobin, hematocrit, and platelet levels were checked using a hematology analyzer. Patients were clinically examined for signs of malaria fever. Malaria was identified through clinical examination and lab tests. All collected data was entered in Microsoft Excel 2020, and were coded then further analyzed through statistical package for social sciences version 22 (SPSS-v.22). Frequencies and percentages were calculated and presented in the tables.

RESULTS

A total number of 384 participants were enrolled in this study. Out of 384, 196(51.0%) were males and 186(48.4%) were females so the male ratio was higher than the female. Out of 384 patients, 178 (46.4%) were between the age of 10 and 30years,164(42.7%) were between the ages of 31 to 50 years, 42(10.9%) were between 51 to 70 years of ages, which means that malaria is higher in the age of 10 to 30 (Table 1).

According to this study, 115(29.9%) belonged to urban areas while 269(70.1%) belonged to rural areas, so it means that the malaria is more common in rural areas as compared to urban areas.

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ISSN: 3006-5852 & ISSN: 3006-5844

Table 1: Distribution of patients according to Gender and Age

Gender	Frequency	Percentage
Male	196	51.0
Female	186	49.0
Total	384	100
Age (Years)		
10-30	178	46.4
31-50	164	42.7
51-70	42	10.9

In the sample size of 384 patients, 26(6.8%) were with a previous history of malaria while 358(93.2%) were with no previous history of malaria (Table 2).

Table 2: Residence and previous history of the patients

Parameter	Frequency	percentage
Urban	115	29.9
Total Rural	269	70.1
Total	384	100
Previous history of malarial patients	Frequency	percentage
Yes	26	6.8
No	358	93.2
Total	384	100

This study shows that in the sample size of 384, 11(2.9%) were normal, 69(18.0%) were anemic, 154(40.1%) were thrombocytopenia, 28(7.3%) were leukocytosis, 54(14.1%) were anemic so it means that thrombocytopenia is more in malarial patient as compared to other parameters. Out of 384, 120(31.3%) were no thrombocytopenia, 113(29.4%) were mild thrombocytopenia, 104(27.1%) were moderate thrombocytopenia,47(12.4 %) were severe thrombocytopenia. In the sample size of 384, 239(62.2%) were not anemic, 11(28.4%) were mild anemia, 31 (8.1%) were moderate anemia, and 3(8%) were severe anemia. It means that anemia is not common in malarial patients but in females' anemia is common than males (Table 3 & 4).

Table 3: Alteration in hematological parameters among malaria infected patients

Parameters	Frequency	Percentage
Normal	11	2.9
HB	84	21.9
Platelets	196	51.0
WBC	28	7.3
Platelets and HB	63	16.4
Al parameter	2	0.5
Total	384	100

The table 3.4 shows that in the sample size of 384, 120 (31.3%) were no thrombocytopenia, 113(29.4%) were mild thrombocytopenia,104(27.1%) were moderate thrombocytopenia, 47(12.4) was severe thrombocytopenia.

In the table shows that in the sample size out of 384 patients, 239(62.2%) were no anemia,11(28.4%) was mild anemia.31 (8.1%) were moderate anemia,3(8%) was severe anemia.

Table 4: Thrombocytopenia and anemia based on severity

Parameter	Frequency	Percentage
Normal	120	31.3
Mild	113	29.4
Moderate	104	27.1
Sever	47	12.2
Total	384	100
Anemia on the basis of severity		
	Frequency	Percentage
Normal	239	62.2
Mild	111	28.9
Moderate	31	8.1
Sever	3	0.8
Total	384	100.0

DISCUSSION

A study conducted by Khattak *et al.,* 2020 from Peshawar which comprised a total of 100 patients who had peripheral smear-diagnosed malarial parasite Plasmodium vivax. 39% of the patients were female, and 61% were male. Moreover, 42% were aged 10-20, 30% aged 21-30, 9% aged 31-40, 10% aged 41-50, 6% aged 51-60, and 3% aged 61-70. [21] Another study conducted by *Arota et al.,* from Ethiopia that all (170) of the participants had a mean age of 27.6 years, and the majority (116, 68%) were male. There was no statistically significant difference in the mean age of malaria patients compared to the malaria-negative groups (P>0.05). Males made up 116 (68%), the bulk of patients with positive malaria tests. In terms of ethnicity, the Dawro ethnic group accounted for around 94% of malaria cases. Males made up 70% of those who tested negative for malaria, just like the majority of patients changes in hematocrit in malaria.[1] Another study conducted Latia *et al.,* from India found that the distribution of thrombocytopenia by age groups showed that 3(3.0%) cases between the ages of 21 and 30 and 5(5.0%) cases between the ages of 10 and 20 had 10000-30000 platelets. Additionally, 31000-50000 platelets were found in 13 patients (14.0%) between the ages of 10 and 20 and 3 instances (4.0%).[14]

In a different study, 84% of the malaria patients were found to have thrombocytopenia (platelet count <140,000/µL), whereas the remaining 16% had normal platelet counts. The second most common hematological deviation seen in cases of malaria infection was anemia. The 40% of malaria patients had normal Hgb readings, and the other 60% had anemia. The most frequent hematological defect linked to malaria infection in the study was thrombocytopenia.[1] Contrast to another study a study conducted by Surve *et al.,* which shows the majority of patients had mild (40%) or severe (30%) anemia; 9% of cases had an HB concentration of less than 7

grams. The most prevalent RBC type in anemic patients was normocytic normochromic (64.55%), which was followed by microcytic hypochromic (29.11%). A roughly identical microcytic hypochromic blood appearance was observed in both vivax and falciparum infections.[22]

Patients having malaria should undergo testing to evaluate for hematological abnormalities, such as anemia and thrombocytopenia. If abnormalities are found, proper treatment should be started to lessen the patient's risk of consequences. Patients experiencing a sudden, severe fever and either thrombocytopenia or anemia in combination should inform the attending physicians about the potential for malaria infection. Thrombocytopenia ought to be employed alongside clinical indices and further laboratory tests as a supplementary diagnostic factor for malaria.

CONCLUSION

This study concluded that thrombocytopenia and anemia were commonly observed hematological abnormalities detected in patients with malaria infection caused by *plasmodium vivax*. It is suggested that thrombocytopenia and anemia in a febrile patient indicate malaria fever therefore additional particular tests can be employed for confirmation. Gaining further knowledge about these hematological indicators would enable their application in monitoring treatment response and early detection of malaria complications. The two most frequent hematological abnormalities results associated with malaria infection were thrombocytopenia and anemia.

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