Epidemiology of malaria during pregnancy in Mangaluru city in the southwestern coastal region of India

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Abstract

Dakshina Kannada district in the Southwestern region of Karnataka State in India is endemic to malaria for the last three decades. About 80% of malaria infections in Mangaluru and its surrounding areas are caused by Plasmodium vivax (Pv) and the remainder are due to Plasmodium falciparum (Pf). Malarial infections during pregnancy led to pregnancy-associated malaria (PAM), which are also being reported commonly in this region. The PAM could lead to serious clinical complications to both the mother and fetus resulting in morbidity and mortality. Despite high endemicity, to-date, very little has been reported on the epidemiology and burden of PAM in this area. Keeping in view of this, we conducted a systematic longitudinal study during 2015 across four malaria active hotspot areas in Mangalore city and recruited both long-time residents and immigrant laborers (temporary residents) to find out the actual burden of PAM. Data on socio-demographic, literacy, knowledge of malaria and treatment-seeking behavior were collected to understand the various contributing factors to PAM in this region.

Analyses of the results show that the majority of PAM malaria illnesses were seen in local individuals associated with mild clinical complications. Of the 6 detected PAM cases, 4 were due to P.vivax and one each due to P.falciparum and mixed (P.vivax and P.falciparum) infections as diagnosed by microscopic examinations.

These cases were referred to local government hospitals for further monitoring and treatment. These data suggest that P.vivax causes a significant number of PAM infections in this region. Introducing stringent preventive public measures by governments and creating awareness of using preventive protective and environmental hygienic measures through educational programs may substantially reduce the risk of contracting malaria infection.

Keywords: Pregnancy malaria, *Plasmodium vivax*, *Plasmodium falciparum*, mixed infection.

Introduction

Malaria is the most common life-threatening parasitic infection in most parts of the tropical and sub-tropical regions of the world. Approximately 40% of the world's population lives in the tropical and sub-tropical regions where malaria is endemic. An estimated 3.2 billion people globally are at risk of contracting malaria every year.[11,22] It is a major contributor to the political, social and economic instability in the developing countries particularly sub-Saharan Africa and South Asia. Although the majority of malaria cases are reported from Africa and sub-African countries, a substantial number of fatalities are found in South-east Asia.

India accounts for the highest malaria burden with an estimated 70% of total malaria cases in the South-east Asian region followed by Indonesia and Myanmar.[4,7] In India, about 82% population is at risk of malaria and an estimated total number of clinical cases are in the range of 1-1.5 million every year, more than half of them due to *Plasmodium vivax*.[11]

Mangaluru, the administrative capital of Dakshina Kannada district in Karnataka state, is a coastal city located on the Arabian seashore of Southwestern India. The city and its surrounding areas have a tropical climate with high rainfall during the monsoon season. The warm and humid climate in this region favors the harboring of high vector density leading to high rates of malaria transmission. Malaria in Mangaluru area persists throughout the year with peak levels of transmission occurring during the rainy season from June to September. In 2018, Karnataka State has reported a total of 22,504 malarial infections, of which Mangaluru area alone accounted for 19,360 cases with ~82.4% *P. vivax* and ~17.6% *P. falciparum* infections.

In the past 15 years, more than 300 people in the Dakshina Kannada district have been succumbed to death due to malaria. Though only 2 deaths have officially reported in Mangaluru over the past 5 years, it is estimated that the actual number of deaths may be even 8-10 times more than reported.

Pregnant women are highly susceptible to infection which, in most instances, may prove not only life-threatening to the mother but may also have a profound impact on fetal outcome[8]. The infected pregnant women present varied

clinical conditions, including low birth weight, anemia, stillbirth, abortion, premature birth and maternal mortality. Repeated infections to pregnant women in malaria-endemic regions impart partial immunity to the disease. Unfortunately, however, there are a lot of clinical manifestations that trigger pregnant women, who have weakened immunity during pregnancy, are at risk of malaria.

Pregnancy-associated malaria (PAM) studies worldwide have demonstrated the impact of malaria on maternal and neonatal morbidity and mortality.[3,9] Relatively little information is available from India about pregnancy malaria and its complications associated with an increased risk of neonatal mortality. PAM caused by *P.vivax*, *P. falciparum* or mixed infections (Pv and Pf) poses a substantial risk to the mother and fetus by increasing the risk of fetal death, prematurity, low birth weight (LBW) and maternal anemia, which are known to vary between stable and unstable settings. Given the limited information on asymptomatic malaria and placental malaria in South India[1,5,10,14], this study was undertaken to better define the burden of PAM, the prevalence of asymptomatic malaria and the relative contribution of *P. falciparum* and *P. vivax* during pregnancy and at delivery.

The study site chosen for our studies is the Mangaluru city, with the ultimate goal of enhancing the development of evidence-based policies to reduce the burden of disease due to PAM in this southwestern region of India. We investigated the local epidemiology pattern of malaria and its impact on pregnant women and their newborns.

The specific objectives were to determine the prevalence of malaria during pregnancy in this population of pregnant women and its association with maternal and birth outcomes and to measure the knowledge, practice and attitude of pregnant women in this region. The data obtained from this study is expected to help build an evidence base for the development of policies to reduce the burden of PAM in south India.[1,3,6]

Material and Methods

Study Site: Mangaluru city is situated 12.91°N, 74.85°E on the basin of rivers Netravathi and Gurupura in the Arabian peninsula of Dakshina Kannada district (Fig. 1). The city and its surrounding areas have a tropical climate with high rainfall and temperature varying from 17°C at night to 38°C during day times. The warm and humid climate of Mangaluru city and its surrounding areas provide an ideal environment for the breeding of mosquitoes and disease transmission. Thus, this area harbors high vector density and has high incidences of malaria.

Fig. 1: Mangaluru city map showing the malaria hotspots in the city

Study design and population: A community-based longitudinal study was conducted among pregnant women residing in malaria hotspot areas in Mangaluru. Four hotspot areas were selected for the survey based on historical malaria transmission data (Chilambi, Bengre, Kapikad, Bunder). Pregnant women irrespective of the gestational age were recruited to the study with informed consent and followed periodically until delivery for any signs of infection due to malaria.

Study tool: A semi-structured interview questionnaire was used to collect the information of the study population that included socio-demographic factors, resident status (whether they are long-time residents or migrated recently to this region for the livelihood), recent travel history and education level. Information about knowledge on the disease, how it spreads and transmits, preventive measures and where to get diagnosed and obtain proper treatment was collected. Other information collected was treatment-seeking behaviors such as measures taken after being sick, symptoms experienced during sickness and previous history of malaria, if any.

Statistical analysis: Statistical analysis of data was performed using Microsoft Excel and GraphPad Prism version 6.

Results

Characteristics of study participants: The study was conducted at four different localities, based on malaria transmission, in the Mangaluru city area within the city corporation limit. These localities are considered malaria hot spots in the city. During our field visits, we were successful in recruiting 29 subjects in our study of which 11 (37.93%) were immigrant and 18 (62.06%) were native pregnant women. Among the 29 pregnant women, 6 women contracted malaria infection irrespective of their gestation period. Out of 6 infections, 4 were due to *P.vivax* (66.6%) and one each (16.6%) were due to *P.falciparum* and mixed infections *(P.vivax* & *P.falciparum*) (Table 1).

Table 1
Classification of study participants

Type of infection	No. of study participants and percentage (n, %)*
P. vivax	4 (66.66%)
P. falciparum	1 (16.66%)
Mixed (Pv & Pf)	1 (16.66%)

*Data expressed as number of study participants and percentages with respect to infected groups

The mean age of study participants was 26 years which ranged between 18-40 years (Table 2). The study population was stratified into different age groups in which 2 (6.8%) were 15-20 years old, 9 (31.03%) were 21-25 years old, 14 (48.27%) were 26-30 years old, 3 (16.7%) were 31–35 years old and 1 (3.9%) was 36-40 years old. The majority of the recruited individuals among native individuals were housewives (9, 31%), construction workers (3, 16.66%) followed by vendors (3, 16.66%), working-class women (2, 11.11%) and daily wages worker (1, 5.55%).

Among 11 non-native pregnant women, 6 were engaged as construction workers (54.54%), 3 were housewives (27.27%) followed by a vendor (1, 9.09%) and a daily wage worker (1, 9.09%). Most of the study participants in the native group (10, 55.55%) had a secondary level of education, 5 (27.77%) had primary level education, 2 (11.11%) had college-level education and the remaining 1 (5.55%) did not have any formal education. Among 11 non-native groups of pregnant women, 4 (36.36%) had secondary level education, 3 (27.27%) had primary level of education and 4 (36.36%) didn't have any formal level of education.

Among the total of 11 immigrant study participants, 3 (27.27%) individuals had one or more time malaria in their lifetime, 6 (54.54%) had no malaria previous infection history and 2 (18.18%) were unsure about previous malarial infection. Among 18 native pregnant individual participants, 9 (50.0%) had the previous history of malaria infection, 6 (33.33%) had no previous infection and 3 (16.66%) individuals were unsure about previous malarial infection (Table 2).

Treatment seeking behavior among malaria-infected native and immigrant population: Among the 11 immigrant pregnant study participants, 8 (72.72%) had visited allopathy clinic or antenatal care for check-ups and seeking the treatment after feeling sick. Three (27.27%) pregnant individuals visited the local drug seller for the treatment. No one was found to try home remedies once they feel sick. Among 11 immigrant study pregnant participants, 9 (81.81%) took immediate treatment within 24 hours after feeling sick. Two (18.18%) had treatment after feeling sick within 2-4 days (Table 3).

Among the native pregnant study individuals, 29 (82.85%) had treatment from allopathy clinic and 3 (8.58%) took the tablets from local drug sellers. Among 18 native study participants, 16 (88.88%) pregnant individuals took the anti-malarial treatment without any delay (within 24 hours). One (5.5%) of the infected individual had treatment after feeling sick for 2-4 days. One (5.5%) was getting home remedies after feeling sick. Interestingly, among native and non-native individuals, no one opted for herbal medications.

Knowledge, attitude and practice about malaria in the native and immigrant population: Based on the knowledge of how malaria spreads, 15 (83.33%) of the total of 18 native individuals replied that the infection spreads through the bite of mosquitoes and 3 (16.66%) said that the infection was due to lack of cleanliness. Among 11 immigrants, 9 pregnant women (81.81%) knew that malaria spreads through the bite of the mosquito, one (9.09%) said

that it is due to lack of cleanliness and one (9.09%) said that it is due to fly/insect bite.

Regarding how malaria can be prevented, 8 (44.44%) of 18 native individuals replied that it can be achieved by limiting breeding sources, 4 (22.22%) said that by using bed nets while sleeping and 6 (33.33%) said that by using mosquito repellents.

Table 2
Socio-demographic characteristics of study participants*

	Immigrants		Native		Total	
	n	%	n	%	n	%
No. of Participants	11	37	18	63	29	100
Age						
15-20	1	9.09	1	5.55	2	6.89
21-25	3	27.27	6	33.33	9	31.03
26-30	6	54.54	8	44.44	14	48.27
31-35	1	9.09	2	11.11	3	10.34
36-40	0	0	1	5.55	1	3.44
Total	11	100	18	100	29	100
Education level						
Uneducated	4	36.36	1	5.55	5	17.24
Primary	3	27.27	5	27.77	8	27.58
Secondary	4	36.36	10	55.55	14	48.27
College education	0	0	2	11.11	2	6.89
Total	11	100	18	100	29	100
Occupation						
Construction workers site	6	54.54	3	16.66	2	6.89
vendors	1	9.09	3	16.66	6	20.68
working woman	0	0	2	11.11	2	6.89
coolie	1	9.09	1	5.55	1	3.44
Housewife	3	27.27	9	50	18	62.06
Total	11	100	18	100	29	100
Previous history of malaria						
Yes	3	27.27	9	50	12	41.37
No	6	54.54	6	33.33	12	41.37
Unsure	2	18.18	3	16.66	5	17.24
Total	11	100	18	100	29	100

*Data expressed as number of study participants and percentages with respect to infected groups

Table 3
Treatment seeking behavior among malaria infected native and immigrant pregnant individuals*

	Group			
	Immigrants		Native	
	n	%	n	%
Measures taken after feeling sick				
Allopathy clinic	8	72.72	16	88.88
Herbal medication	0	0	0	0
Drug seller	3	27.27	1	5.55
Home remedy	0	0	1	5.55
No measure was taken	0	0	0	0
Treatment time after feeling sick				
Within 2–4 days	2	18.18	12	66.66
No delay (within 24 h)	9	81.81	6	33.33
No treatment taken	0	0	0	0

*Data expressed as number of study participants and percentages with respect to infected groups

Table 4
Knowledge on malaria among native and immigrant pregnant women population*

		Group			
		Immigrants		Native	
		n	%	n	%
How does a person get malaria?	Mosquito bite	9	81.81	15	83.33
	Fly/Insect bite	1	9.09	0	0
	Lack of cleanliness	1	9.09	3	16.66
How malaria can be prevented?	Eliminating breeding sources	1	9.09	8	44.44
	Bed nets	5	45.45	4	22.22
	Mosquito repellents	5	45.45	6	33.33

*Data expressed as number of study participants and percentages with respect to infected groups

Among the immigrant group, 5 (45.45%) of 11 said that it can be achieved by using bed nets while sleeping, 5 (45.45.3%) said by using mosquito repellents and 1 (9.09%) said by limiting the breeding sources (Table 4). Overall, concerning knowledge on the risk of infection due to stagnant water storage, not using bed nets, traveling to endemic places and sleeping in those places with high vector density, was significantly higher in native individuals (pregnant women) compared to non-native pregnant women.

Discussion

In this study, an attempt has been made to understand the burden of pregnancy malaria in Mangaluru city. For the past few decades, malaria is endemic in this city and its surrounding areas with peak infections occurring during the rainy season. Although *P.vivax* and *P.falciparum* are prevalent throughout the year, the former infection predominates. The prevalence of *P.vivax, P.falciparum* and mixed infections in this region is ~80%, ~17% and ~3% respectively.

These results are consistent with the data recorded in the Mangaluru city area by the District Vector Borne Disease Control Program (DVBDCP) office of Dakshina Kannada District which shows that ~80% *P.vivax* and ~20% *P.falciparum* had infections. The data recorded by DVBDCP indicates that the Mangaluru city area has been showing similar ratios of *P.falciparum, P.vivax* and mixed infections since 1990.[1,14]

As per the report published by National Vector Borne Disease Control Programme (NVBDCP), the average *P.vivax* and *P.falciparum* infection throughout India are in the ratio of 1.5:1. However, the proportion of *P.vivax* and *P.falciparum* infection varies in different parts of India. The prevalence of malarial infections in Indo-Gangetic plains and Northern hilly states, Northwestern and Southwestern regions is 80-90% *P. vivax* and 10-20% *P.falciparum*, respectively.[8,16]

However, in the forest areas of South Eastern regions inhabited by ethnic tribes, the situation is markedly different with *P.vivax* to *P.falciparum* prevalence ratio of 3:1.[12,15] In Mangaluru, the incidence of malaria infection is significantly higher among immigrant workers compared to native individuals. This is due to the rapid urbanization, construction activity and it also depends on the immune response of the individuals. Most of the infected pregnant women were living in and around the construction sites as workers. These laborers are coming to Mangaluru mainly from Northern and Northeastern States of India where malaria is endemic.

These workers reside in temporary accommodation facilities often at the construction sites with poor living conditions, disposing of malaria infection. The water lagging at the construction sites and stagnant water in building under constructions provide ideal conditions for breeding the mosquito and spreading the disease.

Additionally, limited or lack of health knowledge on malaria contributes to the accelerated transmission of infection.[15,18] Although most pregnant women take ample care during their pregnancy period, other individuals who travel to malaria-endemic places are the main source of spreading malaria locally in Mangaluru, especially, the non-native individuals from Northern or Northeastern parts of India.[2,13] Thus, it appears that traveling of immigrants back and forth to their native places contributes enormously to the perpetual spreading of malaria in Mangaluru, despite several control measures in place.

Our study revealed that native pregnant women were significantly knowledgeable and took better preventive measures after feeling sick as compared to nonnative pregnant individuals.[19] The reduction in pregnancy malaria in this population is because of their awareness about malaria, education level and caretaking of family members during their pregnancy term. The immigrant pregnant women also visited ANC for general check-ups after feeling sick and for seeking treatment. However, due to lack of awareness about malaria, lack of hygiene, no formal education and economic status of the family, they have all contributed to making these pregnant women susceptible to malarial infection during their pregnancy.[16,19,20]

During early stages, particularly the first trimester of pregnancy, parenteral quinine is the drug of choice.

However, if quinine is not available at that time, artemisinin derivatives were given to get out this risky situation for mother and foetus. On the other hand, in the second and third trimester, parenteral artemisinin derivatives are preferred.[17,21]

Conclusion

Despite comprehensive malarial control and elimination programs implemented by the District Health Authority and National Vector Borne Disease Control Program, the control measures specifically aimed at malaria during pregnancy are not properly addressed. The present study has indicated that the underestimated burden of PAM in this region is of serious concern.

The lack of education among women, unavailability and poor coverage of government ANC services, lack of knowledge about malaria and associated anemia as well as non-compliance with preventive measures are the major reasons for malaria prevalence among pregnant women in Mangaluru city and its surroundings.

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