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Full Length Research Paper

Disease dynamics, distribution and surveillance of malaria in arid ecology of Jodhpur, Rajasthan, India during 2002 to 2006

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Malaria is under regular and ongoing surveillance, to detect changes in its trends or distribution in order to initiate investigative or control measures in the country. Owing to limited availability of resources and rational use under the program, prevention and control activities against malaria varies in areas with different intensity of malaria transmission. Transmission dynamics, surveillance, mapping of disease burden for malaria in arid ecological setting of Jodhpur, Rajasthan has described in this study. Monthly epidemiological reports of Jodhpur City, district Jodhpur and all its community health centres were obtained from the office, Chief Medical and Health Officer district Jodhpur for the period 2002 to 2006. Secular trend of malaria incidence, transmission dynamics, mapping of disease burden areas and surveillance of malaria was described. The range of annual parasite incidence (API) was from 0.52 to 2.85 in district Jodhpur, with API <2 in the last consecutive 3 years (2004 to 2006). The slide positivity rate (SPR) ranged from 0.59 to 2.29 in district Jodhpur with continuous decline from 1.51 in 2004 to 0.56 in 2006. Transmission dynamics of total malaria varies from one year to another. Total malaria cases during each year reached at peak in the different months in the duration of 2002 to 2006. Malaria is a persistent health problem in district Jodhpur with variation in its transmission dynamics within and between the years. District Jodhpur with its rural and urban areas is a low risk area for malaria. Malaria prophylaxis and management strategies as applicable in low risk area would be appropriate for district Jodhpur.

Key words: Malaria, Rajasthan, arid ecology, low risk area, desert.

INTRODUCTION

There are 106 malaria endemic countries in the world. Ten out of 11 countries of WHO South-East Asia region are malaria-endemic. India reports about two-thirds of all confirmed malaria cases in South-East Asia region (World malaria report, 2010). Malaria is a major public health problem in India. As at 2007, the disease accounted for about 1.5 million cases and 1,311 deaths in India. Also at the state level, it accounted for about 55000 cases and 46 deaths in Rajasthan in the same year (NVBDCP, 2007). Malaria is under regular and ongoing surveillance, to detect changes in its trends or distribution in order to initiate investigative or control measures in country.

Active and passive surveillances are the two main components that are being undertaken for malaria regularly by health department under national malaria control programme. Additionally, mass survey is carried out in case of malaria outbreak in small population. In mass survey entire population of area including children irrespective of fever status are covered for malaria microscopy. Every village in suspected epidemic zone is covered in rapid fever survey; individuals with fever history are searched and examined for malaria microscopy (Operational manual for implementation of

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malaria programme, 2009). Principal indicators of malaria surveillance are annual blood examination rate (ABER), monthly blood examination rate (MBER), annual parasite incidence (API), slide positivity rate (SPR) and other relevant indicators (Malaria surveillance, 2010). API defines total number of blood smears positive for malaria parasite (MP) per 1000 population in a given year for a given area. This parameter is the most important criterion to assess the progress of eradication programme. It depends on the adequacy of case detection mechanism that is, ABER. ABER gives the total number of blood smears examined for MP per 100 population in a year and expressed as % of population. A minimum of 10% of ABER was fixed under National malaria eradication programme. Monthly breakup of ABER gives the MBER for an area. SPR expresses the total number of blood slides found positive for MP per 100 number of blood slides examined. It is more reliable than API even for areas where ABER fluctuates from the year to year. *Plasmodium falciparum* percentage (Pf%) is the total number of blood smears found positive for *P. falciparum* per 100 number of blood smears positive for MP (Malaria surveillance, 2010).

National vector borne disease control programme (NVBDCP) is the nodal agency for prevention and control activities against malaria and other vector borne diseases in India. The program strategies for malaria are surveillance and case management, integrated vector management, epidemic preparedness and early response and supportive interventions (NVBDCP, 2007). The program envisages of halting and reversing the incidence of malaria by the year 2015 using surveillance as a basis for planning, implementation, and evaluating disease prevention and control activities (Operational manual for implementation of malaria programme, 2009). Owing to limited availability of resources and rational use under the program, prevention and control activities against malaria varies in areas with different intensity of malaria transmission (Operational manual for implementation of malaria programme, 2009).

Jodhpur District comes under arid zone of Rajasthan, with some part of it falling in The Great Indian Thar Desert (Jodhpur, 2010). Information on secular trend, transmission dynamics, surveillance, mapping of disease burden areas for malaria in this mixed arid-desert ecological setting is not available.

The main objectives of this study were (1) to describe the malaria transmission dynamics in rural and urban areas of Jodhpur District over a period of five years 2002 to 2006, (2) to describe the malaria surveillance systems during this period, (3) to describe the total malaria cases in different categories of age and gender, and (4) to map the endemicity of malaria in rural and urban areas of Jodhpur District to look for any change from 2002 to 2006 in order to provide valuable information to local health authority to assess the achievement of prevention and control activities against malaria.

MATERIALS AND METHODS

Study site

District Jodhpur stretches between 26° 0′ and 27° 37′ at North Latitude and between 72° 55′ and 73° 52′ at East Longitude. It is situated at 250 to 300 m above sea level. The district covers 22850 km^2 of geographical area (Jodhpur, 2010). Jodhpur District comprised 3.6 million people as per provisional data of 2011 census (Census of India, Rajasthan, 2011). Its ambient temperature varies from 49 degree centigrade in summer to 1 degree in winter. The average rainfall is 302 mm. There are nine Community Health Centres (CHCs) namely Balesar, Banar, Bap, Bhopalgarh, Mathania, Pilwa, Pipar, Salawas and Somesar in rural area rendering health services in the district (Jodhpur, 2010). Population of urban area of Jodhpur District named as Jodhpur City in this study is look after by urban health centers and hospitals.

Study design

Descriptive epidemiological study was conducted using retrospective secondary data of malaria for the period of 2002 to 2006. We obtained all monthly epidemiological reports for the mentioned period with respect to the 9 CHCs, Jodhpur City and whole district Jodhpur from the office of the Chief Medical and Health Officer district Jodhpur. First author recorded the data from monthly epidemiological reports on similar paper sheets used in the study. Collected data was then entered in Epi-info computer programme. Entered data was then analyzed after proper data cleaning. All the authors participated in data analysis and report writing.

Data analysis

Malaria transmission dynamics was described using surveillance indicators viz. ABER, API and SPR in all the 9 CHCs, Jodhpur City and Jodhpur District along with monthly transmission dynamics for Jodhpur District for period of 2002 to 2006. Monthly incidence rates of total malaria cases and *P. falciparum* malaria were estimated and graphed to describe their transmission dynamics in Jodhpur district. Malaria surveillance in Jodhpur District was described using case detection rate as number of malaria cases detected/1000 slides examined/month and number of cases reported positive yearly separately for active and passive surveillance for the period of 2002 to 2006. Proportion of *P. falciparum* cases to total malaria was estimated from 2002 to 2006 separately to highlight its magnitude in this area. Proportionate malaria cases in different categories of age and genders were estimated using 5 years pooled malaria cases to describe the disease distribution out of total malaria cases reported. Mapping of district was done from 2002 and 2006 to look for any change in annual malaria incidence rates at the level of CHCs.

RESULTS

Malaria surveillance indicators

Table 1 explains the secular trend of malaria surveillance indicators in district Jodhpur including Jodhpur City and all its 9 CHCs for the period 2002 to 2006. The values of ABER range from a minimum of 0.79% in Balesar CHC in year 2003 to a maximum of 26.07% in Somesar CHC in year 2003 during the period of 5 years. Only 2 CHCs

Table 1. Secular trend of malaria in district Jodhpur, Jodhpur city and its 9 CHCs.

Place	Year 2002			Year 2003			Year 2004			Year 2005			Year 2006		
	ABER	API	SPR	ABER	API	SPR	ABER	API	SPR	ABER	API	SPR	ABER	API	SPR
Balesar	8.08	0.83	1.03	0.79	0.06	0.87	10.41	1.74	1.67	7.77	0.83	1.06	10.8	1.07	0.99
Banar	14.89	2.58	1.73	17.7	4.52	2.55	13.48	3.4	2.52	10.55	1.37	1.29	12.12	1.24	1.02
Bap	12.6	3.43	2.72	2.22	0.22	1	22.87	5.57	2.43	13.36	1.93	1.44	18.68	2.18	1.16
Bhopalgarh	10.33	0.61	0.59	13.18	0.94	0.71	10.84	0.61	0.56	8.88	0.2	0.23	11.12	0.27	0.24
Jodhpur City	3.64	0.59	1.64	5.45	0.89	1.63	4.24	0.82	1.93	3.92	0.36	0.93	7.29	0.21	0.29
Mathania	8.81	1.9	2.15	11.37	2.72	2.4	9.23	1.61	1.75	8.86	0.46	0.52	10.5	0.71	0.68
Pilwa	8.79	0.5	0.57	12.36	4.37	3.53	9.61	2.54	2.64	6.24	0.75	1.21	10.71	0.49	0.46
Piparcity	18.65	3.33	1.78	16.91	0.56	0.33	13.11	0.57	0.43	12.5	0.36	0.29	18.15	0.58	0.32
Salawas	11.89	0.16	0.13	12.71	0.76	0.6	8.85	0.24	0.27	7.67	0.11	0.14	9.55	0.22	0.23
Somesar	10.92	1.09	1	26.07	8.51	3.26	11.37	0.66	0.58	5.63	0.16	0.28	13.15	1.47	1.11
Jodhpur District	9.12	1.28	1.4	12.45	2.85	2.29	9.25	1.4	1.51	7.49	0.52	0.69	10.88	0.61	0.56

ABER = Annual blood examination rate, API = Annual parasite incidence, SPR = Slide positivity rate.

(that is, Banar and Piparcity) are reported to be consistently ≥ 10% ABER in the entire 5 years period. Jodhpur City did not report ABER ≥ 10% in any of these years. District Jodhpur reported ABER ≥ 10% only in the years 2003 and 2006. Number of CHCs reporting ≥ 10% ABER was 6 in 2002, 7 in 2003, 6 in 2004, 3 in 2005 and 8 in 2006 out of all 9 CHCs in district.

Range of API was from 0.52 to 2.85 in district Jodhpur, with API <2 in the last consecutive 3 years (2004 to 2006). The values of API ranged from 0.06 in Balesar CHC in 2003 to 8.51 in Somesar CHC in same year. For Banar CHC highest API of value of 4.52 cases /1000 population was reported in 2003 while lowest 1.24 in 2006. For Piparcity CHC highest API of value of 3.33 cases /1000 population was reported in 2002 while of lowest 0.36 in 2006. CHC Bap reported consistently highest API out of all CHCs from 2002 to 2006 except during 2003, when CHC Somesar ranked first.

Figure 1 depicts the mapping of annual malaria incidence rates in all the CHCs of district Jodhpur in years 2002 and 2006. In year 2002 CHC Bap, Banar, and Piparcity reported >2 malaria cases/1000 population. Whereas in year 2006 only CHC Bap remained with annual incidence rate of >2 malaria cases/1000 population. Two CHCs Somesar and Mathania reported 1 to 2 malaria cases/1000 population of annual malaria incidence rate in 2002, whereas 3 CHCs Somesar, Balesar and Banar reported same incidence rate in 2006.

The values of SPR ranged from 0.13% in CHC Salawas in 2002 to 3.53% in CHC Pilwa in 2003. For CHC Banar, range of SPR was 1.02% in 2002 to 2.55% in 2003. For CHC Piparcity, range of SPR was maximum 1.78% in 2002 to minimum 0.29% in 2005. The SPR ranged from 0.59 to 2.29 in district Jodhpur with continuous decline from 1.51 in 2004 to 0.56 in 2006.

Malaria cases in the district

Proportionate *P. falciparum* malaria cases reported annually for the period of 2002 to 2006 is given in Table 2. Highest *P. falciparum* proportion was 2.31% in year 2003, whereas lowest was 0.41% in 2005 in district Jodhpur.

Table 3 describes the proportionate distribution of 5 years-pooled malaria cases in different groups of ages and genders. Malaria cases belonging to age group of 15 years and above were 60.88%, the remaining 30.37 and 8.73% malaria cases were in the age group of 5 to 14 years and 0 to 4 years, respectively. As far as gender distribution of malaria cases is concerned, 61.33% cases were male while 38.66% cases were female. No death due to malaria was reported in district Jodhpur during study period.

Monthly case detection rates in active and passive surveillance in district during 2002 to 2006 have been compared through Line Graph in Figure 3. Peak case detection rate in active surveillance was <20 cases/1000 slides examined in year 2003. While peak case detection rate for passive surveillance was >120 cases/1000 slides examined in same year. In other years also, there

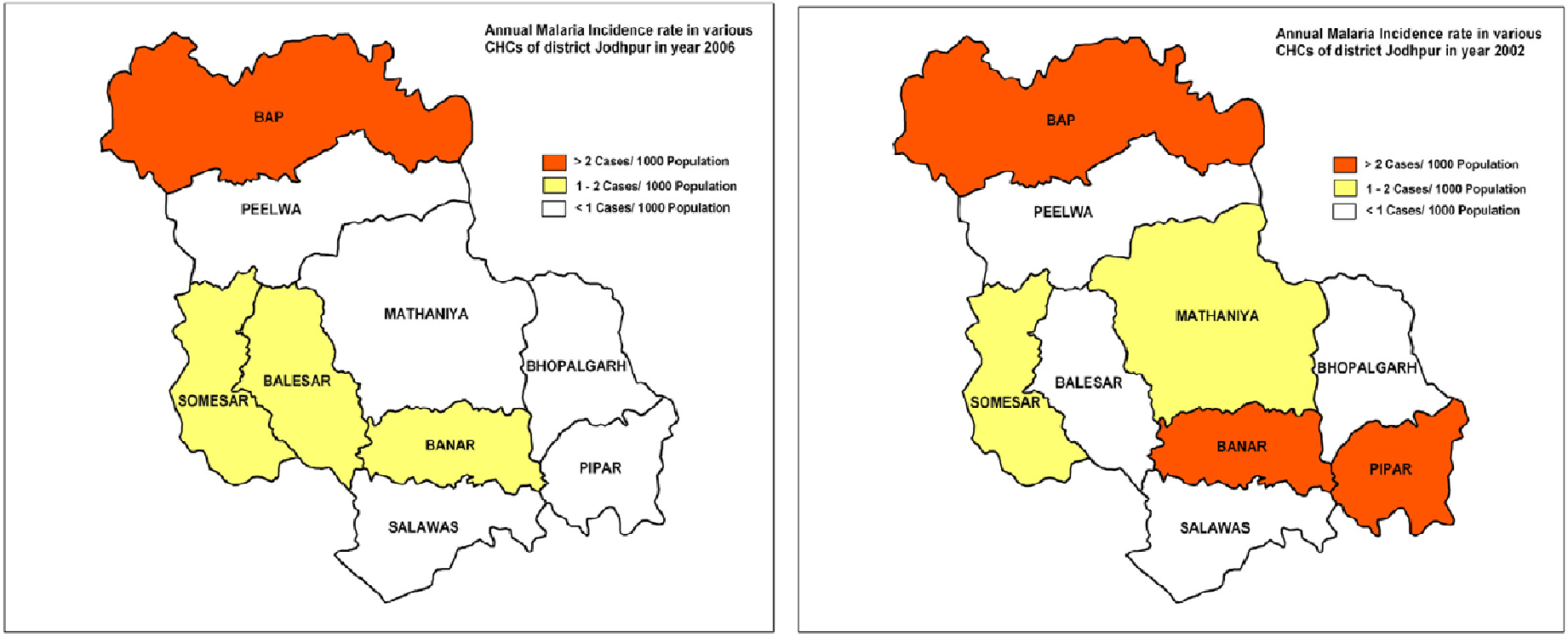

Figure 1. Mapping of annual malaria incidence rates in different CHCs of district Jodhpur in years 2002 and 2006.

Table 2. Proportionate *P. falciparum* malaria cases in district Jodhpur, Rajasthan for 2002 to 2006.

Year	Population	Active surveillance		Passive surveillance		Mass surveillance		Total surveillance		Total cases *P. falciparum*	Proportion of *P. falciparum* cases (%)
		Slides examined	Slides reported positive	Slides examined	Slides reported positive	Slides examined	Slides reported positive	Slides examined	Slides reported positive		
2002	2880777	140654	220	94398	3415	27698	64	262750	3699	46	1.24
2003	2952796	161642	673	134209	7451	47480	134	343331	8258	191	2.31
2004	3053624	144635	241	118319	4026	19809	25	282763	4292	23	0.53
2005	3206306	134675	54	90516	1621	14921	4	240112	1679	7	0.41
2006	3214400	185073	99	135242	1866	28219	22	348534	1987	18	0.90

Table 3. Proportionate distribution in different age and gender groups out of 5 years pooled malaria cases in district Jodhpur.

Parameter	Total malaria cases in 5 years	Average annual cases	Proportionate malaria cases (%)
Age (years)			
0-4	1738	348	8.73
5-14	6051	1210	30.37
15 and above	12124	2425	60.88
Total	19913	3983	100
Gender			
Male	12215	2443	61.33
Female	7698	1540	38.66
Total	19913	3983	100

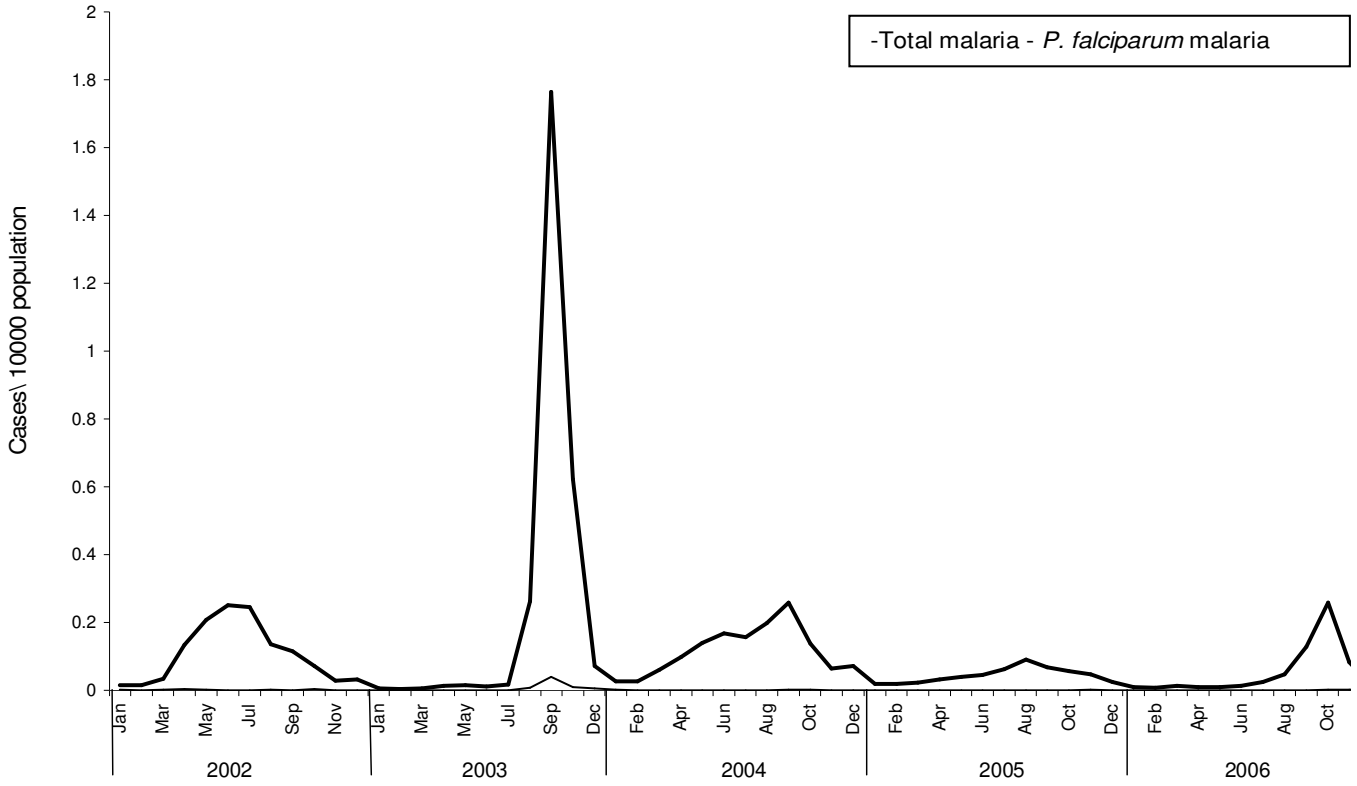

Figure 2. Monthly malaria dynamics in district Jodhpur over the period of 2002 to 2006.

there is large gap between case detection rates of active and passive surveillance system with dominance of passive surveillance over the active.

Malaria transmission dynamics

Malaria transmission dynamics has been described with the help of Line Graph for total malaria (*Plasmodium vivax* and P. *falciparum* both) and *P. falciparum* malaria in district Jodhpur over the period of 2002 to 2006 in Figure 2. Whereas *P. falciparum* malaria is hardly visible total malaria resulted in an almost continuous above zero level line graph. Transmission dynamics of total malaria varies from one year to another. Total malaria cases during each year reached at peak in the different months in the duration of 2002 to 2006. Peak of line graph occurred in June to July months in year 2002, September in 2003 and 2004, August in 2005 and in October in 2006.

DISCUSSION

Malaria prevention and control strategy varies with the risk status of the area. Areas are classified as “high

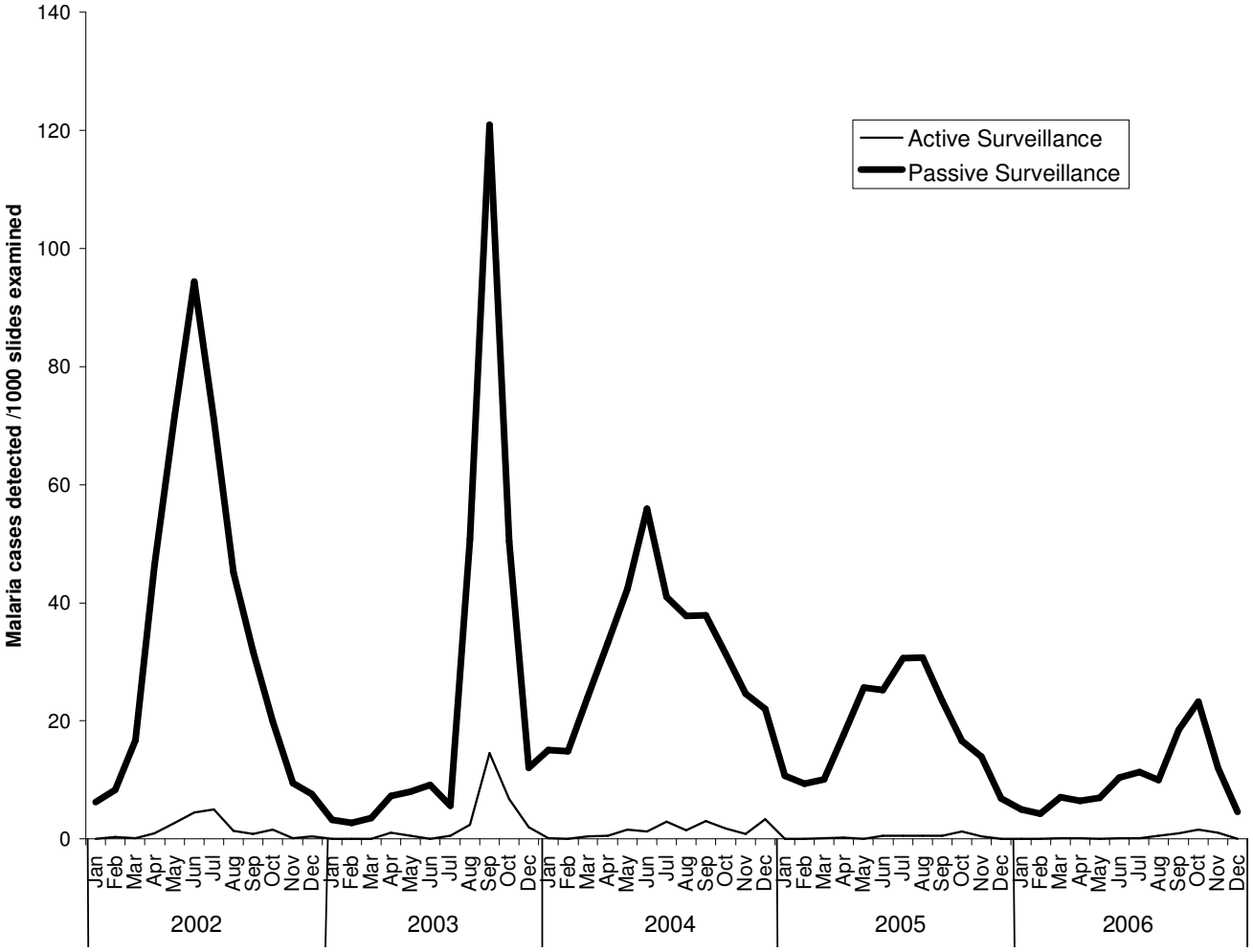

Figure 3. Monthly malaria case detection rates in active and passive surveillance in district Jodhpur during 2002 to 2006.

malaria risk" areas if any of the following applies (otherwise it is classified as "low risk" area): (1) Deaths due to malaria have been reported, (2) The slide positivity rate (SPR) has doubled during the last three years, provided the SPR in the second or third year reaches 4% or higher; or the average SPR of the last three years is 5% or higher, (3) Of all reported malaria cases the proportion of *P. falciparum* proportion is 30% or higher, provided the SPR is 3% or higher during any of the last three years (Project implementation plan, 2008). So as per this definition our study classify district Jodhpur as a low risk area for malaria because neither malaria death has been reported nor SPR and Pf% reached 4 and 30% respectively in any year during study period. Jodhpur District, Jodhpur City and all the 9 CHCs had not reported any death due to malaria and SPR had also not reached 4% in any year. Proportion of *P. falciparum* malaria cases in Jodhpur District remained less than 3% in study years also. Therefore Jodhpur District can be classified as low risk area.

Under prevention strategy against malaria, two rounds of indoor residual spray (IRS) (Project implementation plan, 2008) with adulticidal insecticide or insecticide treated nets (ITN) or long lasting insecticide treated nets (LLIN) (NVBDCP, 2009) are being implemented in rural areas with annual incidence rate of 2 or above. CHCs are rendering health services in rural areas. In these five studied years, few CHCs have reported 2 or more API in some years sporadically. Such CHCs should given utmost observation for malaria surveillance and application of IRS, ITN or LLIN as the need may be in particular year.

Urban areas with annual parasite incidence rate of 2 or above with minimum population of 50,000 are eligible for implementing urban malaria scheme (UMS) (Urban malaria scheme-NVBDCP). In this study Jodhpur City had not reported API of 2 or above in any of the reported years so it seems appropriate to adopt strategy as applicable for areas not covered under UMS to rationalize the limited resources.

As a malaria prevention strategy, chemoprophylaxis is recommended for travelers, migrant laborers and military

personnel exposed to malaria in highly endemic areas (Guidelines for diagnosis and treatment of malaria, 2009). This study will help in decision making by travelers to this area about chemoprophylaxis.

Malaria has affected both genders and all age groups In this desert setting. Each person should be offered preventive services with particular emphasis to 15 years and higher age group population. Overall endemicity of malaria has improved over the period of 2002 to 2006 in district Jodhpur. In the Bikaner, the desert district near to India-Pakistan border, malaria endemicity has improved. In this district API were 3.07, 0.37 and 1.49% in years 2004, 2005 and 2006 respectively (Kochar et al., 2007). There were 3 CHCs with API of 2 or more in year 2002, their number reduced to 1 in 2006. Likewise number of CHCs with API of <1 was 4 in 2002, it increased to 5 in 2006. However Bap CHC remained at same position in both years (2002 and 2006) as far as the API is concerned. Such area should be given priority. Mathur et al. (1992) also highlighted one PHC as the worst affected PHC area, that is, in 1990, Baitu was found in one malaria epidemic desert district Barmer in Rajasthan.

P. vivax malaria is main species of malaria parasite in Jodhpur with a few occasional cases of *P. falciparum* malaria. Preponderance of *P. vivax* has also reported in many outbreaks in district Jodhpur before 2002 (Tyagi, 2004). Malaria is a persistent problem in this desert part of Rajasthan with variation in transmission dynamics not within year only but across the years also. Kochar et al. (2007) report that API was 36.3% in 1976 in Bikaner district of Rajasthan. Since 1976, there has been variation in API till 2006, which was the last study year. Malaria transmission maintains low level in winter season but reaches its peak in monsoon and post-monsoon season. The peak of transmission of malaria varies in different years, also which is worth considering while planning for IRS activities to attain maximum effect. Malaria prophylaxis and management strategies as applicable in low risk area would be appropriate for district Jodhpur.

As far as the malaria surveillance is concerned it is the passive malaria surveillance detecting almost all cases of malaria. Active surveillance was designed to capture all those cases remained out of reach of health services in society, since out patient department cases represent only the tip of iceberg for disease phenomenon. Addition of number of cases through active surveillance should be weighed against the inputs provided in active surveillance in terms of time, man power and money.

Limitation of the study

Study is based on the public health surveillance data representation from private practitioners is not given. Although, this study did not describe all malaria cases in the community, it provides the major distribution and trends of malaria in Jodhpur district.

CONCLUSION AND RECOMMENDATION

Malaria is a persistent health problem in district Jodhpur with variation in its transmission dynamics within and between the years. District Jodhpur with its rural and urban areas is a low risk area for malaria. Prevention strategy should be targeted towards all age groups with appropriate measures for low risk areas. Chemoprophylaxis is hardly advisable for travelers coming in Jodhpur City that is a low risk area.

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