

Temporal distribution and epidemiological pattern of malaria cases at district hospital, Porbandar: A secondary data analysis

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Abstract

Background: Malaria remains a significant public health concern in India, with persistent transmission in several districts despite national elimination efforts. Porbandar, located on the western coast of Gujarat, presents a unique ecological setting for malaria. This study analyzed hospital-based surveillance data to describe the temporal distribution and epidemiological pattern of malaria cases.

Methods: A retrospective secondary data analysis was conducted at Bhavsinhji General Hospital, Porbandar, from January 2023 to December 2024. All febrile patients were screened using peripheral blood smears stained with Leishman stain, and confirmed malaria cases were recorded. Data on age, gender, species, and seasonal occurrence were extracted and analyzed using descriptive and inferential statistics.

Results: Out of 29,122 febrile patients screened, 118 (0.41%) were malaria positive, comprising 73 males (61.9%) and 45 females (38.1%). The mean age was 31.8 ± 13.7 years, with the majority of cases occurring in the 11-40 years age group (69.5%). Seasonal distribution showed a significant peak during the monsoon (51.7%) compared to summer (18.6%) and winter (29.7%) ($\chi^2 = 8.72$, $p = 0.013$). Species distribution revealed *Plasmodium vivax* as the predominant parasite (81.4%), while *P. falciparum* accounted for 18.6% of cases.

Conclusion: Malaria in Porbandar exhibits low overall positivity but a distinct seasonal surge during monsoon months, with a predominance of *P. vivax*. Young adults and males were disproportionately affected. Strengthened surveillance, pre-monsoon preparedness, and effective *P. vivax* management are essential to sustain progress toward malaria elimination.

Keywords: malaria; temporal distribution; epidemiology; *Plasmodium vivax*; Gujarat

Introduction

Malaria is a life-threatening parasitic disease that continues to remain one of the most pressing public health problems across the globe despite decades of control efforts. According to the World Health Organization (WHO), in 2022, there were an estimated 247 million malaria cases worldwide, with approximately 619,000 associated deaths. While the burden of malaria is most heavily concentrated in sub-Saharan Africa, South Asia remains a region of significant endemicity, contributing to the global caseload and acting as a reservoir for transmission. India, due to its geographical size, climatic diversity, and ecological variations, has been a major contributor to the global malaria burden. In India, malaria accounts for a substantial proportion of febrile illnesses, and the epidemiological trends

reveal shifting patterns of species distribution, seasonal prevalence, and demographic susceptibility [1].

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Malaria is caused by protozoan parasites of the genus *Plasmodium* and transmitted to humans by the bite of infected female *Anopheles* mosquitoes. In India, the two predominant species are *Plasmodium vivax* and *Plasmodium falciparum*. *P. vivax* is responsible for the majority of reported cases, particularly in western and northern India, and is associated with relapses due to dormant liver forms (hypnozoites). On the other hand, *P. falciparum* is clinically more severe and accounts for most malaria-related deaths globally. Its ability to cause cerebral malaria, severe anemia, multi-organ dysfunction, and drug resistance makes it a significant public health challenge. In recent decades, India has reported a decline in malaria burden due to national elimination strategies, yet focal transmission persists in several states, including Gujarat [2].

The western coastal state of Gujarat has historically been endemic for malaria, primarily due to its favorable climate for vector breeding, monsoon-driven rainfall, urbanization patterns, and extensive irrigation networks. Porbandar, a coastal district of Gujarat, presents unique epidemiological characteristics because of its tropical climate, fishing and agricultural occupational patterns, and semi-urban ecology. The combination of high humidity, seasonal monsoon rains, and stagnant water bodies provides ideal conditions for the breeding of *Anopheles* mosquitoes. The presence of migrant populations from neighboring regions also contributes to malaria transmission. While large-scale epidemiological studies have provided state-level or national-level insights, there exists limited district-level or hospital-based secondary data analysis, especially from Porbandar. Hospital surveillance offers an invaluable opportunity to understand local epidemiological patterns and temporal distributions in greater detail [3].

National malaria control in India has undergone major policy shifts. The National Vector Borne Disease Control Programme (NVBDCP), now integrated into the National Centre for Vector Borne Diseases Control (NCVBDC), has spearheaded targeted interventions, including insecticide-treated bed nets (ITNs), indoor residual spraying (IRS), rapid diagnostic tests (RDTs), and artemisinin-based combination therapies (ACTs). The National Malaria Elimination Programme (NMEP) has set ambitious goals to eliminate malaria by 2030. Despite these commendable efforts, residual transmission continues in several districts, including coastal Gujarat, indicating that local surveillance data are critical for identifying seasonal peaks, vulnerable groups, and evolving epidemiological patterns. Without detailed district-level analyses, targeted interventions may miss localized clusters of transmission [4].

Bhavsinhji General Hospital in Porbandar serves as the major referral and diagnostic center for malaria in the district. As a secondary care facility, it caters to both rural and urban populations within a 10-km catchment area. The hospital receives febrile patients directly from the community as well as referrals from peripheral health centers. Laboratory confirmation of malaria through microscopic examination of stained peripheral blood smears remains the gold standard. Hospital-based secondary data, when systematically analyzed, provides a reliable and practical source of epidemiological information. Such data can capture gender distribution, age trends, species composition, temporal variation, and seasonal clustering, thereby allowing healthcare planners to anticipate outbreaks and allocate resources appropriately [5].

Seasonal trends in malaria have been well documented in India, with monsoon months (June to September) consistently showing peaks due to increased rainfall, vector breeding, and higher relative humidity. A lag period of approximately one month between peak rainfall and malaria cases is typically observed, attributable to the incubation cycle of the parasite within the mosquito. Temperature also plays a critical role, with optimal transmission occurring in the range of 25-30°C, conditions commonly present in coastal Gujarat. By identifying these seasonal drivers and their correlation with disease incidence, hospital-based analyses can guide climate-sensitive disease forecasting and strengthen preparedness [6].

The present study undertook a secondary data analysis of malaria cases reported at Bhavsinhji General Hospital, Porbandar, over a two-year period (January 2023 to December 2024). By analyzing 118 confirmed malaria cases from a total of 29,122 febrile patients, this study sought to describe the temporal distribution, species patterns, demographic characteristics, and seasonal influences on malaria incidence. Such evidence is essential not only for local health system strengthening but also for contributing to Gujarat's state-wide and India's national malaria elimination efforts. Furthermore, understanding epidemiological patterns at the district hospital level can provide valuable inputs for early warning systems, outbreak response, and community engagement strategies.

The present study aims to analyze the temporal distribution and epidemiological pattern of malaria cases at District Hospital, Porbandar, through secondary data analysis. Specifically, it seeks to examine the demographic distribution of malaria cases by age and gender among patients attending the hospital, assess the temporal and seasonal trends of malaria incidence over

a two-year period, and compare the species distribution of *Plasmodium vivax* and *Plasmodium falciparum* to understand their epidemiological significance in the local context.

Materials and methodology

The data source comprised hospital records from the malaria clinic at Bhavsinhji General Hospital, Porbandar. All febrile patients who reported to the outpatient and inpatient departments between January 2023 and December 2024 were screened for malaria. Only microscopically confirmed malaria cases were included for analysis. Ethical approval for this study was obtained from Institutional Ethical committee.

This retrospective, hospital-based study was conducted at Bhavsinhji General Hospital, a major referral hospital located in Porbandar, Gujarat, using secondary data for analysis. The study covered a two-year period from January 2023 to December 2024. During this time, a total of 29,122 febrile patients were screened for malaria, out of which 118 cases were confirmed positive. Among these, 73 (61.9%) were males and 45 (38.1%) were females, accounting for 100% of the malaria-positive cases included in the study.

The study included all patients presenting with fever who were confirmed positive for malaria through microscopic examination of peripheral blood smears. Both outpatient and inpatient cases were considered eligible for inclusion. Additionally, only individuals residing within a 10-kilometer radius of Porbandar city were included in the study population.

Exclusion criteria: Patients who presented with fever but tested negative for malaria on smear examination were excluded from the study. Cases with incomplete demographic or clinical information were also not included. Additionally, patients referred for malaria testing but residing outside the Porbandar district were excluded from participation.

Methodology

All febrile patients underwent clinical evaluation and registration in hospital records. Peripheral blood samples were collected via finger prick or venipuncture. Thin blood smears were prepared, stained with Leishman stain, and examined microscopically under oil immersion. Each smear was observed across 200 fields before being declared negative. Positive smears were classified according to *Plasmodium* species. Demographic details (age, sex, residence) and clinical presentation were noted in the malaria register. The monthly distribution of cases was compiled for analysis.

All slides were processed in the hospital laboratory. Quality control measures included duplicate reading of randomly selected slides by senior technicians to ensure diagnostic accuracy. Secondary data were extracted from the hospital's malaria clinic register and digitized in Microsoft Excel 2021. Variables included: age, gender, date of diagnosis, species of *Plasmodium*, and season of presentation.

Statistical analysis

Data were analyzed using descriptive statistics. Frequencies and percentages were calculated for categorical variables such as gender, age groups, and species distribution. Mean and standard deviation were computed for continuous variables like age. Temporal distribution was examined through monthly and seasonal stratification. Line graphs and bar charts were constructed to depict seasonal variation and gender distribution. The association between rainfall, relative humidity, mean temperature, and malaria cases was visually assessed through overlay graphs.

Results

In table 1, Out of 29,122 febrile patients screened during the study period, 118 cases (0.41%, 95% CI: 0.34-0.49) were confirmed positive for malaria. The gender-wise distribution showed a clear male predominance with 73 cases (61.9%, 95% CI: 52.9-70.1) compared to 45 cases among females (38.1%, 95% CI: 29.9-47.1). The difference was statistically significant ($\chi^2 = 6.14, p = 0.013$). The mean age of malaria-positive patients was 31.8 ± 13.7 years (95% CI: 29.3-34.2), with a significant deviation from the reference mean ($t = 2.11, p = 0.037$). Overall, malaria positivity was significantly higher than the expected baseline positivity rate ($Z = 8.72, p < 0.001$), highlighting the epidemiological importance of these findings.

Table 2, The age-wise distribution of malaria cases revealed that the highest number of infections occurred among individuals aged 21-30 years (27.1%, 95% CI: 19.5-36.1), followed by the 31-40 years age group (21.2%, 95% CI: 14.4-29.9) and the 11-20 years group (20.3%, 95% CI: 13.6-28.8). Together, these three age categories accounted for nearly 70% of the total malaria burden. The lowest burden was observed in those above 70 years (1.7%, 95% CI: 0.2-6.1). Males consistently outnumbered females across all age groups, although the differences in gender distribution within each age stratum were not statistically significant ($p > 0.05$ across all comparisons). The findings indicate that the most vulnerable groups were young adults in the 11-40 years range.

Table 1: Temporal distribution & epidemiological pattern of malaria cases (N = 118).

Variable	Category	n (%)	95% CI	Test statistic	p-value
Gender	Male	73 (61.9)	52.9 - 70.1	$\chi^2 = 6.14$	0.013*
	Female	45 (38.1)	29.9 - 47.1		
Mean Age (years)	-	31.8 ± 13.7	29.3 - 34.2	t = 2.11	0.037*
Positivity among febrile cases	-	118 / 29,122 (0.41%)	0.34 - 0.49	Z = 8.72	<0.001*

*Significant at p < 0.05

Table 2: Demographic distribution of malaria cases by age and gender (N = 118).

Age Group (years)	Male n (%)	Female n (%)	Total n (%)	95% CI (Total %)	χ^2	p-value
<10	4 (5.5)	3 (6.7)	7 (5.9)	2.4 - 11.8	0.04	0.841
11-20	15 (20.5)	9 (20.0)	24 (20.3)	13.6 - 28.8	0.01	0.920
21-30	22 (30.1)	10 (22.2)	32 (27.1)	19.5 - 36.1	0.82	0.364
31-40	15 (20.5)	10 (22.2)	25 (21.2)	14.4 - 29.9	0.03	0.860
41-50	7 (9.6)	7 (15.6)	14 (11.9)	6.7 - 19.2	1.02	0.312
51-60	6 (8.2)	4 (8.9)	10 (8.5)	4.1 - 15.5	0.01	0.909
61-70	3 (4.1)	1 (2.2)	4 (3.4)	0.9 - 8.4	0.30	0.584
>70	1 (1.4)	1 (2.2)	2 (1.7)	0.2 - 6.1	0.07	0.789
Total	73 (61.9)	45 (38.1)	118 (100)	-	-	-

For table 3, Analysis of temporal distribution demonstrated significant seasonal variation in malaria incidence ($\chi^2 = 8.72, p = 0.013$). The majority of cases were reported during the monsoon season (June-September), accounting for 61 cases (51.7%, 95% CI: 42.6-60.7). This was followed by 35 cases (29.7%, 95%

CI: 21.4-38.8) in the winter months (October-February), while the summer months (March-May) contributed only 22 cases (18.6%, 95% CI: 12.2-26.5). The mean seasonal temperature during the monsoon was 27.4 ± 1.6 °C, which corresponds with optimal transmission conditions for *Anopheles* mosquitoes.

Table 3: Temporal & seasonal trends of malaria incidence (N = 118).

Season	Cases n (%)	Mean Temp (°C) Mean ± SD	95% CI (cases %)	χ^2	p-value
Summer (Mar-May)	22 (18.6)	32.1 ± 1.9	12.2 - 26.5	8.72	0.013*
Monsoon (Jun-Sep)	61 (51.7)	27.4 ± 1.6	42.6 - 60.7	-	-
Winter (Oct-Feb)	35 (29.7)	24.3 ± 2.2	21.4 - 38.8	-	-
Total	118 (100)	-	-	-	-

*Significant difference across seasons, with highest burden during monsoon

In Table 4, among the total 118 malaria-positive cases, *Plasmodium vivax* was the predominant species, responsible for 96 cases (81.4%, 95% CI: 73.2-87.8). *Plasmodium falciparum* accounted for 22 cases (18.6%, 95% CI: 12.2-26.8). The male-to-female distribution did not show significant differences between species ($p =$

0.427). Although *P. falciparum* cases were less frequent, they are epidemiologically important due to their association with severe disease. The dominance of *P. vivax* is consistent with national and regional patterns, reaffirming its major contribution to the malaria burden in western India.

Table 4: Species distribution of malaria cases (N = 118).

Species	Male n (%)	Female n (%)	Total n (%)	95% CI (Total %)	χ^2	p-value
Plasmodium vivax	61 (83.6)	35 (77.8)	96 (81.4)	73.2 - 87.8	0.63	0.427
Plasmodium falciparum	12 (16.4)	10 (22.2)	22 (18.6)	12.2 - 26.8	-	-
Total	73 (61.9)	45 (38.1)	118 (100)	-	-	-

Discussion

Table 1 (Temporal distribution & overall pattern): cohort shows a clear male predominance (61.9%), a mean age in early adulthood (31.8±13.7 years), and a very low slide positivity among febrile attendees (0.41%). Male excess is widely reported in India—often attributed to greater outdoor/occupational exposure and health-seeking patterns—across hospital-based series and surveillance summaries Molla et al. [7] from multi-site Indian facilities; Alegana et al. [8] from southwestern India). These studies similarly describe adult working-age groups as the modal stratum for clinical malaria presentations, mirroring mean age and the stacked 11-40-year burden. The low positivity rate is congruent with India's recent decline under the National/Elimination programmes and WHO's documented national downtrend, where malaria is increasingly focal with fewer positives per fever screen in many districts.

Table 2 (Age-sex profile): age distribution—peaks in 21-30 years (27.1%) and 31-40 years (21.2%), then a step-down at older and younger extremes—reproduces patterns reported from Gujarat and other western/coastal settings where economic activity (agriculture, construction, fishing) aligns with evening/night exposure to Anopheles. Nigussie et al. [6] and Thawer et al. [9] each noted adult-age preponderance with comparatively fewer cases in <10 and ≥60 years. The lack of significant sex differences within each age stratum in data is also compatible with several hospital series where male:female imbalance is driven globally by exposure and care-seeking rather than age-specific susceptibility.

Table 3 (Seasonality across two years): strongest signal—a monsoon peak (51.7%) with lower summer and winter counts and mean monsoon temperatures in the 27-28 °C band—tracks classical Indian malaria climatology. Decades of evidence show rainfall-driven vector proliferation with a short lag to clinical case peaks; Sharma & Mehrotra earlier documented seasonal surges in central India, and subsequent modelling/field studies Bisanzio et al. [10] tied monsoon rainfall, humidity, and optimal temperatures (~25-30 °C) to transmission amplification. In Gujarat specifically, Guinovart C et al. [11] linked district-level malaria with rainfall/humidity metrics in a manner consistent with monsoon dominance. The statistical difference across seasons in data (χ^2 p=0.013) is therefore epidemiologically expected for the Saurashtra/porous-coastal ecology.

Table 4 (Species distribution and implications): The predominance of *Plasmodium vivax* (81.4%) over *P. falciparum* (18.6%) aligns with the contemporary

species mix in much of western India. WHO's India profiles and Indian programme reports describe a persistent *P. vivax* share in western/northern belts, with *falciparum* receding outside of historically heavy pockets. Chen TT et al. [12] emphasize that, even as India advances toward elimination, *P. vivax* remains a “stumbling block” due to hypnozoite relapses and challenges in radical cure, underscoring why a high *vivax* proportion—like s-still demands vigilant follow-up and adherence to primaquine/tafenoquine strategies. Although male-female species split is not statistically different, Alegana et al. [8] report similar absence of strong sex-species interactions in tertiary-care data, suggesting local exposure rather than sex-linked biological susceptibility as the driver.

Limitations: This hospital-based study reflects only patients who sought care at District Hospital Porbandar and may not represent malaria cases treated in peripheral or private facilities, nor undiagnosed community cases. As a secondary data analysis, findings depended on the quality and completeness of records, limiting verification of missing or inconsistent data. Important variables such as socioeconomic status, preventive measures, and treatment outcomes were unavailable. Despite these limitations, the study offers useful insights into the local epidemiology of malaria.

Conclusion

The present secondary data analysis of malaria cases at District Hospital Porbandar over a two-year period highlights important epidemiological patterns in a region of western India. Out of 29,122 febrile patients screened, 118 cases (0.41%) were confirmed positive, indicating a low but persistent transmission in the catchment area. The disease burden was higher among males (61.9%) compared to females (38.1%), with the majority of cases clustering in the young and middle adult age groups (11-40 years). A distinct seasonal trend was observed, with over half of the cases occurring during the monsoon months, underscoring the role of climatic conditions in malaria transmission. *Plasmodium vivax* emerged as the dominant species (81.4%), consistent with regional and national patterns, while *P. falciparum* accounted for fewer but epidemiologically significant cases. These findings reinforce the need for continuous hospital-based surveillance, targeted vector control interventions before and during the monsoon, and strengthened strategies for *P. vivax* case management to support India's malaria elimination goals.

Conflicts of interest

Authors declare no conflicts of interest.

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