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Research Article

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Prevalence of Clinical Features of Malaria and its Distribution of Corresponding Vectors in Kolkata Region

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ABSTRACT

Background: Malaria, caused by protozoa of the genus *Plasmodium*, remains a significant public health concern, especially in subtropical and tropical regions. Kolkata, in particular, has seen a high prevalence of malaria, with *Plasmodium falciparum* and *Plasmodium vivax* being the primary species. This study investigates the clinical features and vector distribution of malaria in the Kolkata region. The aim is to evaluate the clinical features of malaria and corresponding vectors in the Kolkata region.

Methods: This retrospective study, conducted from November 2023 to March 2024, analyzed data from patients diagnosed with malaria over the past three years in Kolkata. Data were collected from hospital records, including blood reports, microscopy results, and patient histories. Patients were surveyed using a structured questionnaire to gather socio-economic and anthropometric data. Statistical analysis was performed using SPSS 27, with significance set at $p<0.05$.

Results: The study included 103 falciparum and 97 *vivax* malaria patients. No significant differences were found in demographic and socio-economic characteristics between the groups. Severe disease was more common in falciparum malaria (82.5% vs. 33.0%, p=0.042). Hypoglycemia was significantly higher in falciparum patients (59.2% vs. 8.2%, p=0.044), while splenomegaly was more prevalent in *vivax* patients (43.3% vs. 15.5%, p=0.0455). No significant differences were observed for relapses, cerebral malaria, or renal failure.

Conclusion: The study concludes that falciparum malaria typically presents with continuous fever and greater severity, including higher incidences of hypoglycemia, whereas *vivax* malaria is associated with recurrent fever and splenomegaly. Thus, alongside standard regimens, symptomatic treatment tailored to the specific type of malaria is necessary.

Key-words: Malaria, *Plasmodium falciparum*, *Plasmodium vivax*, Clinical features, Kolkata

INTRODUCTION

Malaria has been a prevalent illness among humans for millennia. It is mentioned in many biblical verses and the works of Hippocrates. Malaria is caused by protozoa belonging to the genus Plasmodium. Four species of *Plasmodium* cause sickness in humans: *P. falciparum, P. vivax*, *P. malariae*, and *P. ovale* [1,2]. Transmission of Malaria to humans is by the bite of female Anopheles mosquitoes. Every species exhibits distinct clinical signs.

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P. falciparum is recognized for causing the most severe clinical signs, including brain malaria as a significant consequence [2].

Malaria is prevalent in subtropical and tropical regions, with 247 million infections globally in 2006. Approximately 3.3 billion people were at risk, resulting in almost a million deaths, with 89% of fatalities that occur in children below 5 years of age in sub-Saharan Africa. Malaria's impact in Southeast Asia has been underestimated [2,3]. Even though current evidence shows that the region accounts for about 41% of malaria cases worldwide. India accounts for 77.2% of the total cases of malaria in Southeast Asia, and over 95.5% of the people at moderate to high risk of malaria in the SEA Region of India [3].

While *P. vivax* is commonly considered harmless, clinicians in places where it is prevalent are increasingly

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acknowledging its tendency to reoccur, leading to significant illness, especially in young children [4,5]. The abundance and distribution of malaria vectors play an important role in determining the transmission and frequency of the disease. In Kolkata, Anopheles Stephensi is the primary carrier of malaria, while Aedes aegypti is the primary carrier of dengue. The malaria situation in Kolkata has greatly improved over the past decade due to the meticulous supervision of the authorities from the Kolkata Municipal Corporation (KMC). Malaria has emerged as a significant public health concern in India, with the country's malaria cases playing a significant role in the total malaria burden in Southeast Asia. India's eastern and central regions have experienced the greatest incidence of malaria cases. 10 states have accounted for more than 80.2% of the nation's overall malaria cases. In 2014 and 2018, West Bengal documented approximately 26,000 and 25,000 instances of malaria, respectively. Kolkata has the highest prevalence of malaria in the West Bengal district [6].

Clinical features- Fever is the most distinctive symptom of malaria. Additional typical symptoms consist of chills, myalgias, headache, vomiting, and nausea. Diarrhea, pain in the stomach, and cough are sometimes observed. As the parasitic infection advances, some individuals may experience the classic malaria paroxysm, which is marked by periods of illness alternating with symptom-free periods [7]. The paroxysm of malaria consists of three successive stages. The first phase often lasts between fifteen and sixty minutes and is seen as shivers and a feeling of coldness. The 2 to 6-hour hot phase is marked by fever, possibly exceeding 41°C, dry and flushed skin, and symptoms such as vomiting, headache, and nausea. Following is the sweating stage for 2-to-4 hours, during which the fever decreases rapidly, and the person sweats. The recurrent fever in all types of malaria is caused by the rupture of fully developed schizonts [8].

P. ovale and *P. vivax* malaria have a 48-hour cycle where a group of schizonts develops, causing a fever to reoccur every two days. Fever in *P. malariae* infection recurs every 72 hours, known as quartan malaria. In falciparum malaria, for every 48 hours there is an increase in fever but typically lacks a clear pattern of recurrence. Classic patterns of fever are typically not observed in the early stages of malaria; therefore, the lack of regular, synchronized fevers does not exclude the possibility of detection of malaria [9].

Physical manifestations of malaria are not distinctive and provide minimal assistance in diagnosing the disease. In numerous instances, there can be no favorable results save for fever. Splenomegaly is frequent but cannot be noticeable in the initial stages of the disease. Jaundice, hepatomegaly, hypotension, and pain in the abdomen may also be observed. Malaria is not accompanied by a rash or lymphadenopathy [10].

Complications of malaria arise from hemolytic anemia and blockage of small blood vessels leading to tissue ischemia. Severe or complicated malaria is characterized by symptoms such as acidosis, respiratory distress, increased aminotransferases, hypoglycemia, high parasitemia, and severe anemia [11].

MATERIALS AND METHODS

Research Design- This study is designed as a retrospective analysis of clinical data to evaluate the prevalence of clinical features of malaria and the distribution of its corresponding vectors in the Kolkata region. The study was conducted in Kolkata from Nov 2023 to Mar 2024. The population under consideration includes patients, who were diagnosed with malaria in the past three years at major hospitals in Kolkata.

Data Collection and Procedure- Data was collected from hospital records for patients with a confirmed diagnosis of malaria over the last three years. This includes detailed blood reports, microscopy results, records of physical examinations and patient history (personal, family, travel). Patients identified through hospital records were then contacted and invited to participate in a structured questionnaire survey. The survey collected socio-economic factors (education, family income), anthropometric data, awareness and knowledge about malaria and its prevention and attitudes towards hygiene. The study compared the demographic features, socio-economic parameters and clinical features including fever patterns between *vivax* and *falciparum* malaria.

Inclusion Criteria

- Patients of all ages with a confirmed diagnosis of malaria (*P. vivax* or *P. falciparum*) in the past three years.

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- Availability of complete medical records including blood reports, microscopy results, and physical examination records.
- Patients (or guardians, in the case of minors), who provide informed consent to participate in the questionnaire survey.

Exclusion Criteria

- Patients diagnosed with malaria outside the specified three-year timeframe.
- Incomplete medical records that do not provide essential data for analysis.
- Patients (or guardians), who do not consent to participate in the questionnaire survey.
- Patients diagnosed with malaria have underlying chronic conditions that could confound the results, such as HIV/AIDS or tuberculosis.

Statistical Analysis- The study used SPSS 27 for effective analysis. The continuous data were expressed in mean values and their standard deviation while the discrete data were expressed in frequencies and the corresponding percentage. The ANOVA was conducted to analyze the clinical features between patient's *vivax* malaria and falciparum malaria. The discrete value was analyzed with Chi-square while continuous data of demographic characteristics were analyzed using ANOVA. The level of significance was considered to be $p<0.05$.

Ethical Approval- The study was approved by the Ethical Committee of the hospital.

RESULTS

The demographic and socio-economic characteristics of patients infected with either falciparum or *vivax* malaria are summarized in Table 1. For gender distribution, there were 49 males and 54 females in the *falciparum* group, compared to 51 males and 46 females in the *vivax* group. The p-values for males (0.65) and females (0.85) indicate no significant difference in gender distribution between the two groups. The average age of patients was 31.16±15.03 years in the *falciparum* group and 31.8±15.9 years in the *vivax* group, with a p-value of 0.77, suggesting no significant age difference between the groups. Family demographics were similar between the two groups. The average number of family members was 7.68±2.25 for the *falciparum* group and 7.77±2.26 for the *vivax* group (p-value=0.75). Similarly, the average number of children per family was 5.68±2.25 for falciparum patients and 5.77±2.26 for *vivax* patients, with a p-value of 0.94, indicating no significant difference.

The socio-economic status, measured by annual family income on a scale of 1 to 5, was 2.93±0.83 for the *falciparum* group and 3.17±0.77 for the *vivax* group, with a p-value of 0.74, showing no significant difference in income levels. The study found that there were self-employed (38 *falciparum*, 34 *vivax*), salaried laborers (28 *falciparum*, 14 *vivax*), laborers (15 *falciparum*, 18 *vivax*), salaried service (11 *falciparum*, 17 *vivax*), and farmers (11 *falciparum*, 14 *vivax*). The p-value of 0.69 indicates no significant difference in the occupation distribution between the groups.

The main sources of drinking water were government supplies (35 *falciparum*, 24 *vivax*), ponds (27 *falciparum*, 25 *vivax*), self-owned pumps (21 *falciparum*, 26 *vivax*), and tube wells (20 *falciparum*, 22 *vivax*). The p-value of 0.655 shows no significant difference in the primary drinking water sources between the two groups.

Table 1: Demographic and Socio-economic characteristics of the patients in each group

Characteristics	*Falciparum* (n=103)	*vivax* (n=97)	p-value
Sex			
Male	49	51	0.65
Female	54	46	0.85
Age	31.16±15.03	31.8±15.9	0.77
Family			
Number of Family Members	7.68±2.25	7.77±2.26	0.75
Number of children in the family	5.68±2.25	5.77±2.26	0.94
Social Class (Annual Family Income)	2.93±0.83	3.17±0.77	0.74
Occupation of the family head			

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Self Employed	38	34	0.69
Salaried Labours	28	14	
Labour	15	18	
Salaried Service	11	17	
Farmer	11	14	
Main source of drinking water			
Government Supplies	35	24	0.655
Pond	27	25	
Self owned pump	21	26	
Tube well	20	22	

The study found that there are significant patients of *falciparum* malaria with continuous fever (p=0.0322) while recurrent fever was significant among patients with *vivax* malaria (p=0.0211). Fig. 1 shows the detailed data on the number of patients with continuous fever and recurring fever in each group.

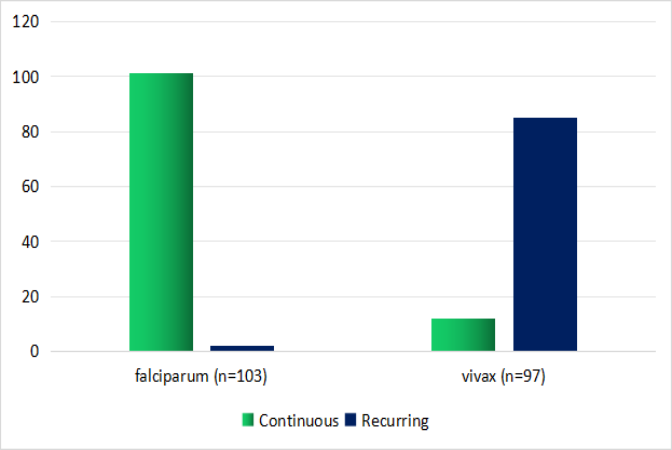

Fig. 1: Fever Pattern of the patients in each group

Table 2 outlines the clinical features observed in patients infected with either *falciparum* or *vivax* malaria. The statistical analysis includes p-values to determine the significance of differences between the two groups for each clinical feature. Among the 103 patients with *falciparum* malaria, 85 (82.5%) exhibited severe disease, whereas only 32 (33.0%) of the 97 patients with *vivax* malaria showed severe symptoms. This difference is statistically significant with a p-value of 0.042, indicating that severe disease is more common in *falciparum* malaria compared to *vivax* malaria. None of the *falciparum* patients experienced relapses within a year, while 5 (5.2%) of the *vivax* patients did. However, the difference is not statistically significant (p-value=0.09), suggesting that relapses are relatively uncommon in both groups but slightly more in *vivax* malaria. Cerebral malaria was rare, occurring in 2 (1.9%) of the falciparum patients and none of the *vivax* patients, with a p-value of 0.75, indicating no significant difference between the two groups. Renal failure was also uncommon, seen in just 1 (1.0%) of the falciparum cases and not at all in the *vivax* cases. The p-value of 0.99 shows no significant difference between the groups for this clinical feature.

Hypoglycemia was significantly more frequent in the *falciparum* group, affecting 61 (59.2%) patients compared to 8 (8.2%) in the *vivax* group, with a P-value of 0.044. This indicates a significant difference, suggesting hypoglycemia is much more common in *falciparum* malaria. In contrast, splenomegaly was more prevalent in the *vivax* patients, with 42 (43.3%) cases, compared to 16 (15.5%) in the *falciparum* patients. The p-value of 0.0455 indicates a statistically significant difference, showing splenomegaly is more commonly associated with *vivax* malaria.

Table 2: Clinical Features of the patients in each group

Clinical Features	***falciparum* (n=103)**	***vivax* (n=97)**	**p-value**
Severity	85 (82.5%)	32 (33%)	0.042
Relapses within a year	0 (0%)	5 (5.2%)	0.095
Cerebral Malaria	2 (1.9%)	0 (0%)	0.75
Renal Failure	1 (1%)	0 (0%)	0.99
Hypoglycemia	61 (59.2%)	8 (8.2%)	0.044
Splenomegaly	16 (15.5%)	42 (43.3%)	0.0455

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DISCUSSION

Malaria, a type of sickness transmitted by vectors, places a significant socio-economic burden on impoverished households, either through direct or indirect means. In a country such as India, where the Below Poverty Line (BPL) population is around 23%, malaria remains a persistent public health issue [8-10]. Research was done in the past to assess the effect of socioeconomic status on disease burden in the Kolkata Municipal Corporation (KMC) Area, known for its high disease burden in West Bengal [5,9]. The disease appears to have a greater economic burden onwards with a higher population of individuals with low socio-economic status (SES). Enhancing the socioeconomic level of households and promoting positive changes in slum areas would reduce disease prevalence and minimize the economic burden on people [11-13].

A study in the past aimed to evaluate the clinical characteristics, severity, and consequences of malaria patients in Mangaluru, a city located on the southern coast of India. Analyzed were the hematological, clinical profile, biochemical markers, and consequences of the disease [14,15]. Severe malaria cases can lead to many clinical consequences such as jaundice, acute renal failure, haematuria, thrombocytopenia, metabolic acidosis, hepatic dysfunction, severe anemia, acute respiratory distress syndrome, hypotension, and cerebral malaria [16]. Most individuals had moderate malaria, possibly because they sought treatment promptly after symptom onset and/or had preexisting immune defenses [11,16]. Nevertheless, a considerable number of patients suffered from severe malaria and needed to be hospitalized, highlighting the urgent necessity to raise awareness among the susceptible immigrant population. Establishing efficient monitoring and vector control strategies in malaria hotspots in the city, along with teaching the population about prevention strategies, is expected to decrease the malaria prevalence in this endemic area [17].

A study was done to assess the current situation and trajectory of Malaria in the KMC area. The objectives were to evaluate the distribution of Malaria in terms of time, location, and affected individuals, identify locations with a high risk of future outbreaks, and propose ways to manage Malaria [18]. The researchers determined that there is a need to enhance the Annual Blood Examination Rate (ABER) in Kolkata. They also recommended the use of Insecticide Treated Nets/ Long Lasting Insecticidal Nets, along with other standard vector-control strategies and Behavior Change Communication initiatives, to effectively manage the problem [19].

A previous study evaluated the impact of socioeconomic status on the prevalence of diseases in the KMC Area, a region in West Bengal with a high disease burden. Malaria is the predominant disease in the region of study, with a prevalence rate of 5%. There is a higher prevalence of males being impacted compared to females, and the working-age group experiences the most severe impact. The disease appears to have a greater cost burden onwards with a bigger population of individuals with poor socio-economic status [20].

Malaria is a significant worldwide and national public health issue. Recently, there has been an increase in recognition of the significance of environmental and demographic factors in influencing the local transmission of malaria. Bag et al., conducted a comparative study at the community level to identify the factors related to malaria infection in urban and rural settings. The study revealed that the incidence of malaria infection among participants in urban regions was 6.1%, while in rural areas it was 18.8%. Additionally, the household-level risks of malaria infection were determined to be 1.8% in urban areas and 6.7% in rural areas [21,22].

CONCLUSIONS

The study has concluded that *falciparum* malaria is more likely to have continuous fever and its severity is also greater than *vivax* malaria. *Falciparum* malaria is also found to have higher incidences of hypoglycaemia while *vivax* malaria is associated with recurrent fever and splenomegaly. Therefore, along with the standard regimens, there is a need to carry out symptomatic treatment for a specific type of malaria. The study has obtained data from hospital records which may limit the comprehensiveness and accuracy, as it depends on the quality of existing records. Additionally, the study has considered the last 3 years' data which may have bias due to a specific timeframe (timeframe bias). Moreover, the study was conducted in a confined region (Kolkata), which may limit the generalizability of the findings to other geographic areas with different environmental and socio-economic conditions. Similar studies should be conducted prospectively and longitudinal studies to

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monitor patients in real-time, providing a more varied and accurate assessment of clinical features and outcomes. Expanding the study to include a larger sample size and extending the duration to cover multiple years and seasons can take seasonal patterns into account and long-term trends of malaria incidence.

CONTRIBUTION OF AUTHORS

All authors have equally contributed.

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