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Original Research Article

A retrospective study of trends of malaria cases admitted in tertiary care hospital in a metropolitan city

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ABSTRACT

Background: Malaria remains a significant public health challenge in India despite global progress, accounting for nearly half of the malaria cases in the WHO South-East Asia Region (SEAR). Although there has been a marked reduction in malaria incidence and mortality in recent years, local transmission patterns and demographic disparities continue to pose challenges. This study aims to analyze the year-wise trends, demographic distribution, and key indicators of malaria transmission at a tertiary care hospital in a metropolitan Indian city.
Methods: A cross-sectional analysis was conducted using retrospective data from the Integrated Disease Surveillance Program (IDSP) cell at a tertiary care facility. Reported malaria cases from 2010 to 2018, diagnosed via peripheral blood examination or rapid diagnostic test, were included. Time-series modeling, logistic regression, Poisson regression, and ANOVA were employed to evaluate temporal trends, demographic factors, seasonal variation, and clinical outcomes.
Results: A total of 10,492 malaria cases were recorded over nine years. Annual incidence declined markedly by 83%, from 3,016 cases in 2010 to 485 in 2018. The slide positivity rate reduced from 12.06% to 0.89%, while case fatality rate dropped from 2.72% to 0.20%. Male patients accounted for 78% of cases, indicating substantial gender disparity. Seasonal peaks persisted, particularly during the monsoon.
Conclusion: The findings highlight a substantial decline in malaria burden and mortality, reflecting the effectiveness of control interventions. Nevertheless, the evident gender disparity and seasonal surges underscore the need for targeted public health interventions and continuous surveillance to ensure continued progress toward malaria elimination.

Keywords: Malaria, Slide positivity rate, Case fatality rate, Surveillance, South-east Asia region

INTRODUCTION

Malaria continues to represent a major public health concern in India; however, it is both preventable and treatable. Investment in malaria control has proven to be among the most cost-effective public health interventions, yielding substantial returns. Over recent years, India has experienced a marked reduction in the burden of malaria-related morbidity and mortality.[1] This success is largely attributed to the implementation of key interventions, such as the adoption of artemisinin-based combination therapy (ACT) for the treatment of Plasmodium falciparum malaria in 2004–2005, widespread use of malaria rapid diagnostic tests (RDTs), the nationwide prohibition of oral artemisinin monotherapy in 2009, the deployment of long-lasting insecticidal nets (LLINs), the same year, and the revision of the National Drug Policy for malaria in 2013.[2] Despite these advances, several emerging challenges threaten continued malaria control in the country. These include the development of resistance to antimalarial drugs and insecticides in certain regions, the emergence of multi-drug-resistant malaria-including ACT resistance-in neighboring areas, rapid urbanization facilitating malaria emergence in urban environments, persistent high-transmission pockets among hard-to-reach and tribal populations, as well as the impacts of climate change, increased tourism, and internal migration.[1]

The World Health Organization (WHO) has emphasized the need for accelerated and coordinated action among member nations to achieve malaria elimination by 2030, in light of the significant reduction in malaria incidence observed regionally. Countries in the South-East Asia Region are demonstrating notable progress and strong dedication to malaria eradication, but sustaining and amplifying these efforts is critical for continued improvement in detection and treatment. According to the latest World Malaria Report, the WHO South-East Asia Region reported an estimated 8 million malaria cases and 11,600 deaths in 2018-a 69% and 70% reduction, respectively, from 2010 figures. This region demonstrated the largest decline among the six WHO regions.[3]

Given the multiple challenges facing malaria control in India and the evolving strategies of the National Malaria Control Programme-including introductions of ACT, LLINs, RDTs, and the 2013 National Drug Policy-ongoing surveillance is necessary. Malaria remains a global public health challenge, especially in tropical and subtropical areas. Metropolitan cities, in particular, experience variable malaria patterns due to rapid urbanization, climatic variability, and evolving public health strategies. This study was undertaken to analyze the year-wise trends of malaria among cases admitted to a tertiary care hospital in a metropolitan city, aiming to understand local epidemiological dynamics and inform future health policies. As recent interventions have resulted in declining malaria trends across India, investigating these trends at the tertiary care level in an urban setting is especially timely and relevant.

Objectives

This study aimed to assess the year-wise trends in malaria cases admitted to a tertiary care hospital, examine demographic characteristics, and analyze seasonal variations in malaria incidence.

METHODS

Study design and setting

A retrospective cross-sectional study and data analysis was conducted at the Department of Community Medicine PAH Government Medical College Baramati, Dist. Pune Maharashtra, India from 1st March to 30th April 2025.

Study population

The study included all confirmed malaria cases reported to the IDSP cell from January 1, 2010, to December 31, 2018. A confirmed case was defined as a febrile patient diagnosed via peripheral blood smear microscopy, RDT, or ELISA for malaria parasites. Cases with incomplete records or unrelated co-infections were excluded.

Data collection

Data on patient demographics (age, gender), diagnosis date, laboratory results, and outcomes (survival or death) were extracted from hospital records. Variables included annual case counts, gender, season (pre-monsoon [March–June], monsoon [July–October], post-monsoon [November–February]), SPR, and CFR.

Inclusion criteria

Confirmed cases of malaria based on laboratory diagnosis (microscopy or rapid diagnostic tests).

Exclusion criteria

Patients with incomplete medical records or those diagnosed with co-infections not related to malaria.

Statistical analysis

Descriptive statistics were used to summarize annual case trends, gender distribution, SPR, and CFR & using appropriate statistical methods inferential analysis done.

Time-series analysis

An autoregressive integrated moving average (ARIMA) model was fitted to annual and monthly case counts to assess temporal trends and seasonality, accounting for autocorrelation.

Poisson regression

Modeled the effect of year, gender, and season on malaria case counts, with incidence rate ratios (IRRs) and 95% confidence intervals (CIs).

Logistic regression

Evaluated factors (year, gender, season) associated with malaria positivity (SPR) and mortality (CFR), reporting odds ratios (ORs) and 95% CIs.

Chi-square tests

Tested associations between gender and malaria incidence, and season and case counts.

One-way ANOVA

Compared mean case counts across seasons. Analyses were conducted using R (version 4.2.1), with statistical significance set at p<0.05. Missing data were handled using listwise deletion, and model assumptions (e.g., overdispersion in Poisson regression) were checked.

RESULTS

During study period, total number of Malaria cases (2010–2018) were 10492. Between 2010 and 2018, there was an overall decreasing trend in the number of cases of malaria from 3016 to 485 in Tertiary care hospital in Mumbai. Overall, there was 83.92% decrease in cases of malaria from 2010 to 2018 (Figure 1). Time-series analysis (ARIMA 1,1,0) model of annual trend of malaria cases shows statistically significant decline in malaria cases over time, with an effect size is average 9.3% reduction per year with p value<0.0001 (95% CI 8.1–10.5 %) & seasonal component monthly malaria cases, effect size seasonal amplitude: 1.8 (95% C.I. 1.5–2.1) with p value<0.001 statistically significant seasonal variation, with peaks in post-monsoon months (Figure 1).

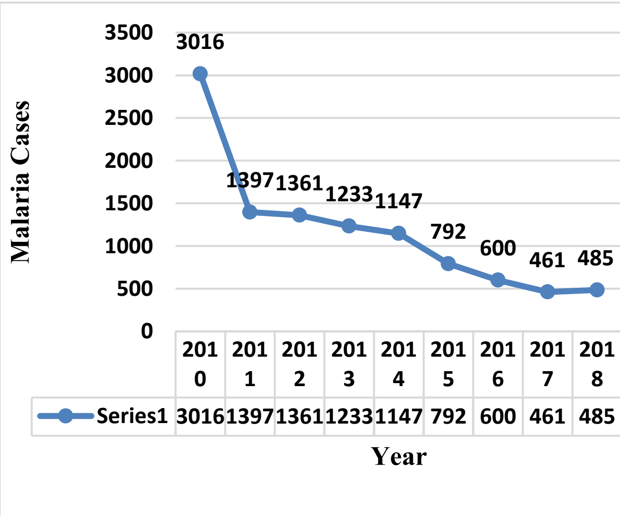

Figure 1: Trends of malaria cases from 2010 to 2018.

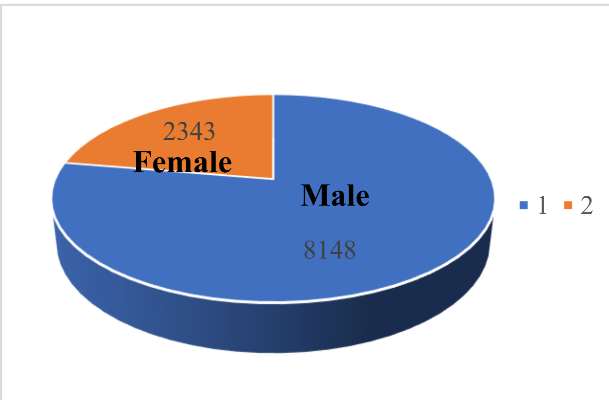

Figure 2: Sex wise distribution of malaria cases.

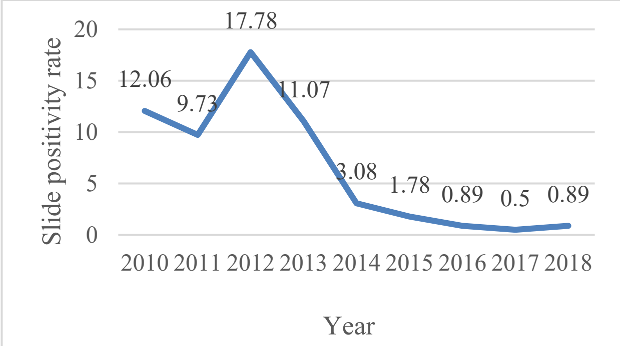

Figure 3: Year wise slide positive rate (SPR).

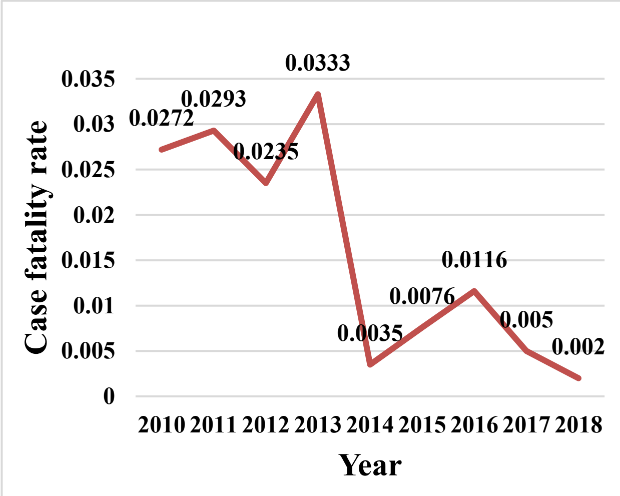

Figure 4: Year wise case fatality rate (CFR).

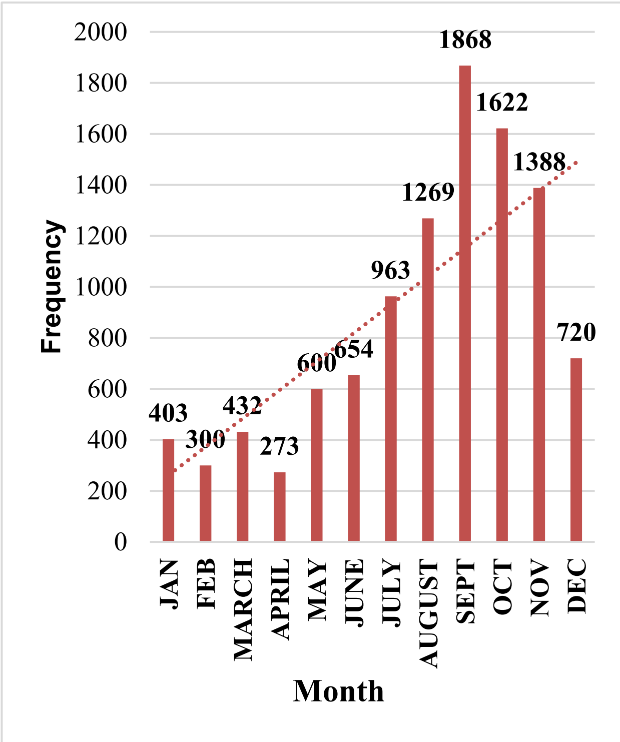

Figure 5: Month wise distribution of malaria cases.

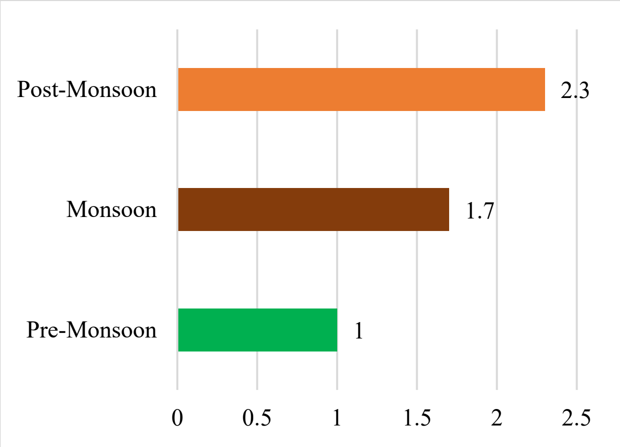

Figure 6: Seasonal effect on malaria incidence (relative to pre-monsoon).

*Season (pre-monsoon March–June, monsoon (July–October), post-monsoon (November–February)**).**

In the study, of the total malaria cases, 8148 (78%) occurred in males and 2343 (22%) in females, It was observed in this study that cases of malaria are more in males then females by 56%. Significant association between gender and malaria diagnosis, with higher prevalence in males with chi-square statistics is χ^2=412.3 with p value<0.0001 and the OR is 2.56 (CI 2.42–2.71), Male patients had 2.56 times higher odds of a positive diagnosis compared to females.

The slide positivity rate (SPR) decreased from 12.06 % to 0.89 % (OR=0.85, p<0.001) & Case fatality rate decreased from 2.72 % to 0.20% (OR=0.88, p<0.001) from year 2010 to 2018 respectively. (Figure 3 & 4 and Table 1)

The study shows, though trends of malaria cases decrease year wise as shown in fig.1 but trends of cases of malaria increases in post monsoon season especially in month of August, September, October, and November (Figure 5 & Table 2). Seasonal effect on Malaria cases counts in post-monsoon vs. pre-monsoon incidence rate ratio is 2.30 (CI 2.15–2.46) with p value <0.0001. It shows that the post-monsoon period has 2.3 times higher incidence than pre-monsoon.

Seasonal effect on malaria cases counts in monsoon vs. pre-monsoon incidence rate ratio is 1.75 (CI 1.62–1.89) with p value <0.0001. It shows that the Monsoon period has 1.75 times higher incidence than pre-monsoon. (Figure 6).

Table 1: Logistic regression analysis slide positivity rate (SPR) & case fatality rate (CFR) outcome with related predictor variable.

Analysis type	Outcome	Predictor	Effect size	95% CI	P value	Interpretation
Slide positivity rate (SPR)	Positive Diagnosis	Year	OR=0.85	0.82–0.88	<0.001	15% annual reduction in odds of positive diagnosis.
		Male vs. female	OR=2.56	2.42–2.71	<0.001	Males have 2.56 times higher odds of positive diagnosis.
		Post-monsoon vs. pre-monsoon	OR=1.92	1.78–2.07	<0.001	Post-monsoon period has 1.92 times higher odds of positive diagnosis.
Case fatality rate (CFR)	Mortality	Year	OR=0.88	0.84–0.92	<0.001	12% annual reduction in odds of mortality.
		Male vs. female	OR=1.34	1.12–1.60	0.001	Males have 1.34 times higher odds of mortality.
		Post-monsoon vs. pre-monsoon	OR=1.15	0.98–1.35	0.086	No significant seasonal effect on mortality.

*Season (pre-monsoon (March–June), monsoon (July–October), post-monsoon (November–February)).

Table 2: Relation between seasonal variation & mean monthly case count using one way ANOVA.

One-way ANOVA						
Analysis type	**Outcome**	**Predictor**	**Chi-square value**	**P value**	**Interpretation**	Significant differences in mean case counts across seasons, with post-monsoon highest.
Seasonal variation	mean monthly case count	Season	F=67.4	-	<0.001	

*Season (pre-monsoon (March–June), monsoon (July–October), post-monsoon (November–February)).

DISCUSSION

In the current retrospective study result analysis spanning over nine years, shows a notable 83.9% reduction in malaria cases that was observed at a tertiary care hospital in Mumbai, decreasing from 3,016 cases in 2010 to 485 in 2018. This significant decline highlights the effectiveness of intensified malaria control interventions implemented under the National malaria control programme during the study period, such as the adoption of artemisinin-based combination therapies (ACTs), rapid diagnostic tests (RDTs), and long-lasting insecticidal nets (LLINs).[1,2]

These findings align with those of Anvikar et al who reported a nationwide decline in Plasmodium vivax infections—from constituting 53% of malaria cases to 34% by 2014-while also highlighting regional disparities.[2] Despite this downward trend, *P. vivax* remains the predominant species in urban centers and continues to cause sporadic outbreaks, often associated with elevated case fatality rates due to delay in diagnosis or emerging drug resistance.[2]

In contrast to local trends, the WHO 2021 report indicated a global rise in malaria incidence-from 56 cases per 1,000 in 2019 to 59 in 2020-likely driven by disruptions in healthcare systems and malaria services amidst the COVID-19 pandemic.[3] In this context, the pre-pandemic decline observed in this study provides a valuable reference point for designing post-pandemic recovery strategies. Demographic analysis in the present study highlights a consistent predominance of malaria among young adult males throughout the study period, corroborating the findings of Dayanand et al, Pradhan et al, and Gupta et al.[4-6] The higher incidence in males may stem from increased exposure to mosquito vectors due to occupational or behavioral factors, differential travel patterns, host susceptibility, and other physiological variables.[7] While males form the majority of cases, children remain the most vulnerable group owing to immature immune responses, placing them at greater risk for severe malaria, developmental impairments, and cognitive delays.[8,9] Malaria transmission is closely linked to environmental conditions, particularly climatic variables such as rainfall, temperature, and humidity.[10] Moderate rainfall promotes vector breeding, whereas excessive precipitation or flooding can disrupt larval habitats.[11] Given the geographic variation in these climatic patterns, understanding the local seasonal dynamics of transmission is essential for predicting disease burden and optimizing interventional strategies.

This study's findings further reveal that malaria incidence during the post-monsoon period is approximately 2.3 times higher than in the pre-monsoon period. Despite the overall year-wise decline in cases, a consistent seasonal surge during the post-monsoon months (August to November) was observed. This trend aligns with established evidence in the Indian context and supports the findings of Chaturvedi et al and Kumar et al, who emphasized the significant influence of seasonal climatic factors on malaria transmission dynamics.[10,11]

The study relied on hospital-based data, potentially missing cases treated in outpatient or primary care settings. Seasonal fluctuations and underreporting may affect data consistency. The retrospective design limits causal inference.

CONCLUSION

This retrospective cross-sectional study examining malaria trends in a metropolitan tertiary care hospital over a nine-year period (2010–2018) demonstrated a statistically significant reduction in malaria incidence, positivity, and mortality rates. The 83.9% decrease in reported cases, along with declining SPR and CFR, reflects the positive impact of intensified malaria control interventions, improved diagnostics, and surveillance mechanisms. The gender-wise disparity-with males showing significantly higher odds of infection and mortality-points toward differential exposure risks requiring gender-responsive strategies. The pronounced seasonal peak in malaria cases during the post-monsoon period emphasizes the climatic influence on vector transmission and the need for anticipatory public health planning aligned with meteorological data.

Despite limitations related to retrospective hospital-based data, this study contributes essential epidemiological evidence to guide urban malaria control policies. Sustained surveillance, seasonal preparedness, and community-level engagement remain critical to achieving the national malaria elimination target by 2030. Future studies integrating community-based surveillance and climatic modelling are recommended to further strengthen the evidence base and optimize intervention timing and targeting.

Recommendations

Primary recommendations

Enhancement of seasonal malaria preparedness and control activities

The study demonstrated a significant seasonal variation in malaria incidence, with post-monsoon months showing a two to threefold increase in case counts. Therefore, it is recommended that malaria prevention and control measures-such as vector surveillance, larval habitat elimination, and intensified indoor residual spraying-be strategically strengthened during the pre-monsoon period to reduce transmission in the post-monsoon season.

Intensified surveillance for sustained decline and elimination

With an observed 83.9% reduction in malaria cases and a year-on-year decline in slide positivity and case fatality rates, maintaining and further strengthening surveillance systems is critical. The IDSP and hospital-based reporting should continue to monitor trends closely, ensuring rapid identification of cases and potential outbreaks to prevent resurgence.

Gender-sensitive risk reduction interventions

The findings revealed a significantly higher burden of malaria among males, with 2.56 times greater odds of positive diagnosis and elevated mortality. Focused interventions are warranted for high-risk male populations, particularly in occupational settings, including health education on personal protection and early treatment-seeking behavior.

Secondary recommendations

Sustained focus on case management and clinical outcomes

The study indicated a substantial decrease in the case fatality rate from 2.72% in 2010 to 0.20% in 2018. Continued emphasis on prompt diagnosis using RDTs and microscopy, early initiation of ACT-based treatment, and adherence to national treatment protocols is essential to further reduce mortality and sustain clinical gains.

Urban-specific intervention planning

As the study was conducted in a metropolitan tertiary care hospital, the results reflect the urban malaria burden, which is influenced by unplanned urbanization and population movement. Malaria control strategies should be tailored to urban contexts, with a focus on slum areas, construction sites, and informal settlements where transmission risk may be concentrated.

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

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