

Malaria in seasonal migrant population in Southern Gujarat, India

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Abstract. Malaria in migrant workers is always a major problem to control due to their temporary stay in shelters, and other operational constraints. Hence, a study was undertaken in brick kilns in Bharuch district, Gujarat state, India to study the problem of malaria in the work force. Mass blood surveys were carried out in 15 brick kilns. Blood slides were collected from both febrile and afebrile cases. Positive cases were treated as per the national drug policy and were followed up. Mosquito collections were carried out by pyrethrum spray collection in early morning hours. Human blood index and sporozoite rates were determined as per standard procedures. All age groups were found affected with malaria at brick kilns. Prevalence of malaria was significantly higher in ≤ 14 years of age-group as compared to adults. Post treatment follow up examination of patients revealed high malaria infection due to non-compliance of chloroquine. The appearance of parasitaemia among *Plasmodium falciparum* treated cases indicate the possibility of chloroquine resistance. The proportion of *P. falciparum* was $>50\%$ in migrant population. In stable population in villages, overall decline in malaria cases was observed in 2008-2010. The sporozoite rate of 4.2% in *Anopheles culicifacies* indicates active malaria transmission at brick kilns. The investigation demonstrated that suitable microclimatic conditions for malaria transmission exist in these areas during hottest period. The district health department should consider these factors in planning malaria surveillance and control. As current magnitude and diversity of population movements in rural as well as in urban areas are unprecedented, this issue is worthy of attention.

INTRODUCTION

Malaria has been associated with enormous economic loss, adversely affecting the agricultural, industrial and infrastructure development in the 20th century (Sharma, 1996; WHO, 1998; Jeffrey Sachs & Pai Malaney, 2002; Singh *et al.*, 2004). The public health department of India reports about two million malaria cases and 1000 deaths annually, although a fair proportion of the patients seek treatment in the private health sector (Yadav *et al.*, 2003). In 2010, 66139 (13267, *Plasmodium falciparum*) malaria cases with 26 deaths occurred in Gujarat state.

Gujarat state, being an industrial and urbanized state of India, migration from neighboring state is a common phenomenon. Seasonal migration has emerged as an important livelihood strategy for at least 20 million people in India living in areas where there is a lack of local opportunities to diversify out of agriculture (Jones & De Souza, 2004). Apart from these, rapidly increasing population also demands increase in construction of housing and infrastructure development. This has attracted nearly 3000 labours at 21 brick kilns from neighboring districts and far from malaria endemic states where *P. falciparum* predominates. The work

force was fetched by contractors in November-December in 2006-2010. They stayed at brick kilns along with their family for 5-6 months. Most of them lived in makeshift shelters made up of bricks, used open space to sleep and adults were working at night due to hot weather condition. The District Malaria Officers reported many malaria cases among the labourers. The Primary Health Centre (PHC) staff was unable to contain the malaria transmission in spite of spraying hutments with deltamethrin (2.5% WP) and impregnation of mosquito nets used by migrants. Therefore, an epidemiological investigation was carried out during April and May 2007 to find out the cause of high prevalence of malaria, to suggest effective methods to contain malaria in Brick kilns and implications and was followed up in 2009 and 2010. In this communication, we report the reason for high malaria prevalence in migrant population working at Brick kilns and possible implications.

MATERIALS AND METHODS

Study area

The study was carried out in the plain area of south Gujarat, taluka Jambusar, district Bharuch where malaria is unstable and rainfall dependent. The Bharuch district is located between 21.41° to 23°N latitudes and 72° to 73.01°E longitudes. The area is characterized by hot climate and receives rainfall between mid June to September from south west monsoon. The average annual rainfall ranges between 600 mm and 800 mm and the mean annual temperature ranges between 25°C and 32°C. The maximum temperature during summer (May/June) rises to 40°C and the minimum during winter (December/January) falls to 10°C. About 10 km area between Jambosur and Kareli in this Taluka is low lying land with high salinity, poor drainage system and poor fertility.

Parasitological survey

A cross sectional mass blood survey was carried out in 15 brick kilns in April 2007, 2009 and 2010. Finger prick blood samples

were collected from febrile and afebrile persons. Thick and thin smears were prepared, stained with Jaswant Singh and Bhattacharjee (JSB) stain and examined for the presence of malaria parasites. All malaria positive cases were treated as per the drug policy of National Vector Borne Disease Control Programme (NVBDCP), Government of India. Each malaria patient received a total of 1500 mg chloroquine (CQ) base (adult) or 25 mg CQ base/kg (children), divided over three consecutive days. All the patients aged >1 year and women without pregnancy were given a single dose of primaquine (0.75 mg/kg) on day one (*P. falciparum*) or 0.25 mg primaquine/kg/day for five consecutive days. As indicated by the then-current national drug policy, the treatment of *P. falciparum* was based on areas identified as chloroquine resistant/sensitive. Second line of treatment was arteimisinin combination therapy (Artesunate, 4mg/kg b w for three consecutive days + sulfadoxine, 25mg/kg-pyrimethamine, 1.25 mg/kg single dose on first day). Relevant information for each migrant such as the native district and State, duration of stay at brick kiln, past malaria history, symptoms, name, age and sex was recorded. The routine malaria surveillance data were collected from District malaria Officer, Bharuch.

Entomological survey

Indoor resting mosquito collections were done in 4-8 dwellings (hutments) at 6 brick kilns using suction tube and flashlight in mornings between 0530 and 0800 hrs. The collected mosquitoes were identified into species using standard keys. Freshly fed female *Anopheles culicifacies* (Diptera: Culicidae) were used to determine the human blood index (HBI) using gel-diffusion technique (Collins *et al.*, 1986). Survivorship of female *An. culicifacies* and identification of potential breeding habitats of vectors were determined by standard WHO methods (WHO, 1975). For the incrimination of vector, samples of head and thorax of *An. culicifacies* were assayed by ELISA for presence of *Plasmodium* sporozoites.

Statistical analysis

The data on various parameters recorded in the field were entered in Microsoft excel for windows 2007 and statistically analysed using student's *t*-test. *P* values <0.05 were considered as significant.

RESULTS

Malariometric indices in migrant workers and treatment

Mass blood surveys in 15 brick kilns in 2007 revealed 54.3% febrile (*Pf*: 59, *Pv*:10 and mixed: 1) and 45.7% (*Pf*:46, *Pv*:10 and mixed:3) afebrile malaria cases (n=129). In four brick kilns, >30% of people were infected with malaria parasites. Slide positivity rate (SPR) in other 9 brick kilns ranged from 4% to 28.6%, and in remaining two kilns, no one had malaria. Of the total malaria cases detected from kilns, 15.5% *Plasmodium vivax*, 81.39% *P. falciparum* and 3.1% were mixed (*Pv*+*Pf*) infections. In general, people of all age groups were affected with malaria and prevalence was highest in children aged 1-4 years (Table 1). Malaria prevalence was significantly higher ($p = < 0.0001$) in children (≤ 14 yr) as compared to adults (> 14 yr). The sex-related difference in parasite rate was not significant statistically ($p = > 0.05$). About 39.4% (43/109) of *P. falciparum* cases had gametocytes along with the rings. The proportion of febrile [19.26%; (21/109)] and afebrile [20.18% (22/109)] *P. falciparum* cases with gametocyte was nearly at par. The asexual parasite density for *P. falciparum* ranged from 280 to 19,720 parasite/ μ l with a median parasite density of 1820 parasite/ μ l. The parasitaemia level for *P. vivax* cases ranged from 200 to 25200 parasite/ μ l with a median parasite density of 3680 parasite/ μ l. State-wise distribution of malaria cases (Figure 1) showed highest parasite rate of 71.4% in migrants from Assam followed by migrants from Haryana (42.45%), Madhya Pradesh (24.1%), Maharashtra (25.6%), Uttar Pradesh (19.8%) and Gujarat (13.8%). The parasite rate was >50 % among children (≤ 14 years) from Madhya Pradesh, Haryana and Maharashtra States (Figure 2).

After 15 days post-treatment, follow up of 69 malaria cases (*Pv* =16; *Pf* = 50 and mixed = 3) showed that in case of mixed infections only *P. falciparum* parasite could be seen, indicating complete clearance of *P. vivax*. Similarly, parasitaemia was found cleared in all *P. vivax* cases, except in 2 cases. Out of the 50 *P. falciparum* cases followed, 23 were still parasitaemic. Interaction with patients revealed low level of drug compliance. All of them had taken incomplete treatment or not at all. The economic burden due to loss of wages and suffering from malaria compelled most patients to return to their native states.

For effective interruption of *P. falciparum* transmission among labourers at work site, in first week of May 2007, three teams of Medical Officers followed up 42 malaria cases who had taken incomplete treatment and registered 66 new fever cases, administered the oral Artesunate + Sulphadoxin-Pyrimethamine (ACT-SP) combination therapy for consecutive three days under supervision. On 4th day post-treatment, blood smear of only 16 people could be examined and none of them was parasitaemic for malaria, showing the effectiveness of artesunate combination therapy.

In a subsequent survey in 2009, low SPR of 5.01% was reported and in 2010 surveys, the SPR was 6 fold higher (34.27%) among the labourers working at the kilns. The proportion of *P. falciparum* ranged from 50-100% in different age groups in each year. The children of 1-14 yr age group were the most sufferers which indicate high risk of transmission among workers at brick kiln sites.

The analysis of malaria cases reported by primary health centre (PHC) in district Bharuch indicates that there was a gradual decline in cases in the district since 2006. However, in PHC Gajera the parasite rate in 2007 was higher as compared to 2006 which declined to < 2 in 2008- 2010. Similar trend was observed in the proportion of *P. falciparum* (Table 2).

Table 1. Age-wise malaria prevalence in migrants at brick kilns, based on mass blood survey

Parameters	Period	Age groups (in years)					All age groups
		<1	1 to 4	5 to 9	10 to 14	>14	
Blood slide examination		5	53	77	55	387	577
Cases		1	31	26	15	56	129
<i>P. vivax</i>		1	4	7	2	6	20
<i>P. falciparum</i>	2007	0	25	17	13	50	105
Pv+Pf	(April)	0	2	2	0	0	4
Slide positivity rate		20	65.5	30	21.7	15.9	25.3
% <i>P. falciparum</i>		0	94.7	58.3	80	85.7	81
Blood slide examination		16	65	56	56	342	535
Cases		2	5	3	3	14	27
<i>P. vivax</i>		1	1	0	0	5	7
<i>P. falciparum</i>	2009	1	4	2	3	9	19
Pv+Pf	(May)	0	0	1	0	0	1
Slide positivity rate		12.5	7.69	5.35	5.35	4.1	5.01
% <i>P. falciparum</i>		50	80	66.6	100	64.3	70.37
Blood slide examination		8	40	41	52	288	429
Cases		3	16	22	23	83	147
<i>P. vivax</i>		1	3	1	5	6	16
<i>P. falciparum</i>	2010	2	11	19	18	74	124
Pv+Pf	(April)	0	2	2	0	3	7
Slide positivity rate		37.5	40	53.6	44.23	28.8	34.27
% <i>P. falciparum</i>		66.6	81.25	95.4	78.3	92.77	89.1

* Pv: *P. vivax*; Pf: *P. falciparum*; Mixed: (Pv+Pf); Pf (%): *P. falciparum* percentage

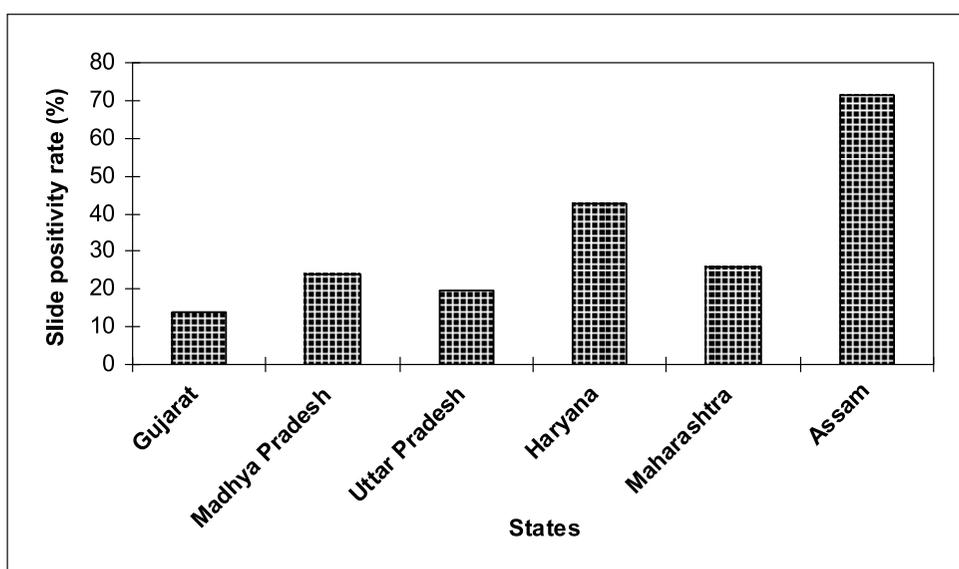


Figure 1. Malaria parasite rate in migrants from different states at brick kilns (clubbed for all the years)

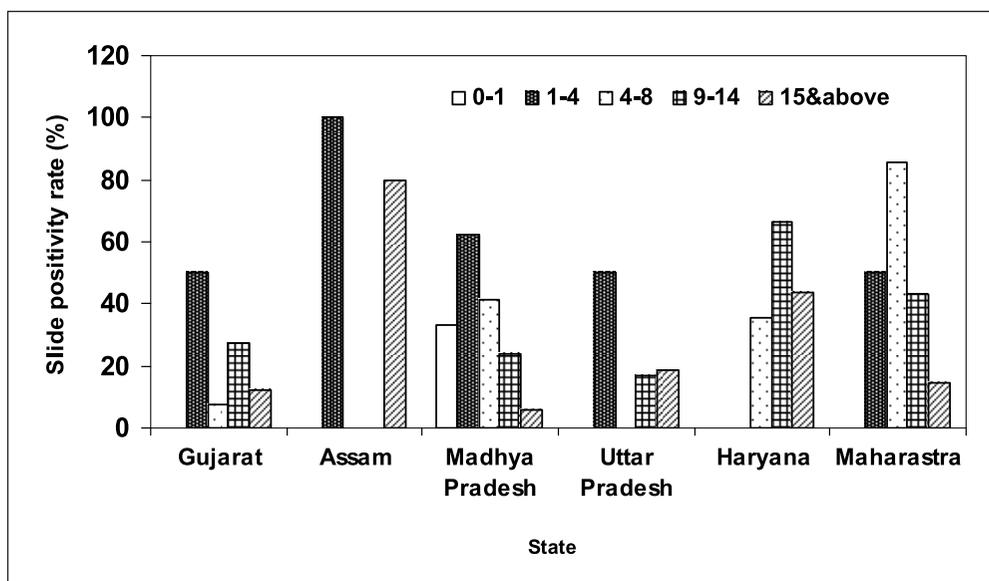


Figure 2. Malaria prevalence in migrants from different states at brick kilns

Table 2. Malaria incidence in district Bharuch and in villages under primary health centre Gajera

Year	BSE	Cases	<i>P. vivax</i>	<i>P. falciparum</i>	SPR	% Pf
Bharuch District						
2006	306936	3076	2082	994	1.00	32.31
2007	191563	2129	1506	623	1.11	29.26
2008	156663	1108	932	176	0.71	15.88
2009	172454	1044	916	128	0.61	12.26
2010	142038	858	748	110	0.60	12.82
Gajera PHC						
2006	9736	218	80	138	2.24	63.30
2007	7492	388	176	212	5.18	54.64
2008	5302	72	62	10	1.34	13.89
2009	5378	107	82	25	1.99	23.36
2010	5680	54	45	9	0.95	16.67

BSE: Blood slide examination, SPR: Slide positivity ate

Malaria vector potential

In indoor resting collections, two anopheline species, *An. culicifacies* and *Anopheles subpictus*, were found in hutments at kilns site. Apart from these, *Culex quinquefasciatus* and *Culex bitaeniorhynchus* were also recorded in small numbers. *Anopheles subpictus* was the predominant species, constituting 85% of the anopheline collections. Geometrical mean density of *An.*

culicifacies varied greatly in different kilns (Table 3). The mosquito blood meal analysis of *An. culicifacies* showed an HBI of 3.6% (4/110) and indicates low preference to human blood. Similar results have also reported from other areas in India (Bhatt *et al.*, 1994; Sharma *et al.*, 2006). The parous rate of *An. culicifacies* was 54.29% (57/105) and survival rate was 0.295 (with gonotrophic cycle being 2 days). The sporozoite rate of

Table 3. Geometrical mean per man hour density of mosquitoes at brick kilns in April 2007

Brick Kilns	<i>Culex</i> spp.*	<i>An. culicifacies</i>	<i>An. subpictus</i>
Patel Bricks	0.294	0.938	1.258
Hindustan Bricks	0.000	0.000	1.546
DH-1 Bricks	0.175	0.524	1.857
Sakir Bricks	0.000	1.109	2.153
Gulab Bricks	0.638	0.239	2.008
Abdul Bricks	0.223	0.223	2.125

**Cx. quinquefasciatus* and *Cx. bitaeniorhynchus*

An. culicifacies was 4.21% [7/166 ($Pf = 4$ and $Pv = 3$)]. The potential mosquito breeding habitats around brick kilns were large burrow pits, seepage pools and cement tanks. *Anopheles culicifacies* was found breeding profusely in 60% (9/15) of burrow pits, infested with aquatic vegetation (mainly Hydrilla).

DISCUSSION

The unprecedented increase in mobility in last few decades has led to great concern about the relationship between mobility and malaria. One of the factors contributing to the resurgence of malaria is human migration (Bruce-Chwatt, 1968; Prothero, 1977). We studied the epidemiology of malaria in migrant work force at brick kilns, in Bharuch district in western part of India where malaria is a major problem. In the brick kilns, people of all age groups had malaria. The prevalence of malaria in afebrile cases indicates high level of immunity and a reservoir in the migrant population. *Plasmodium falciparum* was most prevalent in labourers with high gametocyte rates. High prevalence of malaria among workers from Madhya Pradesh, Haryana and Maharashtra contributed to malaria transmission at brick kilns. The proportion of *P. falciparum* in some of native states (Madhya Pradesh, Orissa, Assam and Maharashtra) of migrants was 30-60% of the total malaria cases per year. These states had already reported chloroquine resistant *P. falciparum* and *P. vivax* strains from different

districts (NVBDCP, 2010). At brick kilns, post-treatment appearance of parasitaemia indicates the possibility of chloroquine resistance among *P. falciparum* cases whereas among majority of the *P. vivax* cases parasitaemia was cleared after treatment except in two cases, indicating low level resistance against CQ or incomplete treatment or CQ was not taken by patient. Secondly, poor awareness about the importance of chloroquine and primaquine treatment among workers led to low drug compliance and high parasite/ gametocyte load. Incomplete treatment by Registered Medical Practitioners, not giving primaquine had made the situation complicated. Possibly, the malaria transmission in stable population (nearby villages in PHC Gajera) was enhanced in 2007 due to local workers. Aggregation of such work force may also contribute to drug resistance or accelerate transmission of resistant strains (Srivastava & Sharma, 2000). In subsequent years (2008-2010), decline in morbidity in PHC Gajera indicates effective action of the health staff and impact of ACT administration for treatment of *P. falciparum* infections.

The investigation demonstrated that prevailing local ecological conditions favoured the malaria transmission. *Anopheles culicifacies*, a major malaria vector species in this area, was found resting indoors and breeding profusely in burrow pits. In Gujarat, the temperature above 35°C and low humidity in summer affect the population and survivorship of *An. culicifacies* (Bhatt *et al.*, 1994). However, incrimination and

adequate survivorship of *An. culicifacies* in April showed that suitable microclimatic conditions for malaria transmission exist in this area even during the hottest month of the year. Therefore, increased exposure of workers to the vector, sleeping pattern and low cattle population could have enhanced the man-mosquito contact. The spraying with deltamethrin (2.5%) in makeshift shelters and other anti-mosquito measures implemented in January by State health staff were too late and ineffective to block the transmission in brick kilns.

Generally, all available resources of the health department are concentrated to stable populations in rural and urban areas. In remote areas, where workers stay, health facilities are limited. Moreover, most of the workers seek treatment according to their economic status either from private medical practitioners or traditional medicines from the quacks. Although aggregation of labours from all over India is a regular phenomenon in Gujarat, insufficient attention has been paid to migrant population in planning malaria control. Short duration stay of labourers along with their families at kilns in deplorable conditions has created a serious problem for the state health department.

Emphasis must be placed on regular malaria surveillance in seasonal labours, monitoring of drug resistance among migrants, strengthening infrastructure in Primary Health Centres to ensure early detection and treatment. Since indoor residual spray in the makeshift hutments is not much effective for vector control, insecticide impregnated nets, bio-larvicides or Insect Growth Regulator compounds would be effective to prevent the malaria transmission by local vectors at brick kilns and construction sites in the state. Labourers should be made aware of the malaria risks and have adequate access to treatment. Areas at risk for epidemics through the influx of infected people should be identified. The district health department should consider these factors in planning malaria control. As current magnitude and diversity of population

movements in rural as well as in urban areas are unprecedented, this issue is worthy of attention.

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