



Research Article

Analysis of Clinical and Hematological Findings in Malaria Infected Patients in Hyderabad, Sindh

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Abstract | To investigate the effects of Plasmodium species on hematological parameters in a descriptive case study was carried out on malaria positive patients. The objective of the study is to determine how malaria disturbs complete blood cell parameters. If it is left untreated, it will only get worse and may even result in human death. Therefore, it is essential to observe blood cell parameters sensibly. In this observational study, the data has been collected from 220 malarial patients from Hyderabad Sindh. The diagnosis of malaria was confirmed by malarial test and complete blood count. The clinical and laboratory features were classified for statistical analysis. Out of 220 patients 76.36% had *Plasmodium vivax*, 20.90% had *Plasmodium falciparum* and only 2.72% had mixed infection. Not a single case of *Plasmodium malariae* and *Plasmodium ovale* were noticed. Males accounted for 124 cases (56.36%) of malaria specie, whereas females accounted for 96 cases (43.63%). Age wise estimation was highest 110 cases (50%) revealed from the age group of 1 to 10 years. Anemia was observed in 80% cases. In 75.45% of the patients had thrombocytopenia identified. Leukopenia was detected in 16.36% of cases, and leukocytosis was revealed in 12.72% of cases, while the WBC count was normal in 70.90% of cases. This study found that *Plasmodium vivax* cases were more than *Plasmodium falciparum*. This study suggests that in malarial cases anaemia, thrombocytopenia, leukocytosis, and leukopenia have been found to be the most prevalent haematological abnormalities.

Received | September 28, 2024; **Accepted** | December 06, 2024; **Published** | December 27, 2024

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Citation | Chang, Z., N.A. Birmani, A.H. Chang, L. Jamali, N. Chang and F. Chang. 2024. Analysis of clinical and hematological findings in malaria infected patients in Hyderabad, Sindh. *Biologia (Lahore)*, 70(2): 47-53.

DOI | <https://dx.doi.org/10.17582/journal.Biologia/2024/70.2.47.53>

Keywords | Malaria, Plasmodium, Hematological findings, Thrombocytopenia, Anemia



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Introduction

Malaria infection accounts for 200–300 million infections and 500,000 fatalities worldwide

each year. Malaria is endemic in about half of the world's population, and it has been a major factor in the decline of public and economic growth in many developing nations. According to estimates from

the World Health Organization (WHO), there are 1.5 million cases of malaria in Pakistan each year. Pakistan is one of the nations in group 3 of the Eastern Mediterranean Region, which accounts for 95% of the malaria cases in the region (Khan *et al.*, 2019). Five distinct species of Plasmodium, including *Plasmodium vivax*, *Plasmodium falciparum*, *Plasmodium malariae*, *Plasmodium knowlesi*, and *Plasmodium ovale*, are typically responsible for the disease. Malaria is one of the most common diseases in Pakistan, where it is endemic. In Pakistan, *P. vivax* and *P. falciparum* are the main malarial pathogens that cause the parasitic infection (Mukry *et al.*, 2017). Malaria is the common reported disease in under-developed nations of the world which carry out a great burden on health. The most perilous species is *P. falciparum* which is responsible for around 90% mortality in malarial cases. Half of world populace is at risk of malaria with an estimated 250 million proven cases and nearly one million deaths were reported in 2006. The primary vector species are *Anopheles culicifacies* and *Anopheles stephensi* (Suleman, 2012).

Most of the malaria-affected nations are among the world's underprivileged nations. Pakistan is widespread with malaria cases. In Pakistan there are two species of Plasmodium which are predominant *Plasmodium falciparum* and *Plasmodium vivax* (Ashley *et al.*, 2014).

Malaria remains a major health problem in Pakistan cities and rural areas owing to lack of facilities and awareness. Pakistan's major transmission period for malaria infection is through August. Malaria is present mainly in the Balochistan, Sindh, KPK and FATA (Palaniyandi, 2021). Different provinces and even cities with diverse climates have varying malaria endemicities. Every year, 3.5 million instances of suspected and confirmed malaria are recorded in Pakistan. In Pakistan, 60% of the population resides in areas where malaria is common (Qureshi *et al.*, 2019).

Malaria is present in tropical and subtropical regions across the planet, including certain regions of America, Asia, Africa, and the Pacific Islands. Malaria is endemic in 91 of Pakistan's 123 districts, making it a frequent disease there. *Plasmodium vivax* and *Plasmodium falciparum* are the two most often identified parasites that cause malaria in Pakistan. *Plasmodium falciparum*, a malaria parasite that is

widespread throughout the world, is more hazardous than *Plasmodium vivax*. Both *Plasmodium falciparum* and *Plasmodium vivax* pose a threat to human health and can be fatal. Genetic variation is present in *Plasmodium vivax*, *Plasmodium falciparum*, and other Plasmodium species. There are almost 3,000 different kinds of mosquitoes, and 100 of them are vectors. Pakistan is home to roughly 25 species of anopheles out of these 100 (Khan *et al.*, 2018).

Mosquitoes of the genus Anopheles are essential to the global transmission of human malaria parasites. Approximately 465 identified Anopheles species and over 50 unidentified members of Anopheles species complexes have been recorded globally, with approximately 70 of them having the ability to operate as Plasmodium vectors. There have also been reports of roughly 23 Anopheline species in Pakistan. Of which two Anopheline species *Anopheline culicifacies*, the principal vector in rural areas, and *Anopheline stephensi*, a significant vector in the nation's cities have been identified as vectors of malaria (Oneeb *et al.*, 2016). Before returning to humans, the malarial parasite needs to finish its life cycle in the female Anopheles mosquito (Jawaid, 2021). Signs and symptoms of malaria are usually basic and mostly comprise of fever, malaise, weakness, gastrointestinal problems such as nausea, vomiting, and diarrhea, neurologic complaints like dizziness headache, chills, back pain, and cough (Sosale *et al.*, 2016).

Scientific condition and pathological alterations in several body systems are the symptoms of malaria. The parasite enters and multiplies inside the red blood cells that are in circulation. It results in several haematological alterations. The easiest tissue to use for disease diagnosis and screening, including malaria, is blood. Health care practitioners can easily look for abnormalities in numerous haematological parameters because of its effects on blood cell physiology, which makes blood examination an easy target. A notable characteristic of malarial infection is blood cell count fluctuation. Variations in all three cell lines platelets, white blood cells (WBC), and red blood cells (RBC) cause thrombocytopenia, anaemia and leukocytosis or leucopenia (Hyder *et al.*, 2020). The body's most readily accessible tissue, blood, can be utilized to quickly diagnose haematological abnormalities that have been linked to malaria. Haematological abnormalities such as anaemia, thrombocytopenia, atypical lymphocytosis, leucopenia, leukocytosis,

neutropenia, and neutrophilia have previously been documented in the literature (Haroon *et al.*, 2013).

The most frequent consequences, haematological alterations, are crucial to these deadly complications. Haematological abnormalities such as anaemia, thrombocytopenia, atypical lymphocytosis, and infrequently disseminated intravascular coagulation have been reported to be invariably present. There have also been reports of leucopenia, leukocytosis, neutropenia, neutrophilia, eosinophilia, and monocytosis (Abdou *et al.*, 2008). Blood cell counts fluctuating is a well-known aspect of malarial illnesses. Erythrocytes, thrombocytes, and leukocytes are the main cell lines impacted by these changes. This study aimed to show how differing parasite densities and *P. falciparum* and *P. vivax* infections affected blood cell parameters in malaria patients (Kotepui *et al.*, 2015).

The type of malarial parasite and the intensity of infection seem to have an impact on the frequency and severity of thrombocytopenia. In areas where malaria is endemic, thrombocytopenia may also serve as a marker for the disease's existence (Ashraf, 2014). These outbreaks have been connected to the spread and multiplication of vectors during the monsoon season because of the flooding and population dislocation that takes place at this time. The malaria-carrying mosquito thrives in an environment that is favored by monsoon rains, floods, poor waste management, low sanitation standards, and a weak healthcare system, especially in rural regions. As a result, areas typically have greater rates of malaria prevalence than regions (Fatima *et al.*, 2023).

Experimental

All confirmed cases of malaria who presented to Civil Hospital Hyderabad between August 2021 to January 2022. A random sampling cluster was employed. The considered population consisted of 220 malarial patients. The statistics was collected from the studied population through a questionnaire with three parts. Part 1 demographic section comprised variables like age and sex, part 2 clinical section included clinical data in which inquired about fever, headache, nausea, Part 3 hematological parameters included hematological findings documented about complete blood counts (CBC), plasmodium type, RBCs, WBCs, and Platelet's count. All malaria-positive smears were reviewed by a hematologist for confirmation. Verbal consent was taken from the

hospital and patients. Cases of malaria that were verified and had significant CBC data were included. The patient data was arranged according to the three patterns. (1) Data on malaria patients' ages was tallied for each age group (2) Data on *P. vivax*, *P. falciparum*, and mixed species were tabulated according to gender (male and female). (3) To evaluate the haematological parameters, including RBCs (erythrocytes), WBCs (leukocytes), platelets, and haemoglobin level (Hb) of malaria patients, the data was finally tabulated.

Results and Discussion

Plasmodium vivax accounted for most positive cases (76.36%) out of 220 total cases. *Plasmodium falciparum* ranked second in terms of specie (20.90%). Mixed infection had the fewest cases 2.72%. Every case was examined using tabular formats, which included prevalence, sex, age, and, lastly, haematological alterations. There have been no reported cases of *Plasmodium ovale* or malariae.

When compared to *Plasmodium falciparum*, *Plasmodium vivax* is claimed to have the highest prevalence, while mixed infections are considered to have the lowest prevalence of any parasite. Table 1 shows that males (56%) had a higher prevalence of malaria, compared to females (44%). Males have a higher prevalence of Plasmodium species than females, according to some research expert. Table 1 indicates the age group 1-10 years had the highest percentage of positive cases (50%) while the age group 11-20 years had the lowest (11.81%). The age group 1-10 years had the highest prevalence of Plasmodium vivax, at 84 (50%) and the age group 11-20 years, the lowest, at 12 (7.14%).

Table 1: *Malarial parasite and demographic characteristics of malarial patients.*

Characteristics	Percentage
Malarial type	
Plasmodium vivax	76.36%
Plasmodium falciparum	20.90%
Mixed infection	2.72%
Sex distribution	
Male	56%
Female	44%
Age in years	
1-10 years	50%
11-20 years	12%
21-above	38%

With each exposure, immunity to the malaria parasite infection grows, making youngsters more susceptible to malaria than adults. Malaria is the second leading cause of death for children in developing nations, with an estimated 1.5 to 2.7 million deaths worldwide each year. Mohammad conducted research on the frequency of malaria infections among the local population in Jhal Magsi district gender wise incidence was higher (65.3%) in males (Yasinzai and Kakar, 2012). In one of the comparable research incidence of malaria was higher in males (52.35%) as reported by Khan *et al.* (2014), related to females prevalence of malaria was lowest (47.64%) (Khan *et al.*, 2014). Ullah *et al.* (2019) assembled information from seven tehsils in District Lower Dir and observed 90% of patients had Plasmodium vivax infection, he also reported that children had a greater gender-wise incidence of 14.9%.

A diagnosis of malaria is supported statistically by the clinical signs and symptoms. Table 2 shows in malarial patients, clinical complaints were prevalent. Malaria symptoms such as fever, chills, and headaches were frequently reported. In 100% of the cases fever was observed, in 88% there were rigors and chills, and in 62% headache was reported. Vomiting and nausea was seen in 20% cases, cough in 15% cases and loose stool/diarrhea in 3% cases.

Table 2: Presenting clinical features in cases of malaria.

Clinical Symptoms	Percentage
Fever	100 %
Rigors and chill	88 %
Headache	62%
Nausea and vomiting	20%
Cough	15%
Loose stool / diarrhea	3%

Usually, a few weeks may pass before any symptoms or signs appear. Fever, chills, headaches, nausea,

Table 3: Haematological parameters between *P. vivax* and *P. falciparum*.

Parameter <i>Plasmodium vivax</i>	Parameter <i>Plasmodium falciparum</i>
Anemia 128 (76.19%)	Anemia 42 (91.30%)
Thrombocytopenia 122 (72.61%)	Thrombocytopenia 38 (82.60%)
Mild Thrombocytopenia 92 (54.76%)	Mild Thrombocytopenia 24 (52.17%)
Moderate Thrombocytopenia 24 (14.28%)	Moderate Thrombocytopenia 8 (17.39%)
Severe Thrombocytopenia 6 (3.57%)	Severe Thrombocytopenia 6 (13.04%)
Leukocytosis 18 (10.71%)	Leukocytosis 10 (21.73%)
Leukopenia 22 (13.09%)	Leukopenia 12 (26.08%)

vomiting, diarrhea, abdominal pain, exhaustion, weakened muscles, joint pain, rapid breathing rate, and cough are the most common ones. The diagnosis of uncomplicated malaria is frequently challenging due to its vague signs and symptoms. Severe malaria is a common result of one to two percent of *P. falciparum* infections. Severe malaria is characterized by a number of symptoms, including multiple convulsions, acidotic breathing, altered cognition, acute renal injury, jaundice and coma (Tabassum *et al.*, 2023). Table 3 showed comparison study of haematological parameters of *P. vivax* and *P. falciparum*.

The WHO considers patients to be anemic if their haemoglobin levels are less than 13g/dl for males and less than 12g/dl for females.

Figure 1 illustrates that well-known characteristic of malarial illness. In 20% of patients, the Hb level was normal however in 80% of the patients anaemia was noted and 40% cases were with reduced Hb less than 9 g/dl, 20.90% had 9.1 g/dl to 11 g/dl, and 19.09% had 11.1 g/dl to 12 g/dl. Several researchers have worked on malaria a study by Hussain Haroon *et al.* was conducted in Karachi, Pakistan 75% of the malaria cases were male, and seventy-one percent of the malarial cases had anaemia (Haroon *et al.*, 2013).

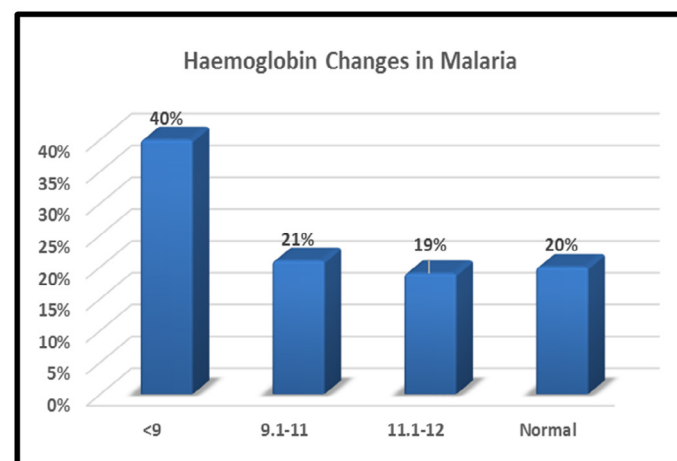


Figure 1: Haemoglobin changes in malarial patients

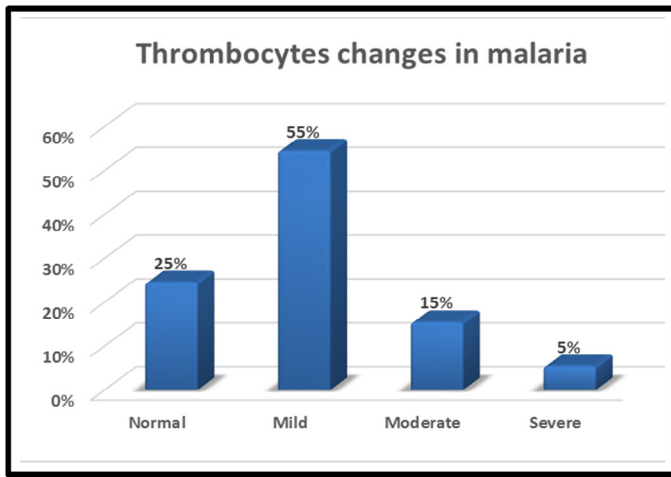


Figure 2: Thrombocytes changes in malarial patients.

As presented in Figure 2 that, 75.45% patients had thrombocytopenia, and only 24.54% had normal platelets. Thrombocytopenia is a well-known characteristic of severe malaria in (5.45%) of cases had showed severe thrombocytopenia, compared to the majority (54.54%) of the cases had mild thrombocytopenia although moderate thrombocytopenia was reported in (15.45%) patients. Layla A.M. in his findings demonstrated that 430 individuals (59.2%) had anaemia while thrombocytopenia was present in over half (55.6%) of the individuals (Bashawri *et al.*, 2002; Basu and Sahi, 2017).

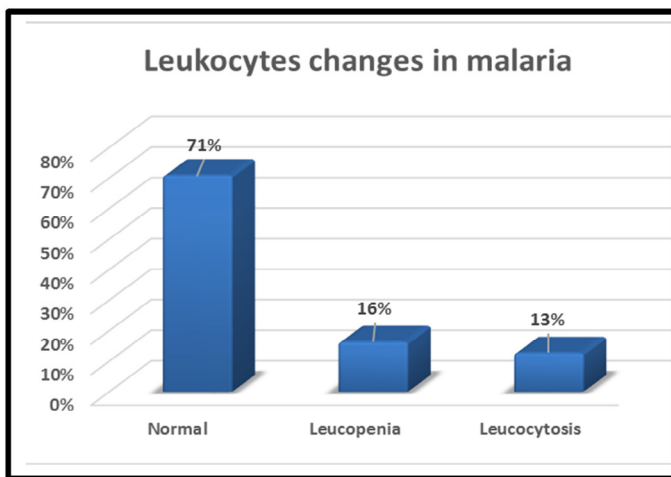


Figure 3: Leukocytes changes in malarial patients.

Figure 3 indicates that in 71% of the cases, the WBC count was normal while 16% showed a decrease of leucopenia and 13% showed an increase of leucocytosis. Akbar *et al.* (2016) in his study detected that Leukocytosis was noticed in just 0.9% of patients, mild leucopenia in 20.9%, and severe leucopenia in 1.7% of cases (Akbar *et al.*, 2016; Varo *et al.*, 2020). Nutan Agrawal examined that anaemia affected 94% of patients, thrombocytopenia affected 85% of cases,

and leucopenia affected 27% of cases (Agrawal *et al.*, 2015). A similar study was conducted by Hussain Haroon in Pakistan they noticed thrombocytopenia in 87% of patients while in the 71% of the cases anaemia was perceived (Haroon *et al.*, 2013; Kokwaro, 2009).

Conclusions and Recommendations

Malaria rate is greater in overall Sindh province after the monsoon season. This study can be concluded as the malaria is a public health problem in Hyderabad region in which majority of the patients had *Plasmodium vivax* infections (76.36%) while *Plasmodium falciparum* being the second most common type of malaria was noticed. Our findings show that children frequency rate was greater in contrast to other age groups. Childhood malaria infection is more common than adult malaria infection because immunity to malaria parasite infection grows with each exposure. Males had a higher prevalence of malaria species (56.36%) than females (43.63%). There was a substantial effect of malarial parasite on blood cells parameter and this includes that the most common variants are thrombocytopenia and anaemia.

Acknowledgements

Authors are thankful to Civil Hospital Hyderabad. They allowed to collect data.

Novelty Statement

This work is not previously studied hence the work is novel and would be beneficial for health.

Author's Contribution

Zarina Chang: Performed lab work, wrote paper.
 Dr. Nadir Ali Birmani: Supervised the work.
 Dr. Adil Hassan Chang: Allow to collect data from civil hospital.
 Dr. Laraib Jamali: Helped to conclude data.
 Noreena Chang: Helped to recheck manuscript.
 Dr. Fouzia Chang: Finalized manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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