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Dynamics of malaria in Bikaner, Rajasthan, India (1975–2006)

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Epidemiological scenario of malaria differs from state to state and region to region and the data of a country cannot represent the situation in different regions. One should have a clear knowledge about the dynamics of malaria in a particular region so that prevention and management strategies can be planned in a better way. If we look at the epidemiological trends of India there is a trend towards increasing proportion of *Plasmodium falciparum* cases[1]. There is also a report from central India showing increase in the proportion of *P. falciparum* malaria cases[2].

Bikaner is in the Thar desert situated between longitude 71°54' and 74°12' east and latitude 27°11' and 29°3' north and having an area of 27,000 km^2. Its altitude is 237 m above the sea level and the temperature ranges from a minimum of 2°C in winters to a maximum of 48°C in summers. It is situated in the northwestern part of Rajasthan, India, near India-Pakistan border. The region is characterised by a hot summer, a cold winter and with a low annual rainfall of 25 cm. Almost all the rain occurs in a single period between July and September. Malaria surveillance is a regular and continuous activity in the region under the government malaria control programmes.

Since 1975, after the initiation of irrigation activities in this region, there has been a tremendous increase in the number of malaria cases. We have reviewed the data from 1975 to 2006 from Bikaner district to define the extent and timing of changes in *P. vivax* and *P. falciparum* infections to determine trends. Our objective was to describe the dynamics of *P. vivax vs P. falciparum* infections. This documentation would certainly help in designing effective control strategies.

There are two species of *Anopheles* mosquito namely *Anopheles culicifacies* and *An. stephensi* (Diptera: Culicidae) in this region responsible for transmission of malaria. Analysis of malaria epidemiological data of last 32 years from 1975 to 2006 as given in Table 1 reveals that malaria cases were seen throughout the year with marked seasonal variation. Maximum cases occur in the post-rainy season and least number of cases occur in January and February. Only two *Plasmodium* species are encountered, namely *P. vivax* and *P. falciparum*. The population of this region has increased from 5,73,149 in 1975 to 23,29,138 in 2006. In 1975, there were 12056 cases of *P. vivax* and only 441 cases of *P. falciparum*. Similarly, in 1976, 77 and 78 there were 20,370, 11,192 and 5352 cases of *P. vivax* and 440, 201 and 83 cases of *P. falciparum* respectively, suggesting an epidemic of malaria with more than 90% of cases due to *P. vivax*. Subsequently, from 1978 to 1991 the number of malaria cases dropped drastically and remained around 1000/year, however, from 1992 onwards there was a steady increase in number of malaria cases. The proportion of *P. falciparum* cases had shown continuous increase from 1981 and during 1992, the prevalence of infection caused by the two species were roughly equal. From 1993 onwards the number of *P. vivax* cases again started increasing and in 2003, the *P. vivax*

Table 1. Year wise epidemiological data of Bikaner, Rajasthan, India

S. No.	Year	Population	BSC	*Pv*	*Pf*	ABER	API	*Pf*%	*Pv*%
1	1975	573149	107026	12056	441	18.6	21.8	3.53	96.47
2	1976	573149	111457	20370	440	19.4	36.3	2.11	97.89
3	1977	573149	102585	11192	201	17.8	19.8	1.76	98.24
4	1978	573149	99268	5352	83	17.3	9.4	1.53	98.47
5	1979	573149	81601	1476	13	14.2	2.5	0.87	99.13
6	1980	573149	91145	486	9	15.9	0.8	1.82	98.18
7	1981	840059	100192	612	20	11.9	0.7	3.16	96.84
8	1982	840059	81026	507	26	9.6	0.6	4.88	95.12
9	1983	840059	86497	1026	93	10.2	1.3	8.31	91.69
10	1984	840059	80551	895	112	9.5	1.1	11.12	88.88
11	1985	840059	75050	1274	70	8.9	1.5	5.21	94.79
12	1986	840059	67837	1202	75	8.0	1.5	5.87	94.13
13	1987	840059	70210	782	17	8.3	0.9	2.13	97.87
14	1988	840059	67488	537	28	8.0	0.8	4.96	95.04
15	1989	840059	74206	980	134	8.8	1.3	12.03	87.97
16	1990	840059	76015	1518	525	9.0	2.4	25.70	74.30
17	1991	1217361	64729	991	129	5.3	0.9	11.52	88.48
18	1992	1217361	95455	3533	3704	7.8	5.9	51.18	48.82
19	1993	1217361	83980	3271	458	6.8	3.0	12.28	87.72
20	1994	1217361	156034	9672	3657	12.8	10.9	27.44	72.56
21	1995	1217361	180158	12689	924	14.7	11.1	6.79	93.21
22	1996	1217361	152089	4828	225	12.4	4.1	4.45	95.55
23	1997	1339097	128281	2620	149	9.5	2.0	5.38	94.62
24	1998	1339097	104255	1150	63	7.7	0.9	5.19	94.81
25	1999	1556314	98267	1376	55	6.3	0.9	3.84	96.16
26	2000	1556314	108812	776	60	6.99	0.53	7.18	92.82
27	2001	1867500	208559	4650	362	11.16	2.68	7.22	92.78
28	2002	1977755	173494	1131	82	8.77	0.61	6.76	93.24
29	2003	2092667	378230	12684	926	18.07	6.5	6.80	93.20
30	2004	2092667	314364	6363	78	15.02	3.07	1.21	98.79
31	2005	2092667	228591	773	19	10.92	0.37	2.40	97.60
32	2006	2329138	348709	3017	50	14.47	1.49	1.63	98.37

BSC – Blood slides collected; ABER – Annual blood examination rate; *Pv – Plasmodium vivax*; *Pf – Plasmodium falciparum*; API – Annual parasite incidence.

cases had a share of about 90% of the total cases. In 1992, 1994, 1995, 2001 and 2003 there was an abrupt increase in number of malaria cases.

The available data indicate that malaria is endemic and both the species, namely *P. vivax* and *P. falciparum* were equally prevalent in this area. The mortality was very low however, the measurement of mortality from malaria was difficult as there was no system of routine certification of all deaths. Similar results have also been reported from other parts like Thailand, which is also under the influence of both the above mentioned species[3].

We compared the data of Bikaner with that of India (Fig. 1) and observed that in Indian scenario the per-

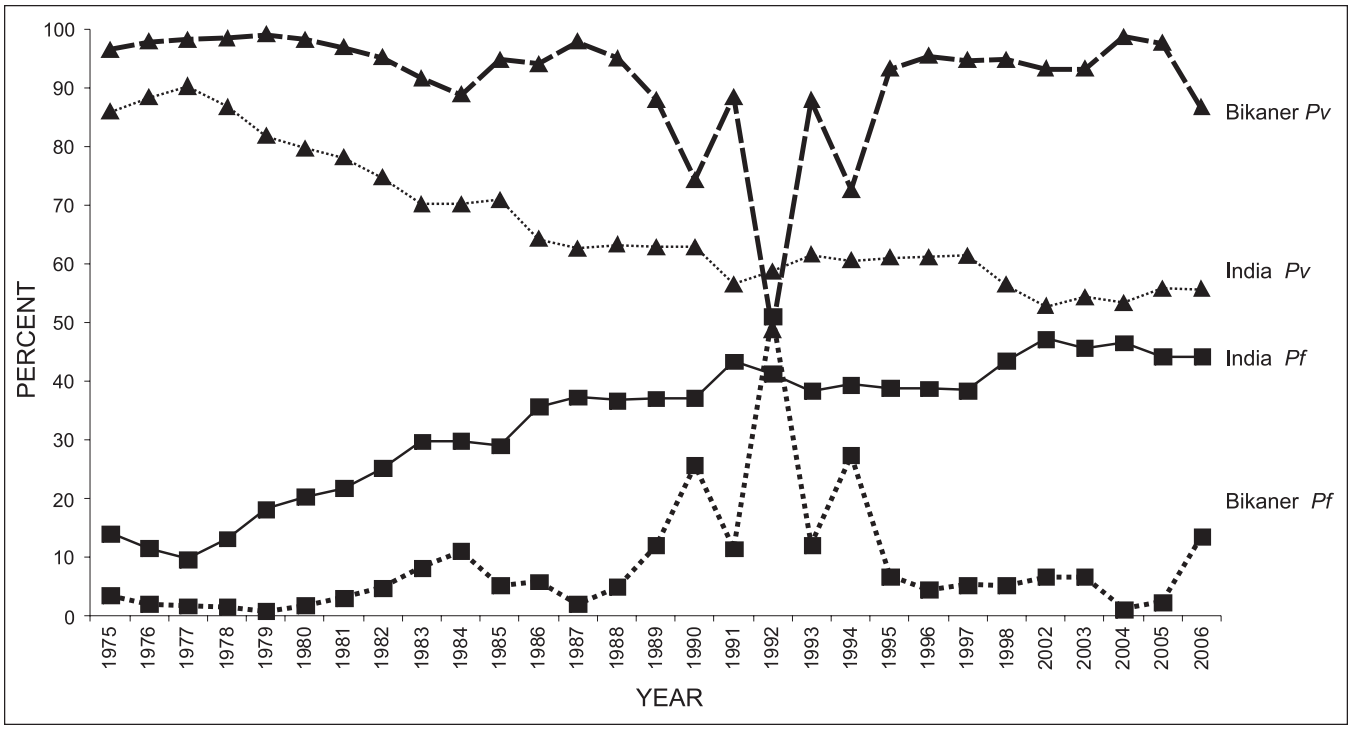

Fig. 1: Comparison of Indian/Bikaner scenario of *P. falciparum* and *P. vivax* malaria cases

centage of *P. vivax* cases is decreasing whereas the percentage of *P. falciparum* cases is increasing but still less than that of *P. vivax*. Singh *et al*[2] observed that in central India in last 15 years the *P. falciparum* cases are continuously increasing and has surpassed the number of *P. vivax* cases. However, in Bikaner we found that from the beginning *P. vivax* was more predominant. *P. falciparum* has shown an increase from 1981 and taken the 50% share of total cases in 1992, but there after it again started decreasing and in 2003, 90% of total cases were due to *P. vivax*. This difference in species in this region from the rest of the country is not known but it may be because of influence of regional environmental factors or some genetic changes in vector which is favouring transmission of *P. vivax* or it may also be possible that the *P. vivax* in this region had undergone some genetic changes and acquired a better adaptation power in comparison to *P. falciparum*. This is also supported by the reports of severe *P. vivax* malaria from this region and observation of some genetic difference in the strain of *P. vivax* prevalent in this region[4,5].

It is not clear whether the changes described in the parasite ratio are transient or is a pattern of permanent transformation which will continue under these conditions. To quantify the contribution made by chloroquine resistance or by any other operational and environmental factors would require further intensive studies. These data are very valuable in designing the treatment protocols and other preventive measures in the community. Whereas, most of the regions in India are showing dramatic increase in the number of *P. falciparum* cases, Bikaner is witnessing an increase in *P. vivax* infections.

References

1. Lal S, Sonal GS, Phukan PK. Status of malaria in India. *J Indian Acad Clin Med* 2000; *5*(1): 19–23.

2. Singh N, Mishra SS, Singh MP, Sharma VP. Seasonality of *Plasmodium vivax* and *P. falciparum* in tribal villages in central India (1987–1995). *Annals Trop Med Parasitol* 2000; *94:* 101–12.

3. Luxemburger C, Ricci F, Nosten F, Raimond D, Batnet

S, White NJ. The epidemiology of severe malaria in an area of low transmission in Thailand. *Trans R Soc Trop Med Hyg* 1997; *91:* 256–62.

4. Kochar DK, Saxena V, Singh N, Kochar SK, Kumar SV, Das A. *Plasmodium vivax* malaria. *Emerg Infect Dis* 2005; *11*(1): 132–4.

5. Rajesh V, Elamaran M, Vidya S, Gowrishankar M, Kochar DK, Das A. *Plasmodium vivax:* genetic diversity of the apical membrane antigen-1 (AMA-1) in isolates from India. *Exptl Parasitol* 2007 Jan 23; [Epub ahead of print]

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