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TRIBAL MALARIA

Malaria is a major public health problem in India and its dynamics vary from place to place[1]. In central India malaria is complex because of vast tracts of forest with tribal settlement. According to a 1987 estimate , 54 million tribals of various ethnic origins residing in forested areas and accounting for 8% of the total population contributed 30% of total malaria cases, 60% of total *Plasmodium falciparum* cases and 50% of malaria deaths in the country[2]. Keeping this in view a new malaria control strategy named Enhanced Malaria Control Project (EMCP) was introduced in 1998 by the National Anti Malaria Programme (NAMP) in seven peninsular states of India with World Bank assistance[3]. The main components of the EMCP are early case detection and prompt treatment, selective vector control, personal protection measures, information, education and communication with community involvement for malaria control activities and distribution of more potent and less toxic drugs in resistant areas as identified by NAMP[3]. In Madhya Pradesh (MP) and Chhattisgarh districts having more than 25% tribal population have been brought under EMCP. The gravity of the problem can be assessed by the fact that in MP (pop 63,668,000), 19% population of the 15 districts of state is under EMCP which contribute 53% malaria and 71.5% *P. falciparum* cases. Similarly Chhaittisgarh has a total population of 23,070,000 of which 41% are under EMCP, which contribute 91% of malaria and 96% of *P.falciparum* cases in the state[4]. Almost all the deaths (91%) in Chhattisgarh were from EMCP districts. The ethnic tribal population of Chhattisgarh is one third of total population which is highest for any state in the country. Further, it is the 2nd highly malarious state in India after Orissa[5]. The annual blood examination rate (ABER) and annual parasite incidence (API) of India were 8.5 and 1.8 respectively in 2002, while the corresponding figures for Chhattisgarh were 16.22 and 10.6[5].

Since large part of both MP and Chhattisgarh are hilly, forested and inaccessible with poor communication facilities, control of malaria is logistically difficult and outbreaks are frequently recorded[6-7]. The present article attempts to provide a profile of malaria in the region briefly covering various elements of disease transmission in order to asses the magnitude of problem of tribal malaria in central India (MP and Chhattisgarh).

Topography

Madhya Pradesh is situated in the central part of India with an area of 305.3 thousand km^2 of which forest covers 95,221 km^2 (about 31% of the total land area). Chhattisgarh is comparatively smaller state with an area of 135,194 km^2 of which 60,928.9 km^2 is under forest (about 45% of the land area). Both are rural agricultural states marked by severe poverty and under development[8]. The terrain is highly undulating and the villages are located on the hill top or on slopes of the hillocks cris-crossed by hilly streams. The topographical conditions of the area appear to be responsible for keeping the inhabitants at the stage of hunting, food gathering, primitive agriculture and shifting cultivation.

Climate

The climate of the region is characterized by a hot summer (March-June), mansoon/rainy seasons (July-October) and a cool/autumn seasons (November-February). The area receives good annual rainfall which ranges between 1400 to 2000 mm. Almost all the rain falls in a single rainy season between June to October. There is very little precipitation during the rest of the year. May is the hottest month and December is the coldest month.

Habit and Habitat

There are hardly any school or health centre in these tribal villages and people are mostly illiterate, scantily clothed and have immense faith in sorcery and witch craft. Their houses are scattered in agricultural fields and forest and are made of mud, thatch and bamboo. Houses are generally dark, damp and often without ventilation. Fewer than 20% house have electricity (only one point connection per dwelling). Very often domestic animals are also sheltered in the same house. Drinking water is brought from the wells or seepages or streams. A typical tribal house consists of a living room and a kitchen almost combined. The doors are low and small and windows are seldom present in about 90% of the houses. Majority of residents sleep on floor without any mattress or blanket. The family size varied from 2 to 17 with an average of 5.6 members. Most of the men and women work as laborers in forest nurseries, road construction and other casual jobs away from their homes.

Vectors

Malaria in this region is transmitted by two efficient vectors *ie. Anopheles culicifacies*[9-10] and *An.fluviatilis*[11]. The densities of *An.culicifacies* are very high throughout the year in most parts of MP[7,9]. It is mainly endophilic but in dense forest it was partially exophilic[12]. On the contrary, *An.fluviatilis* was mainly exophilic[9]. Interestingly, monitoring of indoor resting density revealed that densities of *An.fluviatilis* were very low or absent in forest villages, however, in outdoor light trap catches, *An.fluviatilis* were trapped in large numbers almost throughout the year (Table). Both *An.culicifacies* and *An.fluviatilis* breed profusely in the rocky beds of streams, stream bed pools and seepages. *An.fluviatilis* breeds in slow running streams and its tributaries. The problem is further compounded by the fact that *An.culicifacies* is resistant to DDT. Susceptibility tests carried out in MP revealed that the corrected mortality to 4% DDT ranged from 5-34% in various districts[13].

Table. Light trap collections (outdoor) and indoor resting per man hour density (PMH) of malaria vectors in forest villages of Mandla district (M.P.).

Year/ Month (1996)	*An.culicifacies*		PMH	*An.fluviatilis*
	PMH	No. of Mosquito/ Trap		No. of Mosquito/ Trap
Jan	46.2	9.0	6.5	16.2
Feb	65.0	15.2	3.5	11.2
Mar	70.7	47.7	0.5	82.3
Apr	41.5	44.3	0	50.3
May	50.5	5.5	0	2.0
Jun	41.5	2.0	0	0.5
Jul	37.5	16.3	0	2.0
Aug	110.5	24.2	0.5	7.4
Sep	84.3	14.3	0.5	11.3
Oct	40.5	7.5	1.5	33.5
Nov	47.0	8.2	2.5	16.0
Dec	26.0	10.3	2.5	23.3

Source : Singh, N. (Unpublished data), 1996.

Epidemiological Profile

Madhya Pradesh

In India the National Malaria Eradication Programme was launched in 1958 and consequently malaria control activities peaked during the 1960 with the help of powerful tools like DDT and chloroquine (CQ). Encouraged by the spectacular success it was expected that eradication would be achieved by 1966-67. However, malaria resurged in the 1970's (Fig. 1) and reached its peak in 1976. But the number of malaria cases reduced drastically to more than half in 1977 and it showed a steady decline till 1979. This may be considered as the usual post epidemic decline after a deadly epidemic of 1976. In 1980, the number of cases again increased exponentially and then showed a gradual decline till 1984 as a result of antimalarial measures. Records reveal a moderate but constant increase in the number of malaria cases in 1986-87, which remained almost static till 2002 with some fluctuations probably as a consequence of ease of self-treatment.

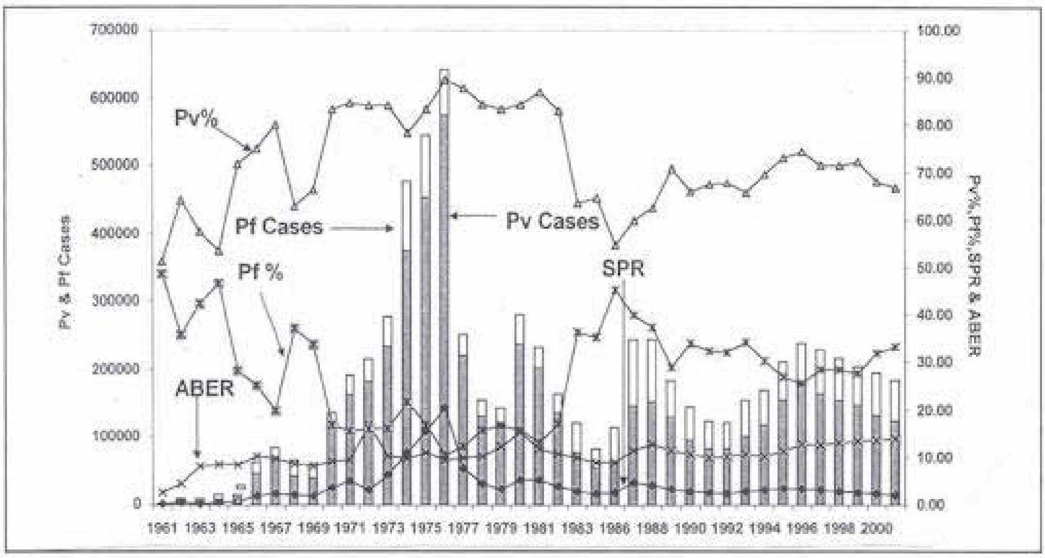

Fig.1. Malaria profile of Madhya Pradesh (1961-2001)
(Source : Directorate of Health Services, Madhya Pradesh)

On the contrary, in Mandla, a tribal district of MP under EMCP with more than 60% ethnic tribal population, the trend of malaria is different compared to MP as a whole (Fig.2). The NAMP records revealed that 16 million

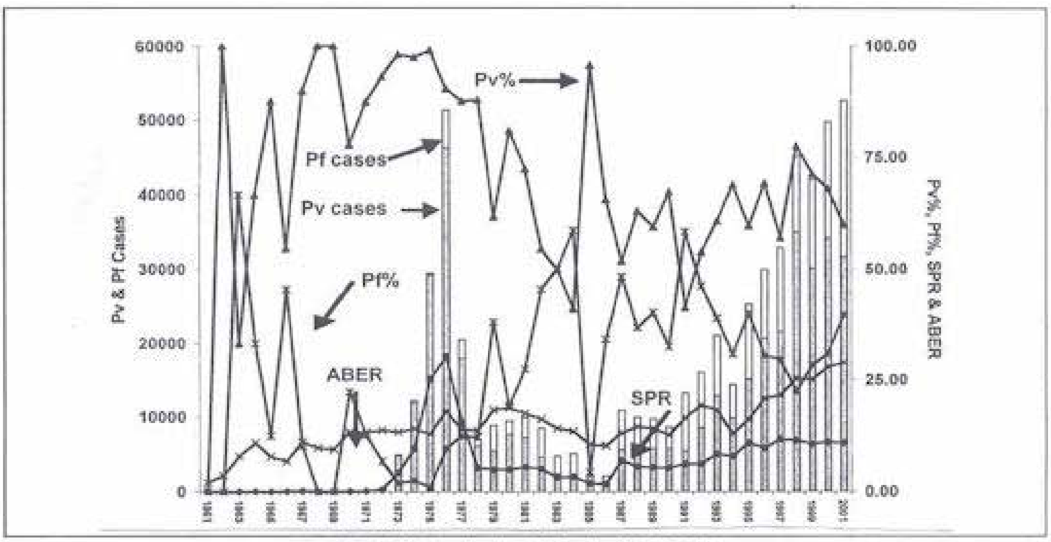

Fig.2. Malaria Profile in Mandla (1961-2001)
(Source: District Malaria Officer Mandla, Madhya Pradesh)

population of Mandla (2.6% of total population of MP) contribute to 25% malaria and 15% *P.falciparum* infections[14]. Records also revealed that in 1962 only two malaria cases were recorded from the district and between 1963 to 1970, the total number of malaria infections recorded were only 315. However, malaria cases started increasing from 1971 and showed peak in 1976 when 51183 malaria cases were recorded. There after as a result of intervention measures malaria showed a decline till 1986. The reasons for striking increase in malaria cases from 1987 onwards were not known and the malaria situation was gradually back to 1976 stage (epidemic year). This seemed to be related to hydrological changes brought about by major irrigation and hydroelectric projects on river Narmada. Outbreaks were also recorded in some other districts of MP[15] and foci of the disease shifted virtually from year to year. It appears that human migration between malaria endemic and non-endemic areas for employment and for social interaction had contributed to increased malaria transmission and thereby focal outbreaks as recorded earlier from northeast[16]. The malaria outbreaks became more common and more wide spread and resurge even in areas that were at one time freed from the disease[6].

Analysis of malaria data collected by the Malaria Research Centre (MRC) Field Station, Jabalpur for trends (1986-2000) in five villages of Mandla revealed that in 1986 malaria was mainly due to *P.vivax* and *P.falciparum* was only 27% (Fig 3). However, from 1988 onwards there was a steady increase in *P.falciparum* and infection due to both parasites were almost equal in 1991 (*P.vivax* 49.5%, *P.falciparum* 50.5%). From 1992 onwards there was an increase in *P.falciparum* proportion while *P.vivax* was on decline. There was an abrupt increase in *P.falciparum* in 1996 and in 1999-2000, the infection caused by *P.falciparum* was over 90%[13]. The *P.vivax* and *P.falciparum* infection trend was more or less similar in both children and adults. Further analysis of month-wise data revealed that *P.vivax* increased before *P.falciparum* in the community throughout the study years (Fig. 4). The *P.falciparum* did not increase in either year until July-August (about one month after the onset of rainy season). In September of each year, as the number of *P.falciparum* infections rose steeply, *P.vivax* began to drop. Generally, highest number of *P.falciparum* infections were recorded in October-November and its predominance was persisted until January each year. *P.vivax* started increasing in February-March but gradually from 1991-1992 onwards infection due to *P.falciparum* remained dominating till March thereby reducing the *P.vivax* season[13]. More than 20% asymptomatic *P.falciparum* infections were recorded in school children also in Mandla in February-March[17] as reported earlier from Orissa[18]. The striking increase

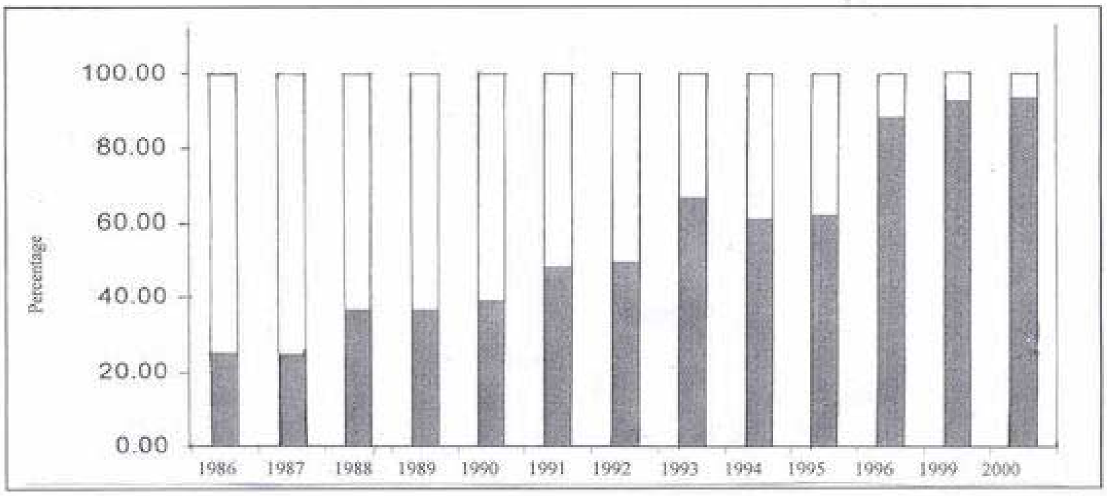

Fig.3. The dynamics of *P.vivax* ☐ and *P.falciparum* ■ ratio in study area showing shifting trends.

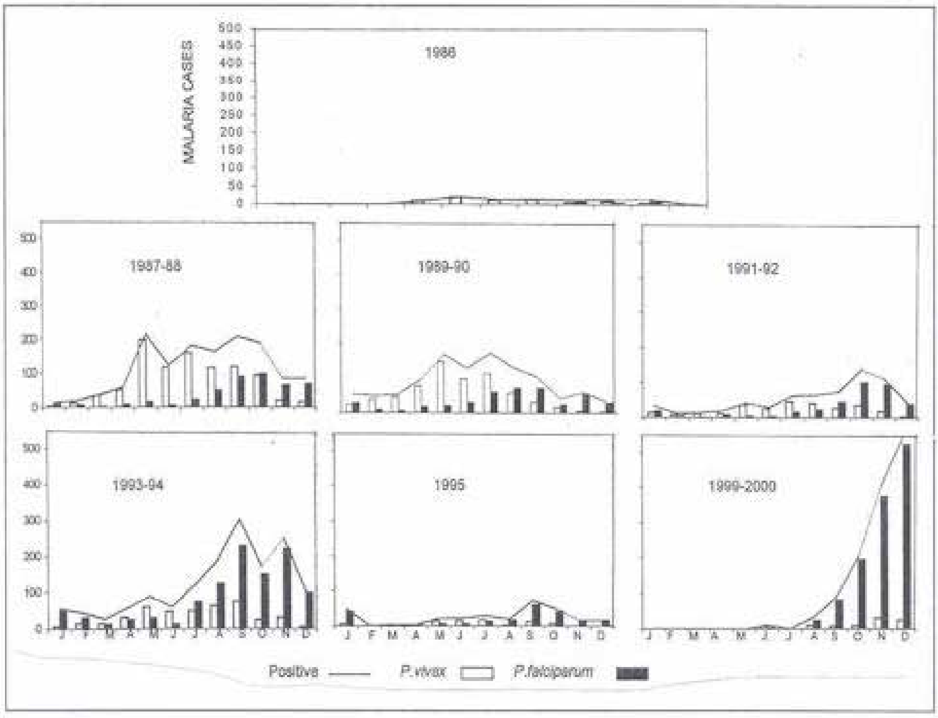

Fig. 4. Month-wise, year-wise cases of *Plasmodium vivax* and *P.falciparum* recorded in study villages between 1986-2000.

in the proportion of *P.falciparum* infections over *P.vivax* may be because of prevailing chloroquine resistance against *P.falciparum* which is existing in the area since 1980[19]. The drug resistance is unlikely to decrease unless the selection pressure (use of chloroquine) is removed. In MP, the availability of chlroquine or the drug policy have not changed. It appears that decline in *P.falciparum* % in the NAMP record (Fig.1 and 2) may be due to the fact that during rainy seasons most villages were not approachable, hence the potential cases might have not been recorded. It is worthwhile to mention that both *An. culicifacies* and *An.fluviatilis* were prevalent during the study period in this area (Fig.5). Densities of *An.culicifacies* were very high in all these study villages (range: 5-200 per man hour) with a main peak in August-September (95.5± 39.7) and a 2nd small peak in February-March (45.5± 14.5). *An.culicifacies* was incriminated in the month of May, August and November from indoor resting collections[13]. Densities of *An.fluviatilis* were low (range:

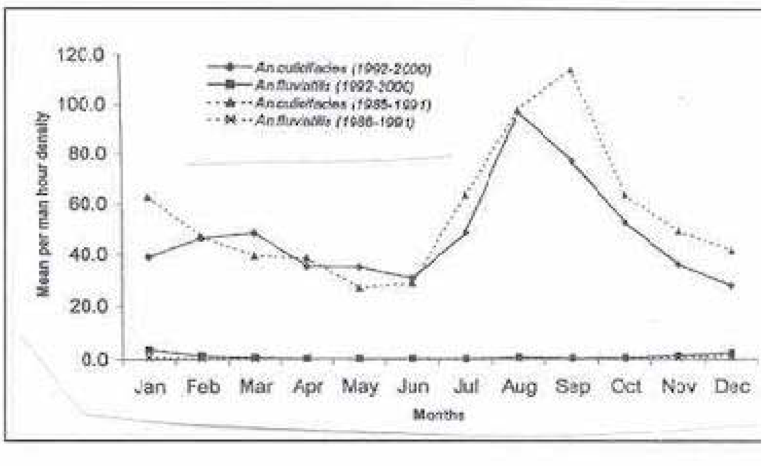

Fig.5. Mean indoor resting density (per man hour) of *An.culicifacies* and *An.fluviatilis* in study villages (1986-2000).

February and completely absent during the hot dry months of May and June in each year (Fig.5). Though year to year variations were noticed in the prevalence of two vector species in each village but the overall trend was similar during 1986-91, when *P.vivax* was the predominant infection and during 1992-2000 when *P.vivax* almost disappeared.

Recently in the urban area of Jabalpur, a focal outbreak of malaria due to *P.falciparum* was recorded by MRC in April-May 2003 when temperature was around 40°C, among migrants who spent 3 weeks in forest of Panna district for Mahua (*Madhuca indica*) collection[20]. These migrants slept under the Mahua tree without any preventive measures against malaria. Three deaths were also recorded among 39 migrants (District Malaria Officer, Jabalpur: unpublished observation). Mass surveys in neighbouring families of migrants did not show any malaria cases. Investigation on the site of occupational activities of these migrants in Panna revealed 63% *P.falciparum* in rapid fever survey and 30 % malaria infections in mass surveys. All age groups including infants were affected. Five deaths were also recorded indicating low immunity among population. Therefore, the importance of malaria should be evaluated from place to place according to ecological and epidemiological situation because the same causes do not necessarily produce the same effect. Moreover, the risk of disease depends on additional factors, the vulnerability of human community and capacity and capability of health care agencies[21].

Chhattisgarh

Chattisgarh was demarcated on 1st November, 2000 from eastern part of central India as the 26th state of India. There are 13 districts in the state, however, only 10 are provided with district malaria officers (DMOs) for data collection and coordinating the anti-malaria activities at the district level. The malaria profile of areas falling under Chattisgarh presents an entirely different picture from MP (Fig.6). From 1976 onwards, malaria cases

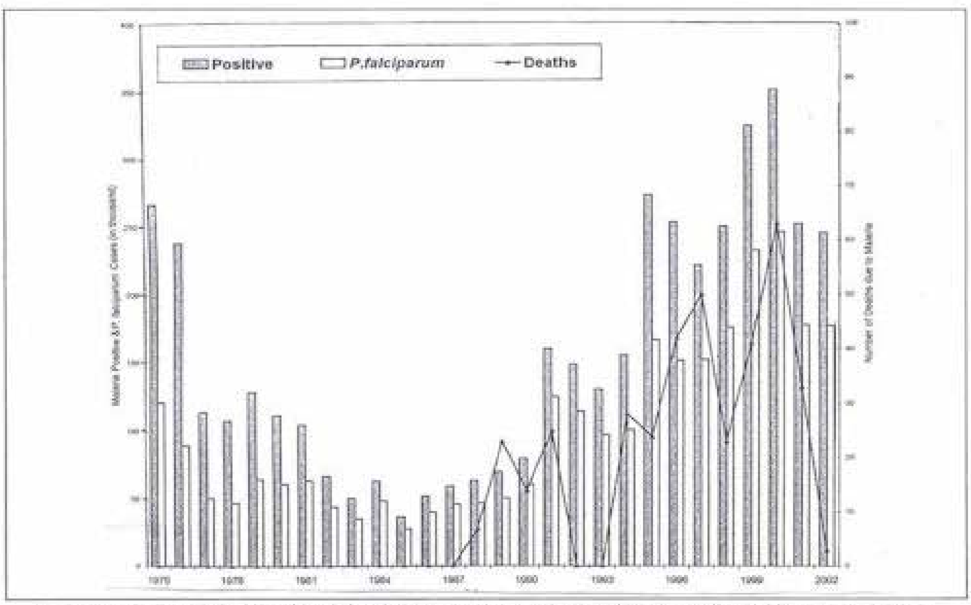

Fig.6. Malaria situation in Chhattisgarh (1975-2002) showing a rising trend in *Plasmodium falciparum* and deaths.

showed a sharp decline and the number of infections reduced to 113,550 in 1977. The impact was mainly on vivax malaria. Further significant and continuous decline in number of malaria infections was reported till 1985 (86%) and this decrease was largely at the expense of *P.vivax* as *P.falciparum* cases had been on increase. The ratio of *P.vivax* and *P.falciparum* was 50:50 in 1979, while in 1985 the *P.falciparum* was more than 70%[22]. The widespread use of chloroquine might have suppressed *P.vivax* more than *P.falciparum*. Malaria in the 1980s had returned with new features, such as establishment of *An.culicifacies* as major vector[23-24] besides *An.varuna* and *An.fluviatilis*[25-27], development of resistance to DDT[28] and the emergence of chloroquine resistance in *P.falciparum*[29]. It was further revealed that between 1985 to 1997 the number of malaria cases increased >500% and number of *P.falciparum* increased more than 450%. Deaths due to malaria were also on increase during the corresponding period (>600%). All these deaths were due to *P.falciparum* infections. Further, studies carried out in 1997 showed that in 5 worst malaria affected districts in the state *ie*. Jagdalpur (Baster), Kanker, Ambikapur, Bilaspur and Janjgir, the corrected mortality to 4% DDT was 24,34,16,12 and 18% respectively[30]. While chloroquine resistance in Kanker and Jagadalpur was known since 1981[28,31], the resistance status in other places are not known. It is stated that in the absence of vector control, drug resistance could grow at an increasing rate and with vector control, drug resistance might develop more slowly over time[32]. Clearly, further studies are required to establish that development of DDT resistance in vector has played a role in the emergence of chloroquine resistance.

From 1998 onwards, synthetic pyrethroid (deltamethrin, 2.5%) was sprayed in some areas and large number of larvivorous fishes were introduced in several perennial breeding sites, as several focal outbreaks swept across the state affecting 159,467 population in 162 villages of 7 districts due to which the number of malaria infections further increased from 221,296 in 1997 to 351,095 in 2000 and *P.falciparum* infections increased from 151,949 to 246,192 during the corresponding period with number of deaths increased to 26%. This apparent increase in malaria infections might have been partly due to improved surveillance under EMCP. To contain the outbreak and prevent malaria mortality, prompt treatment with effective drugs was administered. As expected chloroquine failed to produce the desired impact, yet there was significant decline in the number of malaria cases and deaths in 2001 and in 2002 while *P.falciparum* ratio increased only marginally[14].

Analysis of district-wise data revealed that almost all the districts showed a steady rising trend in malaria incidence between 1986 to 2000 . Kanker and Jagadalpur were the worst affected districts, where 7 and 21 deaths respectively were recorded in 2000. Yet again, malaria outbreak revisited the districts in 2001causing 1 and 21 deaths respectively[14]. Incidentally, these districts are having highest ethnic tribal population (62% and 75% respectively) in the state and are also known for rich and magnificent forests.

Additionally, the possible relationship between increase in Pf and malaria resistance was recorded in district Baster[31]. There was a tremendous increase in Pf infections since 1980 onwards. The chloroquine sensitivity tests in 1981 revealed prevalence of RI-RIII chloroquine resistance[29]. Though, the impact of chloroquine resistance has been difficult to measure because of logistics and small health budgets, the studies indicated that an increasing number of patients treated with chloroquine did not clear their parasitaemia nevertheless severe complications were rarely seen [33-34]. As majority of patients improved clinically within a few days, even in the parasitologically failure cases, the assumption was that the chloroquine retained sufficient efficacy to justify its use as reported from Sri Lanka and Pakistan[35-36].

Further, it was found that in remote and scattered areas public knowledge of the cause of malaria was poor and it was treated by a number of traditional practices[37-38] including herbal remedies[39]. Moreover, most of the malaria cases are treated with chloroquine at home through forest-gaurds or school-teachers[37] and it is the only antimalarial kept at home and used for self treatment which is now likely to result in treatment failures owing to drug resistance. However, measuring mortality from malaria is difficult, as in villages there is no system of routine death certification. Deaths in women and children occur mostly at home, often before any contact has been made with the formal health service. Only the PHC hospitals, where a limited number of sick patients come for treatment, can give a reasonably accurate indication of the malaria mortality rate. The problem is compounded by poor infrastructure making the access of government facilities further difficult for seriously ill patients. Neither there are telephone services in majority of the government maintained health centers and dispensaries within the PHC/Block nor ambulances to take patients to a betterequipped hospital, if necessary. The widespread food shortage increases susceptibility to infections. Thus the inference is that the number of malaria infections and associated deaths could indeed be much higher than reported due to the fact that the clinical malaria cases and suspected deaths have been excluded for want of blood slide and their report. Consequently the reported data on morbidity and mortality portray only a trend and not the absolute figures as reported earlier from Orissa[18]. The records reveal that in Chhattisgarh tremendous efforts are being made towards determining the most effective means of combating the malaria. However, the malaria situation in Chattisgarh is worse now than it was 25 years ago. During this period (1975-2000), the population of Chattisgarh has increased from 12,278,000 to 20,795,956 (70% increase) where as the number of malaria and *P.falciparum* cases have increased from 266,220 and 120,500 to 351,095 and 246,192 respectively (32% increase in malaria and 104% in *P.falciparum* infections).

Conclusions

This review has attempted to provide important and hitherto unreported insights about tribal malaria. Food gathering and cultivation are the main occupation of tribals. The unfertile soil, lack of irrigation and primitive mode of cultivation make sustenance difficult even for 6 months a year. During the remaining 6 months the tribals depend exclusively on forest produce or on forest labour. The constant movement of people makes it difficult to treat individuals and the malaria gametocyte load remains high in communities. Although the site of anopheline infection in forest villages was obscure, the villagers frequently spent the night in the open, providing a source of infection to the anophelines prevalent outdoors. There is a strong possibility of extra domiciliary transmission and many cases may have gone unrecorded.

Mosquito repellents, coils and bed nets were not used by the communities as neither they have the knowledge about these gadgets nor they could afford such personal protection methods[37]. But, in the evening most people burn dry leaves to drive mosquitoes out of their houses. People have faith in guniya as these traditional healers hail from the same community, live among them and are always available. Only when they did not get cured, they go to untrained and unlicensed practitioners or quacks, who may give adulterated, under dosed treatment which is often broad spectrum and focuses mainly on symptomatic relief. The quacks prepfer to give them injections, as people beleive that a single injection is more powerful than 10 tablets of chloroquine[37]. Another point of concern is the strong misconception that malaria convulsions are due to evil spirits. Such misconceptions have a considerable impact on use of antimalarial drug.

The use of larvivorous fishes has been successful in malaria control in many parts of India[40], but ethnic tribes consume larvivorous fishes as well during January-June. This is the time when their lean period of food resources start and they have nothing to eat and this nearly eliminates fishes. Insecticide impregnated bed net is an other alternative that has shown promise recently in most parts of the world, however, bed nets were not found effective in remote tribal villages because of outdoor life and forest based economy of the tribals[41].

Review of the epidemiological data and an analysis of the relationship between transmission, morbidity and potential mortality from malaria suggested that no intervention aiming to reduce the malaria burden was on a long term basis in majority of epidemiological contexts. Gradually the transmission of *P.falciparum* is extending throughout the year[42-44] ,from post mansoon season[9,15] to extreme winter[6,33] to spring[17] and to summer[20]. However, the effect of such a shift in *P.falciparum* season might only become apparent if PCR is used for monitoring drug resistance in parasite. It appears that the control of *P.falciparum* is unattainable in the absence of new tools. Therefore, a more diversified research programme might be needed in consonance with the cultural and social frame work of the population for sustainable results on long-term basis. Finally, it must never be forgotten that social and economic instability has helped perpetuate the burden of malaria, and wherever the conditions are stable, the prospects for disease control have greatly improved.

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