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# A hospital-based study to compare the clinical profile of *P. falciparum*, *P. vivax* and mixed infections of malaria: Retrospective study

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**Abstract**
**Aim:** The objective of this study was to compare the clinical profile of *P. falciparum*, *P. vivax* and mixed infections of malaria.
**Methods:** This retrospective observational study included malaria patients who were admitted to a tertiary care teaching hospital. Inpatient retrieved and scrutinized on the basis of the patient's demographic profile, clinical findings, investigations, treatment, and complications during this 12- month period. The institutional ethical committee approved the study. A total of 100 subjects were included.
**Results:** The study included a total of 60 cases of *P. vivax* and 40 cases of *P. falciparum*. The cases of *P. vivax* included 45 men and 15 females, while the cases of *P. falciparum* were 18 males and 22 females. Fever was the predominant manifestation in all 100 individuals, regardless of whether they were infected with falciparum or vivax. Subsequently, 80 individuals had chills and rigours, with 45 of them having falciparum infection and 35 of them infected with vivax. Among the total patients, 70% reported experiencing nausea and vomiting, with a higher prevalence identified in those with falciparum malaria (40%) compared to those with vivax malaria (30%). Another less prevalent symptom was easy fatiguability, which was reported in 30 individuals, whereas cough was evident in 20 patients. These signs were more often found in falciparum malaria compared to vivax malaria. Altered consciousness was only found in 12 individuals with falciparum malaria. Patients with mixed infection had a wide range of symptoms including fever accompanied by chills and rigours, excessive fatigue, vomiting, coughing, and changes in mental alertness. The bivariate analysis of the clinical characteristics and consequences of *P. vivax* and *P. falciparum* malaria did not reveal any statistically significant difference.
**Conclusion:** This study finding indicate that *P. vivax* mono infection has a comparable progression and consequences to malaria caused by *P. falciparum* mono infection.

**Keywords:** *P. falciparum*, *P. vivax*, mixed infections of malaria

## Introduction
Malaria is a prevalent worldwide infectious illness caused by parasitic protozoans belonging to the genus Plasmodium. Human infections predominantly include five Plasmodium species: Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae, and Plasmodium knowlesi [1]. Malaria was a highly feared illness throughout the 20th century. Thanks to the endeavours of public health organizations and the accessibility of artemisinin derivatives, the incidence and death rate related to malaria have declined, instilling optimism that malaria would be eliminated from our nation in the next decades. Although there have been recent decreases in the total number of malaria cases, malaria nevertheless continues to be a significant contributor to illness and death. The disease is responsible for an estimated 300-500 million instances of illness worldwide and adds to over 3 million deaths per year [2].
Infection with *P. falciparum* is linked to serious consequences and death. In 2017, the World Health Organization (WHO) estimated that there were 7.5 million cases of *P. vivax* worldwide. *P. vivax* is the most widespread form of malaria in Southeast Asia. The prevalence of *P. vivax* is a significant issue in urban areas due to the escalation of building and developmental projects, as well as the growing number of migrant workers in Indian cities.

Previously classified as harmless, there is a growing number of reports of severe symptoms occurring in cases with vivax malaria worldwide [4, 5].

India is a region where both Plasmodium falciparum and Plasmodium vivax are commonly found. This presents difficulties in controlling and eliminating malaria because these two species of parasites may have different mosquito vectors, spatial distributions, and transmission patterns. Additionally, *P. vivax* infection is characterized by a dormant stage in the liver, which can cause recurring episodes of illness [6, 8]. In India, *P. falciparum* is responsible for over 66% of malaria infections, whereas *P. vivax* causes roughly 34% of the cases [9]. Nevertheless, the distribution of malaria cases varies proportionally across India, and a diverse array of clinical manifestations may be seen from both prevalent malaria species [6]. Unlike Africa, malaria transmission in India is less widespread. Both adolescents and adults are susceptible to severe malaria, and a significant number of cases are caused by *P. vivax*, which is often less severe than the more virulent *P. falciparum*.

The aim of this research was to assess and evaluate the clinical characteristics of *P. falciparum*, *P. vivax*, and mixed infections of malaria.

## Materials and Methods

This is a retrospective observational study which included malaria patients who were admitted to a tertiary care teaching hospital. Inpatient retrieved and scrutinized on the basis of the patient's demographic profile, clinical findings, investigations, treatment, and complications during this 12-month period in the year 2023. The institutional ethical committee approved the study. A total of 100 subjects were included.

### Inclusion Criteria

All slide positive and rapid diagnostic tests (RDT) that confirmed cases of malaria (*P. vivax* and *P. falciparum*) admitted and treated were included.

### Exclusion Criteria

These criteria included (1) patients presented with fever (smear negative for *P. vivax* and P. falci- parum malaria) but treated empirically for malaria, (2) mixed infection of PF and PV malaria, and (3) patients presented with clinical features mimicking malaria like dengue fever, sepsis, meningitis were excluded from this study. We also excluded the newborn babies and those patients who died during resuscitation within the first hour in an emergency department before hospital admission formalities were complete.

### Methodology

The identification and verification of *P. falciparum* and *P. vivax* malaria species were determined by the inspection of thick and thin blood smears taken from the periphery of the blood sample. This examination was conducted using oil immersion and giemsa stain, as well as Rapid Diagnostic Tests (RDT) [10]. The RDTs used the identification of Plasmodium spp. lactate dehydrogenase (OptiMal test, Diamed AG, Cressier sur Morat, Switzerland) and histidine-rich protein 2 (Falcivax test; Zephyr Biomedical Systems, Goa, India) for detection. The classification of severe complex malaria was determined according to the rules set by the World Health Organization. This study included cases of severe complicated malaria, specifically cerebral malaria, severe anaemia (haemoglobin< 5 mg/dL), thrombocytopenia (platelet count < 1 lac/cumm), pancytopenia, jaundice (bilirubin > 3 mg/dL), acute renal failure (serum creatinine > 3 mg/dL), gastrointestinal tract dysfunction, acute respiratory distress syndrome, and multiorgan dysfunction. The assessment of consciousness level was conducted using the modified Glasgow Coma Scale for patients under the age of 9 months, and the Glasgow Coma Scale for children above the age of 9 months. Standard laboratory tests, such as a comprehensive blood cell count, evaluation of a blood sample under a microscope, analysis of blood indices, and measurement of platelet count, were promptly conducted upon admission of all patients. Urine analysis, liver and kidney function tests, blood clotting profile, investigation of cerebrospinal fluid, chest X-ray, and blood culture were performed as necessary. The criteria for identifying difficult and severe malaria were derived from the 2010 [11]. WHO recommendations for malaria therapy. Anaemia was defined in this research as a haemoglobin (Hb) level of ≤9 gm %. Elevated alanine aminotransaminase (ALT) was defined as ALT levels above 3 times the upper limit of normal.

### Statistical analysis

The statistical analyses were conducted using the social package for statistical science (SPSS) version 16. The data from both groups were compared using either the Fisher or chi-square test, depending on the specific research parameter. The study also provided the confidence interval and odds ratio for both groups.

## Results

**Table 1:** Baseline characteristics of patients

| Baseline characteristics | *P. vivax*(n = 60) | *P. falciparum*(n=40) | Allpatients (n=100) |
|---|---|---|---|
| Gender (Male/Female) | 45/15 | 18/22 | 63/37 |
| Duration of fever (days, mean SD) | 6.4(4.02) | 5.5 (2.8) | 5.6(3.7) |
| Length of hospital stay (days, mean SD) | 4.6(2.48) | 5.0(3.2) | 4.6(2.8) |
| Hemoglobin (gm %, mean SD) | 11.45(8.32) | 11.80(9.31) | 11.72(9.41) |

A total of 100 subjects were included in the study. It consisted of 60 *P. vivax* and 40 *P. falciparum* cases. The *P. vivax* cases consisted of 45 males and 15 females while *P. falciparum* cases consisted of 18 males and 22 females

**Table 2:** Clinical symptoms among the patients participated in this study

| Symptom | *P. falciparum* | *P. vivax* | Total |
|---|---|---|---|
| Fever | 60 | 40 | 100 |

| | | | |
|---|---|---|---|
| Chills and rigors | 45 | 35 | 80 |
| Easy fatigability | 25 | 15 | 40 |
| Nausea, vomiting | 40 | 30 | 70 |
| Cough | 12 | 8 | 20 |
| Altered sensorium | 12 | 0 | 12 |

Fever was the most common presentation in all 100 patients both falciparum and vivax infected patients. This was followed by chills and rigors were present in 80 patients, 45 of patients with falciparum and 35 of the patients infected with vivax. Nausea and vomiting were the another common complaint was observed in 70 of total patients, more in falciparum 40 than vivax 30. Other less common symptom were, easy fatigability observed in 30 patients and cough was present in 20 patients. All these manifestations were most commonly observed in falciparum than vivax. Altered sensorium was observed only in falciparum 12 patients. Patients who had mixed infection presented with almost all symptoms like fever with chills and rigors, easy fatigability, vomiting, cough and altered sensorium.

**Table 3:** Comparison of various parameters between *P. vivax* and *P. falciparum* malaria at initial presentation

| Parameters | *P. vivax* | *P. falciparumn* | Odds ratio | 95%CI | *P* value |
|---|---|---|---|---|---|
| Anemia | 18 | 16 | 0.64 | 0.26–1.77 | 0.24 |
| Splenomegaly | 26 | 20 | 0.80 | 0.32–2.01 | 0.36 |
| Thrombocytopenia | 21 | 14 | 0.96 | 0.36–2.44 | 0.29 |
| Raised ALT | 6 | 2 | 1.79 | 0.32–13.96 | 0.95 |
| Jaundice | 4 | 3 | 0.69 | 0.10–4.09 | 0.68 |
| Renalfailure | 2 | 1 | 0.65 | 0.01–27.1 | 0.45 |
| ARDS | 3 | 1 | 1.32 | 0.10–41.88 | 0.49 |
| Cerebralmalaria | 1 | 1 | 0.67 | 0.6–6.73 | 0.36 |

Bivariate relationship between clinical features and complications of *P. vivax* and *P. falciparum* malaria showed no statistically significant difference

## Discussion

UNICEF reports that one kid dies from malaria every 30 seconds [12]. One of the major issues in our nation is the lack of control over diseases in places where they are prevalent, as well as the movement of people and the severe complications resulting from the diseases themselves. Intensive measures have been primarily adopted against *P. falciparum* malaria because to its association with more severe illness, higher fatality rates, and increased morbidity. *P. vivax* malaria has been overlooked and erroneously regarded as "benign" [13]. However, there is little evidence from research conducted in Asian nations over the last decade to suggest that *P. vivax* is capable of causing serious illness [14, 16]. These results may be attributed to numerous significant biological distinctions, such as the presence of latent stage (hypnozoites) in the liver, which leads to relapse, and the higher transmission capacity of *P. vivax* at low parasite numbers. *P. vivax* is the predominant and widely distributed species of Plasmodium that causes malaria in humans.

The study included a total of 100 patients. The dataset included of 60 cases of *P. vivax* and 40 instances of *P. falciparum*. The cases of *P. vivax* included 45 men and 15 females, while the cases of *P. falciparum* were 18 males and 22 females. The investigations conducted by Yadav RK *et al* [17] and Surve KM *et al* [18] reported a male to female ratio of 1.32:1, indicating comparable rates. Fever was the predominant manifestation in all 100 individuals, regardless of whether they were infected with falciparum or vivax. Subsequently, 80 individuals had chills and rigours, with 45 of them having falciparum and 35 of them infected with vivax. Another prevalent symptom reported in 70% of the patients was nausea and vomiting, with a higher incidence in falciparum malaria (40%) compared to vivax malaria (30%). Additionally, 30 patients had the less prevalent symptom of easy fatigability, whereas 20 individuals experienced cough. The aforementioned signs were more often found in cases of falciparum malaria compared to vivax malaria. Altered consciousness was only found in 12 individuals with falciparum malaria. Patients with mixed infection had a wide range of symptoms including fever accompanied by chills and rigours, excessive fatigue, vomiting, coughing, and changes in mental alertness. Khuraiya P *et al*, Patel G *et al*, and Anshika Jain *et al* all reported identical findings, with fever being the primary symptom and present in 100% of the patients in their respective studies [19, 21].In the research conducted by Rathod SN *et al*., it was shown that fever was present in 95.1% of the patients [22]. In a separate research conducted by Surve KM *et al*, it was shown that fever was present in 99% of the patients [18]. However, the primary grievance reported in all research groups is just fever. In addition to fever, chills and rigours are often seen symptoms in the majority of research.

The bivariate analysis of the clinical characteristics and consequences of *P. vivax* and *P. falciparum* malaria did not reveal any statistically significant difference. Construction sites in India are often identified as possible locations for the spread of severe *P. falciparum*, particularly in regions with low incidence and very affluent places like Goa [23, 24]. Construction workers, who reside and work in these locations and often originate from the eastern and northeastern regions of India, constituted about half of the malaria-positive individuals in the research conducted at GMC. Interestingly, they were equally susceptible to being infected with either *P. vivax* or *P. falciparum*. These results might impact the traditional knowledge of risk factors and the foundation of focused control actions at and near building sites in the low transmission state of Goa. A future analysis will be conducted to assess the potential impact of pre-existing immunity to *P. falciparum* and *P. vivax* on transmission in Goa. The inquiry will examine the effects of age, gender, origin, and employment.

## Conclusion

In comparison to malaria caused by *P. falciparum* mono infection, we came to the conclusion that *P. vivax* mono

infection tends to have a course and consequences that are comparable to those of each other.

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