# Migration malaria associated with forest economy in central India

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**An investigation on malaria was undertaken after reports of high fever and deaths in Jabalpur, Madhya Pradesh (MP) during the dry, hot weather. Inquiries revealed that 39 people from 14 families went to the forest in Panna district (MP) for collection of mahua (for making liquor), among which two had died. Examination of 37 migrants revealed 84% *Plasmodium falciparum* infection and the death of one migrant. Investigation on the site of occupational activities of these migrants in Panna revealed 77% *P. falciparum* in rapid fever surveys. The epidemiological role of migrants in the dissemination, maintenance and enhancement of malaria transmission is discussed in this study.**

MALARIA is a focal disease with multitudinous variations in its epidemiological pattern in relation to topographical and socio-economic features[1,2]. Large-scale developmental activities in the tribal belt of Madhya Pradesh (MP) due to several multipurpose projects resulted in the movement of people from one area to another[3,4]. This coupled with nomadism as practised in some tribal populations of the State has posed a sizeable problem, which is a major threat to the country. Consequently, the disease is affecting areas that have been previously free from malaria and is becoming more severe as a consequence of the increasing incidence of *Plasmodium falciparum* infection.

This study was undertaken after reports of high fever and deaths during the last week of April 2003 in some families of Panagar Primary Health Centre (PHC), District Jabalpur, MP (*Hindustan Times*, 28 April 2003 and *Dainik Bhaskar*, 28 April 2003). An emergency medical team was sent to investigate the cause of high fever and death[5]. Clinically, the fever appears to be due to malaria, but epidemiological evidence is against it.

## Materials and methods

This study was carried out between 28 April and 30 June 2003 in two district, i.e. Jabalpur and Panna, MP (Figure 1).

### *Study area*

Jabalpur (22.8–24.2°N lat, 79.4–80.9°E long) with an area of 5.6 thousand km$^2$ is the third largest town in MP (14% area under forest). The district has a total population of 2.1 million (ethnic tribal 14.9%). Malaria is low to meso-endemic. Peak transmission seasons are July–January for *P. falciparum* and February–June for *P. vivax*[6]. Village Raipura, Panagar PHC, Jabalpur has a population of 2000. The houses of 14 affected families are on the roadside and approachable throughout the year. These people are illiterate and have immense faith in sorcery and witchcraft. Thirty-nine persons went to Pawai PHC, Panna District (250 km) in last week of March for collection of forest produce. They stayed for about 3 weeks in the dense reserve forest and returned to their homes during the second week of April. Within 2 weeks almost all of them developed high fever, among which two died (one adult and one girl of 13 yrs) (District Malaria Office, unpublished data 2003). A medical team from the Malaria Research Centre examined these patients to investigate the cause of high fever. A finger-prick blood sample was collected from all migrants by a team of two field-workers. The sample was used to prepare thick and

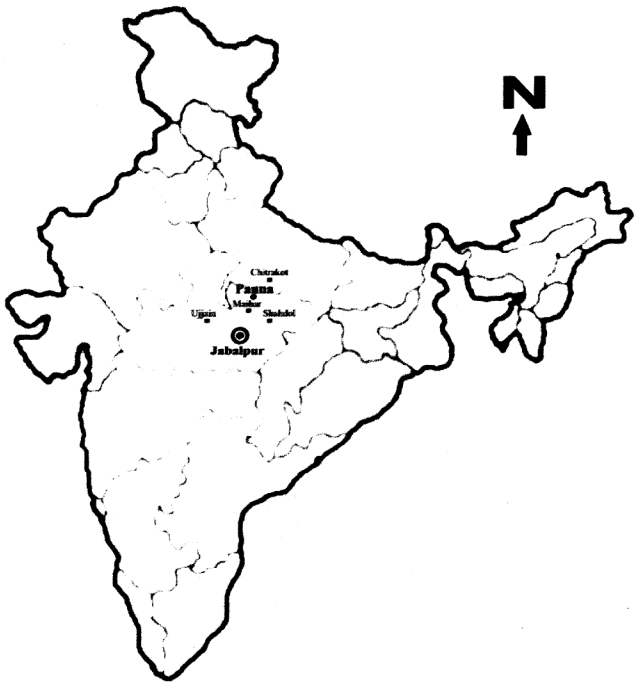


**Figure 1.** Map of India showing Jabalpur and Panna districts, Madhya Pradesh and other districts where migrants visited for worship after outbreak of malaria. (Source: http://www.mrcindi.org).

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thin blood smears and for testing with the Paracheck Pf test[5]. Simultaneously, blood samples from neighbouring families were also collected to assess the prevalence of malaria among the indigenous population.

Another team was sent to the site (Shyamgiri section, Pawai PHC; Panna District; 23.48–24.27°N lat, 79.45–80.40°E long, 7135 km$^2$; 57% area under forest cover), where the migrants went for occupational activities. The terrain in Pawai PHC is highly undulating, hilly (492.86–700 m msl) and the forest is tropical deciduous. The total population of the district is 0.92 million, of which 15% is ethnic tribe. A visit to the forest site revealed that not a single migrant labour was present as the season of forest produce was over. The team surveyed 13 nearby inaccessible and remote villages and found high fever rate in the community. The blood smears were made from all fever cases and cases with history of fever in ten villages. To assess the magnitude of the problem, blood smears were also collected door-to-door from all persons available in three villages. People from these villages are illiterate, poorly clothed and poor. Their houses were made of mud and thatch often near the stream or its tributary in the forest. The houses were dark and damp even during summer. Windows were seldom provided.

### *Parasitological and entomological monitoring*

Blood smears were stained with JSB and examined in field to provide prompt malaria treatment according to National Vector Borne Disease Control Programme (NVBDCP), i.e. 1500 mg chloroquine over 3 days (600 mg, 600 mg and then 300 mg) and 45 mg primaquine as a single dose, to adult patients with *P. falciparum* infection. Next 600 mg chloroquine followed by 15 mg primaquine/day for 5 days to adult cases of *P. vivax* infection and proportionally smaller doses for children, according to age. Pregnant women and infants were not given primaquine. Parasites were counted against 200 white blood cells and converted into counts/µl, assuming the average count in 8000/µl.

Mosquito collections were made from three villages in Panna and from village Raipura, Jabalpur. Anophelines resting inside four fixed houses were sampled during early morning (0600 h) for 15 min in each place according to standard techniques. Mosquitoes were also collected by light trap from one village (other than those selected for indoor resting collections) in Panna as described earlier[6].

The climate is characterized by a hot summer (March–June), a monsoon/rainy season (July–October) and a cool autumn season (November–February). Rainfall in Panna in 2002 was 1026.4 mm and in Jabalpur 1274.8 mm. Both Jabalpur and Panna districts were under regular HCH spray (hexa chlorocyclo hexane 200 mg/m$^2$) till 1996. From 1997 HCH was banned and since then both the districts have not been sprayed. For analysis of epidemiological trends, previous years' data (1986 2002) of both the districts were obtained from the respective District Malaria Officers of Panna and Jabalpur. Records of Raipura revealed that not a single case of malaria was found either in 1999 or in 2002. However, only two cases were recorded in 2000 and 2001. Records from Pawai PHC during the last five years revealed almost stable malaria situation. In 1998, only 183 parasitologically confirmed malaria cases and in 2002 only 184 malaria cases were found.

### *Statistical analysis*

Student's *t* test and chi-square test were employed for assessing the statistical significance of differences between malaria incidence and prevalence.

## Results

### *Panagar, Jabalpur*

Out of 37 fever cases, 31 were infected with *P. falciparum* among which one died (adult aged 35 yrs). The age group ranged from 4 to 46 years. Only 13% had gametocytes along with ring stages. The parasite density ranged from 120 to 300,000 with a geometric mean parasite density (GMPD) of 1021.33 ± 10.5 parasites/µl. The patient with 300,000 parasites/µl died. Inquiries revealed that these people went to Panna district in March for collection of mahua (*Madhuca indica*) flowers (Figure 2) (used for making country liquor) and spent 3 weeks in open dense forest, about 2–5 km from villages, where they slept under the mahua tree without any preventive measures against malaria. After returning to Jabalpur, within a fortnight they all had *P. falciparum* infections. All patients were admitted in District Hospital, Jabalpur for prompt treatment by the district administration. However, these people were so scared because of severe symptoms and death of their companions in a short period, that they all left the hospital to different religious places (Figure 1). A follow-up of 30 cases on day-14 post-treatment revealed that seven cases were still parasitaemic, among which 71% had gametocytes (563.1 ± 1.67 parasite/µl). They were given single dose (SP) sulfadoxine pyrimethamine (1500 mg sulfadoxine and 75 mg pyrimethamine). Additionally, one *P. vivax* was also recorded during follow-up on day-14. Follow-up on days 3, 7, and 14 after SP treatment revealed that none was parasitaemic for malaria (data not shown).

The results of blood smears from adjoining houses of these migrants showed that none was positive for malaria (0/150). However, one month later, six malarial cases (3 *P. falciparum* and 3 *P. vivax*) out of 50 fever cases were found among the indigenous population.

### *Pawai, Panna*

Point prevalence surveys carried out in ten villages revealed 244 fever cases, of which 115 were infected with malaria,

**Table 1.** Age-wise malaria prevalence in rapid fever survey (ten study villages) and mass survey (three study villages) in Pawai PHC, Panna District, MP

| Age group (yrs) | Survey | BSE* | +Ve | Pv | PfR | PfRg | Pfg | SPR (%) | SfR (%) | Pf (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| ≤ 4 | RFS | 71 | 29 | 10 | 17 | 2 | 0 | 40.8 | 26.8 | 65.5 |
| | MS | 56 | 20 | 5 | 11 | 2 | 2 | 35.7 | 26.8 | 75.0 |
| > 4 to 8 | RFS | 33 | 20 | 5 | 12 | 2 | 1 | 60.6 | 45.4 | 75.0 |
| | MS | 59 | 19 | 3 | 10 | 5 | 1 | 32.2 | 27.1 | 84.2 |
| > 8 to 14 | RFS | 24 | 15 | 3 | 10 | 1 | 1 | 62.5 | 50.0 | 80.0 |
| | MS | 52 | 22 | 2 | 14 | 4 | 2 | 42.3 | 38.5 | 90.9 |
| >14 | RFS | 116 | 51 | 9 | 37 | 3 | 2 | 44.0 | 36.2 | 82.3 |
| | MS | 147 | 34 | 3 | 20 | 6 | 5 | 23.1 | 21.1 | 91.2 |
| All age groups | RFS | 244 | 115 | 27 | 76 | 8 | 4 | 47.1 | 36.1 | 76.5 |
| | MS | 314 | 95 | 13 | 55 | 17 | 10 | 30.2 | 26.1 | 86.3 |

*BSE, Blood slide examined; +Ve, Malaria-positive, Pv, *Plasmodium vivax*; PfR, *P. falciparum* rings; PfRg, *P. falciparum* ring and gametocytes; Pfg, *P. falciparum* gametocytes; SPR (%), Slide positivity rate; SfR (%), Slide falciparum rate; Pf (%), *P. falciparum* percentage, RFS, Rapid fever survey; MS, Mass survey.

**Figure 2.** Women collecting mahua (*Madhuca indica*) flower in forest for making liquor. Grazing animal is also seen.

**Table 2.** Average per man hour density of cattle shed and human dwelling in Jabalpur and Panna (May–June 2003)

| | May | | June | |
|---|---|---|---|---|
| Species | Jabalpur | Panna | Jabalpur | Panna |
| *An. culicifacies* | 0 | 2.5 | 2.0 | 10.7 |
| *An. subpictus* | 0 | 0.75 | 2.5 | 8.0 |
| *An. annularis* | 0 | 0 | 0 | 1.5 |
| *An. pallidus* | 0 | 0 | 0.5 | 0.75 |
| *An. varuna* | 0 | 0 | 0 | 0.5 |

76% was *P. falciparum*. All age groups were found affected (Table 1) and the difference in malaria prevalence between children (≤14 yrs) and adults (>14 yrs) was not significant statistically. The asexual parasite density for *P. falciparum* ranged from 120 to 890,000 parasites/µl with a GMPD of 1676.72 ± 9.61. The patient with 890,000 parasites/µl died. For *P. vivax*, the GMPD was 917.81 ± 3.27 (range 168–3120 parasites/µl).

Mass surveys in three villages revealed the presence of 95 malaria cases out of the 314, among which *P. falciparum* was 86%. Analysis revealed that malaria prevalence was significantly higher ($P < 0.005$) in children (≤14 yrs) compared to adults (>14 yrs). Similarly, *P. falciparum* prevalence was significantly higher ($P < 0.025$) in children as compared to adults. The GMPD for *P. falciparum* was 937.35 ± 7.83 (range 120–579,000 parasites/µl) and for *P. vivax* 818.19 ± 2.26 (range 120–3120 parasites/µl). These patients were treated immediately by PHC staff. Four cases (all adults) with *P. falciparum* infection died, among which one was a 7-month pregnant woman.

### *Entomological monitoring*

The results of four indoor resting mosquito collections in Panna in May revealed the presence of only *Anopheles culicifacies* and *An. subpictus* (Table 2). However, with rains in June, *An. annularis*, *An. pallidus* and *An. varuna* were recorded. In light-trap catches, *An. theobaldi* and *An. splendidus* were also trapped additionally. On the contrary in Jabalpur not a single *An. culicifacies* or any other vector was found in May. Small numbers of *An. culicifacies*, *An. pallidus* and *An. subpictus* were found in indoor, resting collection in June.

## Discussion

The spread of malaria from one district to another has become increasingly common due to dramatic increase in migration and the development and spread of drug resistance in malaria parasites[7]. However, studies on migration malaria are scarce and epidemiology of migration malaria is complex. It is important to understand how migrants have affected the epidemiology of malaria.

The age-specific prevalence of malaria in Panna indicates that they had little experience of malaria and therefore only a low level of herd immunity and faced a high risk of malaria infection. The PHC responsible for providing

health services to the villages was understaffed and could hardly cope with the high prevalence of malaria; it was practically focusing on short-term curative medicines. Further, the temporary stay of migrant labours created new risk situations which result in heavy loss of life and severe morbidity due to malaria. The importance of mahua in the tribal economy and its correlation with malaria was suspected in an earlier study[6]. The migrants frequently spent the night in the open, presumably providing a source of infection to the anopheline prevalent outdoors. Epidemiologically, this results in a mix of immune and non-immune population and dissemination of malaria throughout the country.

Monitoring of vectors revealed that *An. culicifacies* was the only vector species found in small numbers. Rise in temperature and drop in humidity affect the anopheline population. Further, transmission is not feasible during hot summer months[8], as the average temperature is above 30°C. Interestingly, *An. culicifacies* was incriminated in the month of May, in an earlier study from Mandla, a neighbouring district[9]. Perhaps microclimate is playing a role in the survival of *An. culicifacies* to support *P. falciparum* sporogony during extremely hot conditions.

NVBDCP in India is redirecting its efforts from large-scale indoor residual spraying to other means of controlling the disease. Much emphasis is given on early detection and prompt treatment (EDPT). However, in such scattered areas knowledge of the cause of malaria is poor and malaria was treated by a number of traditional practices[10], herbal remedies[11], including spiritual therapy. Moreover, most of the malaria cases are treated with chloroquine at home through forest guards or school teachers, which may not provide radical treatment. People are not aware about the efficacy of drugs and the malaria gametocyte load remains high in communities. The severity of symptoms among the low immune population was a serious concern. The problem is further compounded by poor infrastructure, making it difficult for seriously ill patients to access government facilities. There are no telephone services to any of the government-maintained PHC and mini PHCs, nor ambulances to take patients to a better-equipped hospital, if necessary. Deaths occur mostly at home, often before any contact has been made with the formal health services.

In planning for malaria control, insufficient attention was given to the multi-faceted nature of mobility and other human factors. The constant movements in the forest make it impossible to maintain contact with people for EDPT. Migrants seek new avenues of employment generated by the forest, hence they are at a particularly high occupational risk of malaria. Thus there is need to understand and monitor these special migrations in a forest ecosystem to reduce and control the disease. It is important to ensure that migrants should take chemoprophylaxis. Therefore, policy makers should be made well aware of the need of chemoprophylaxis to the migratory population.


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ACKNOWLEDGEMENTS. We thank Dr A. P. Dash, Director, Regional Medical Research Centre, Jabalpur for help and guidance; Dr N. K. Jain and Dr S. S. Bhadoria, District Malaria Officers (NAMP) of Jabalpur and Panna respectively, for help and support during this investigation.

Received 16 April 2004; revised accepted 23 July 2004