

Original Research Article

Clinico-hematological study of urban malaria in patients attending a tertiary care center in India

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Received: 11 April 2025

Revised: 07 June 2025

Accepted: 08 June 2025

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ABSTRACT

Background: Malaria is a life-threatening disease, and it accounts for 7.8% of deaths in children globally. Changes in the hematological parameters are also believed to serve as supporting evidence in the suspicion of malaria during diagnosis. When combined with microscopy, a hematological profile will allow for quick diagnosis, efficient treatment, and prevention of subsequent issues. The aim was to evaluate malaria parasitemia and its relationship with clinico-hematological parameters in urban patients.

Methods: An observational retrospective study of 78 cases of malaria in urban population were studied from the medical records of 3 years collected from a tertiary care centre in Visakhapatnam, after getting IHEC approval. All the patients admitted with diagnosed malaria were included, and their comprehensive clinical, demographic, and haematological data were noted.

Results: In the 78 patients, 53.8% showed *Plasmodium falciparum* infection, 35.9% showed *vivax* and 10.3% had mixed infection. Anemia was seen in 57 subjects (73.1%), and severe anemia was noted in 17 cases. Thrombocytopenia was observed in 57.7% of them, and raised PT was seen in 65.4% cases. MCV and MCHC values were decreased in 32, and 36 subjects, whereas leukocytosis was seen in 27 cases. *Falciparum* malaria was significantly associated with thrombocytopenia, leukocytosis, and severe anemia in our study.

Conclusions: *Plasmodium falciparum* malaria is a serious threat and has shown significant hematological alterations. To identify the complications early and to provide appropriate treatment, it is essential to understand the hematologic and biochemical alterations.

Keywords: Anemia, *Falciparum*, Hematological, Malaria, Thrombocytopenia, Urban

INTRODUCTION

Malaria remains a major global health concern, with transmission occurring in 91 countries. About 216 million cases were reported in 2016, resulting in 446,000 fatalities. Due to vector pesticide and parasite medication resistance, recurrence is difficult despite intensive control methods. Although *Plasmodium falciparum* is the

deadliest species, severe infections are also caused by *P. vivax*, *P. malariae*, and *P. ovale*. Immunocompromised people, pregnant women, and newborns are among the vulnerable groups most at risk for complex *falciparum* malaria.¹

To enhance the diagnosis of malaria, a number of diagnostic techniques have been developed, including

conventional peripheral blood smear examination and sophisticated molecular technologies like PCR, flow cytometry, and mass spectrometry. Notwithstanding these developments, the illness is still common in underdeveloped countries like India, where socioeconomic and geographic constraints make it difficult to effectively control it. Because of the rise in migrant populations and building activity, *P. vivax* is especially dangerous in metropolitan settings, where severe cases are becoming more frequent.²

Malaria has a substantial effect on hematopoiesis, changing blood parameters as red blood cell indices, white blood cell counts, and platelet counts. Particularly in environments with limited resources, these hematological alterations can help with the early suspicion and diagnosis of malaria. These differences are influenced by variables like immunity, dietary state, hemoglobinopathies, and endemicity. Research has indicated that the integration of hematological profiling and microscopy improves the precision of diagnosis and enables prompt intervention.³

Modern molecular and serological diagnostic techniques have better sensitivity and specificity, but their high cost and infrastructural needs prevent them from being widely used in underdeveloped areas. In these situations, easily available diagnostic techniques, such as complete blood counts, in conjunction with microscopy, offer a successful way to identify malaria and start treatment right away.⁴ In the continuous fight against malaria, bolstering the healthcare system and guaranteeing access to reasonably priced diagnostic equipment are still essential. This study was conducted with an aim to evaluate the prevalence and pattern of malaria parasitemia and assess its association with clinical manifestations and hematological parameters among urban patients.

METHODS

This was a cross-sectional observational study, conducted during a period of three months from August 2024 to October 2024. Malaria cases among urban Visakhapatnam residents were the subject of this retrospective clinical observational study. The medical records of patients who were released following a peripheral blood smear or dipstick test diagnosis of malaria were examined. Information about the age, sex, clinical presentation, investigations, and results of the patients was gathered. The sample size was estimated using the formula, $n=4pq/d^2$, and based on that, the sample size came to be 71, and adding 10% non-response rate, the total sample size came to be 78.

The inclusion criteria for this study were all urban residents of Visakhapatnam who were diagnosed with malaria using peripheral blood smear or dipstick tests and had complete medical records available for review. Exclusion criteria included individuals with known hematological disorders, chronic liver disease, chronic

kidney disease, or chronic neurological conditions, as these could confound the hematological parameters under investigation. The following hematological parameters were examined for eligible patients: hematocrit (HCT), mean cell volume (MCV), mean cell hemoglobin (MCH), mean cell hemoglobin concentration (MCHC), platelet count (PC), total white blood cell count (TWBC), differential WBC count, red blood cell count (RBC), and hemoglobin level (Hb%).

Hemoglobin values <13 gm/dl in males and <12 gm/dl in females were considered anemic, according WHO criteria. Thrombocytopenia was defined as platelet count <150,000/mm³, leukopenia as WBC count <4000/mm³, and leukocytosis as WBC count >11000/mm³. All urban inhabitants with malaria diagnosed by peripheral smear and dipstick methods satisfied the inclusion criteria; individuals with known hematological disorders, chronic liver illnesses, chronic kidney diseases, or chronic neurological disorders were not. The National Vector Borne Disease Control Programme (NVBDCP) recommendations were adhered to during treatment.

Microsoft Excel was used for data entry, and SPSS software version 20 was used for statistical analysis. We used descriptive statistics like frequency, mean, standard deviation, and percentage. Associations were evaluated using inferential statistical tests, such as the t-test and chi-square test, with a p value of less than 0.05 regarded as statistically significant.

RESULTS

The present study observed that out of the 78 malaria patients, 42 had *falciparum* malaria, 28 had *vivax* infection, and 8 subjects had mixed infection. The study has a mean age of 19.6 years with a standard deviation of 12.04 years. The mean age for those with mixed infections was 14.7 years, showing high prevalence of mixed malaria in younger age groups, and *vivax* in higher age groups (mean=23.8 years). This association was slightly significant ($p=0.05$) (Table 1).

Table 1: Baseline frequencies of variables in the study.

Variables	Frequency	Percentage
Gender		
Male	36	46.2
Female	42	53.8
Plasmodium species		
<i>Falciparum</i>	42	53.8
<i>Vivax</i>	28	35.9
<i>Mixed</i>	8	10.3
Organomegaly		
Hepatomegaly	15	19.2
Splenomegaly	7	9.0
Both	13	16.7
None	43	55.1

Table 2: Positivity rate of different tests and their combinations.

	Frequency	Percentage
No anemia	21	26.9
Anemia	57	73.1
TCP	33	42.3
No TCP	45	57.7
Increased PT	27	34.6
Normal PT	51	65.4
Decreased PCV	40	51.3
Normal PCV	38	48.7
Normal MCV	29	37.2
Decreased MCV	37	47.4
Increased MCV	12	15.4
Elevated ESR	54	69.2
Normal ESR	24	30.8
Normal MCHC	30	38.5
Decreased MCHC	36	46.2
Increased MCHC	12	15.4
Leukocytosis	27	34.6
No leukocytosis	51	65.4
Leukopenia	16	20.5
No leukopenia	62	79.5

Table 3: Gender and complications in different species of malaria.

	<i>Falciparum</i> (n=42)	<i>Vivax</i> (n=28)	Mixed (n=8)	P value
Gender				
Male	19	13	4	0.969
Female	23	15	4	
Organ involvement				
Hepatomegaly	11	4	0	0.061
Splenomegaly	4	2	1	
Both	7	2	4	
None	21	20	2	

Table 4: Hematological parameters in different plasmodium species.

	<i>Falciparum</i> (n=42)	<i>Vivax</i> (n=28)	Mixed (n=8)	P value
Hematological Parameters				
Anemia (n=57)	36	13	8	0.001*
Thrombocytopenia (n=33)	17	11	5	0.041*
Leucopenia (n=16)	10	3	3	0.062
Leukocytosis (n=27)	14	11	2	0.094
Increased PT (n=27)	15	8	4	0.001*
Elevated ESR (n=54)	37	12	5	0.532
Decreased PCV (n=40)	28	10	2	0.001*
Increased MCV (n=12)	5	6	1	0.221
Decreased MCV (n=37)	17	13	7	0.024*
Increased MCHC (n=12)	6	5	1	0.216
Decreased MCHC (n=36)	16	14	6	0.036*

*Statistically significant

In this slight female predominant study, organomegaly was noticed in 35 out of 78 cases, where in both

hepatomegaly and splenomegaly were seen in 16.7% of them. Anemia is the biggest hematological abnormality

noticed in this study with a prevalence of 73.1%, and also thrombocytopenia was seen in 42.3% of the cases. The other hematological abnormalities were seen at different levels, which could be due to the fact that patients appear at various stages of the parasitemia, which could have affected the abnormality more (Table 2).

The present study has observed that, *falciparum* malaria has shown significant hematological abnormalities followed by those with mixed infections than in *vivax* infections. The most common, anemia and thrombocytopenia was seen in significantly higher proportions in all types of malaria, with a preponderance seen in mixed infections (100%), and then in *falciparum* infections (36 out of 42 cases) (Table 3).

Decreased PCV, MCV and MCHC values were also seen more in *falciparum* cases rather than in *vivax* cases, which was found to be significant in our study. Leukopenia was seen in more *falciparum* cases (23.2%), but leukocytosis was seen in more *vivax* cases (39.2%) (Table 4).

DISCUSSION

In this cross-sectional study conducted among 78 malaria patients in urban Visakhapatnam, we observed a higher prevalence of *Plasmodium falciparum* (53.8%) compared to *P. vivax* (35.9%) and mixed infections (10.3%). This contrasts with a 2019 study by Sharma et al, where *P. vivax* was overwhelmingly dominant (98.3%) and no mixed infections were reported.⁵ Our study population had a mean age of 19.6 years, with a younger average age in mixed infections (14.7 years), suggesting greater vulnerability in children. This is consistent with studies by Gupta et al and Singh et al, who also reported a higher incidence of malaria in younger age groups in India.^{6,7} Being a retrospective cross-sectional study, it relied on medical records, which might be incomplete or inconsistently documented, introducing information bias.

A slight female preponderance was noted in our study, which is uncommon compared to most literature, where males show higher infection rates due to occupational exposure.⁸ This difference might relate to equal healthcare access or local sociocultural factors. Organomegaly, particularly hepatosplenomegaly (16.7%), was observed in 35 of the 78 patients. This finding aligns with Khuraiya et al, who reported frequent organ enlargement, especially in *falciparum* infections, possibly due to parasite sequestration and immune hyperactivity.⁹ The relatively small sample size (n=78) limits the generalizability and statistical power. Malaria diagnosis was based on microscopy and dipstick tests without PCR confirmation, potentially missing low-parasitemia or mixed infections.

Anemia (73.1%) was the most prevalent hematological abnormality. It was most striking in mixed infections (100%) and *falciparum* cases (85.7%). Verma et al

reported anemia in 54.3% of *P. vivax* and 50% of *P. falciparum* cases, while 41.6% was seen in mixed infections.¹⁰ Muwonge et al emphasized red cell changes even in uncomplicated malaria.¹¹ The high anemia rate in our cohort may result from hemolysis, bone marrow suppression, and inflammatory cytokines such as TNF- α suppressing erythropoiesis.¹²

Thrombocytopenia (42.3%) was another significant finding, in line with Kochar et al, who noted its prevalence in both *falciparum* and *vivax* malaria.¹³ The proposed mechanisms include immune-mediated platelet destruction, splenic sequestration, and endothelial activation. Regarding red blood cell indices, our study found that decreased PCV, MCV, and MCHC values were significantly associated with *falciparum* cases, consistent with findings by Muwonge et al.¹¹ The more marked changes in *falciparum* infections likely reflect greater hemolysis and higher parasitic burden compared to *vivax* infections.

In terms of white blood cell abnormalities, leukopenia was more common in *falciparum* (23.2%), whereas leukocytosis predominated in *vivax* (39.2%). This contrasts with Srivastava et al, who found leukopenia (21.6%) more common than leukocytosis (2.5%).¹⁴ Such variations may result from differing immune responses, co-infections, or the timing of patient presentation across populations. The study has certain limitations. It did not account for confounding factors such as nutritional status, co-existing infections, or chronic illnesses that could influence hematological findings. Lastly, follow-up data were not available to assess disease progression or treatment response.

CONCLUSION

It was understood from our hospital-based study, that in urban areas of Bathinda, *falciparum* cases were mostly prevalent, but as per our assumption, it is due to the fact that they cause complicated malaria, which compels them to attend hospitals. Most of these cases were presented with anemia and thrombocytopenia, especially in mixed infections, and therefore, in all cases of fever with anemia and thrombocytopenia, a malarial diagnostic test should be done. The clinic-hematological profile in malaria patients need to be studied at the community level too, to understand the pathogenesis in different forms of malaria at different stages.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Mukkamala SB, Priyanka ALN, Sivanand ALS, Vardhan YV. Clinico-hematological study of urban malaria in patients attending a tertiary care center in India. *Int J Community Med Public Health* 2025;12:3138-42.