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Disease Dynamics and Surveillance of Malaria in Malwa Region of Punjab and Evaluation of RDT Test

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Authors' contributions

This work was carried out in collaboration between all authors. Authors RB and NJ designed the study, wrote the protocol, and managed the literature searches. Authors RB, NJ and SS managed the analyses of the study. Author RB wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aim: Malaria remains an enormous public health problem. Regular and ongoing surveillance to detect changes in its trends to initiate the control measures is the need of the hour. The present study was undertaken to provide the malaria transmission dynamics using surveillance indicators through active and passive surveillance in district Faridkot. Usefulness of rapid malaria diagnostic test was also evaluated.
Methodology: This retrospective study extended over a period of two years (2010-2011). Thick and thin blood smears were prepared from suspected cases of malaria complaining of fever and headache for the last three days (i) of 2 CHC's, 8 PHC's and 68 sub centers as a part of active surveillance and (ii) those who visited GGS Medical College & Hospital and civil hospital Faridkot as a part of passive surveillance. Out of all the samples collected during the passive surveillance 995 samples collected at GGS Medical College and Hospital, Faridkot were also subjected to rapid diagnostic test (OptiMAL®).
Results: The annual blood examination rate (ABER) was 9.0 and 9.7 in 2010 and 2011 respectively. Annual parasite incidence (API) recorded was < 2 (0.5) in both the years and slide positive rate (SPR) was 0.5 and 0.05 in the two respective years of study. Significant gap in the rate of case detection of active and passive surveillance systems was observed with predominance of passive surveillance. More than 96% of cases were of *P. vivax*.

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RDT's showed an excellent correlation with conventional microscopy.
Conclusion: Malaria (*P. vivax*) is a persistent problem in the Malwa region with variation in its transmission dynamics with in the year. *P. vivax* is the main species of malarial parasite in the Faridkot district with occasional cases of *falciparum* malaria. Prevention strategy should be targeted towards on the spot diagnosis by using RDT and hence prompt treatment. It could help to prevent spread of drug resistance and complicated malaria.

Keywords: P. vivax; surveillance; ABER; API; RDT.

1. INTRODUCTION

Malaria is one of the most prevalent parasitic diseases worldwide and every year 300 to 500 million people suffer from it. From India, about 2 million confirmed malaria cases and 1000 deaths are reported annually [1]. Geo-ecological diversity, multiethincity and variation in the distribution of anopheline vector transmitting various plasmodial species make the epidemiology of malaria very complex in India. There is wide variation in the distribution, specific seasonal prevalence and the proportion of *P. vivax* and *P. falciparum* infections in the different regions of India. Not much information on the true burden of malaria is available. This is partially because of clinical misdiagnosis of malaria which has been reported both in public and private health sectors [2].

Two procedures are currently available for the laboratory diagnosis of malaria. Microscopy is the gold standard or diagnostic reference test. However, it requires well trained and motivated human resources and is time consuming. The Rapid Diagnostic tests (RDT's) are simple and accurate based on immune-chromatographic technique and detect antigens in all forms of parasite (sexual and asexual). The present study provides information on the current burden of malaria in district Faridkot which is situated on the South western corner of Punjab, India. It has dry climate and a short rainy season. In addition, usefulness of the rapid diagnostic test (RDT) for the early case detection and prompt treatment which are the key strategies of malaria control program has been discussed.

2. MATERIALS AND METHODS

The present study extended over a period of two years (Jan. 2010 to Dec. 2011) in Faridkot district of Punjab. Thick and thin blood smears were prepared from suspected cases of malaria complaining of fever and headache for the last three days (i) of 2 CHC's, 8 PHC's and 68 sub centers as a part of active surveillance and (ii) those who visited GGS Medical College and Hospital and civil hospital Faridkot as a part of passive surveillance. Demographic information was obtained from the patients who were included in the study. Patients already treated for malaria in the previous four weeks were excluded from the study.

All the blood smears prepared during active and passive surveillance were giemsa stained and microscopically examined under oil immersion lens. Among the suspected cases of malaria of passive surveillance, 995 were also analyzed by rapid diagnostic test (OptiMAL®). This test is based on the immunological detection of parasitic lactate dehydrogenase (PLDH) which differentiates between falciparum and non falciparum malaria species. The test was performed according to manufactures instruction and results were recorded as positive or negative based on the observations of precipitation bands.

3. RESULTS

Table 1 shows the trend of malaria surveillance indicators in district Faridkot (2 CHC's, 8 PHC's, and 68 sub centers) during the year 2010 and 2011. Annual Blood Examination Rate (ABER) was ≤ 10 during the study period; it was 9.0 in 2010 and 9.7 in 2011. Annual parasitic incidence (API) was ≤ 2 (0.5) in both the years of the study. Year wise Slide positivity rate (SPR) was 0.5 and 0.05 respectively.

Table 1. Malaria surveillance indicators of 2010 & 2011 in district Faridkot

Year	ABER	API	SPR
2010	9	0.5	0.5
2011	9.7	0.5	0.05

ABER = Annual blood examination rate; API = Annual parasite incidence; SPR = slide positivity rate.

Table 2 shows the proportion of positive malaria cases in active & passive surveillance. Out of the total of 53583 blood smears examined during 2010, 32040 were from active surveillance and 21543 from the passive surveillance. Of this 308 were found to be positive, 45(14.6%) were from active surveillance and rest of the 263 (85.4%) in passive surveillance. During the year 2011, out of 58231 blood smears examined 33203 were from active and 25028 from passive surveillance. A total of 328 smears were positive for malarial parasites; 39 (11.9%) in active surveillance and 289 (88.1%) in passive surveillance. Statistically the difference between the slide positivity rate of active and passive surveillance was highly significant (p= 0.000) during both the years. Of all the reported malaria positive cases, the proportion of *P. vivax* was 96.7% (298 out of 308), while 1.9% (6 out 369) were of *P. falciparum* mono infection. Mixed infection was observed in 1.6% (2 out of 308 cases) in year 2010 only. In 2011, there was no case of mixed infection & 99.3% (326 out of 328) cases were of *P. vivax* & only 0.6% (2 out of 328) were of *P. falciparum* (Table 3).

Table 2. Proportion of positive malaria cases in active and passive surveillance in 2010 and 2011

	Total surveillance		Active surveillance		Passive surveillance	
Year	**Slides examined**	**Slides positive**	**Slides examined**	**Slides positive**	**Slide examined**	**Slides positive**
2010	53583	308 175(M) 133(F)	32040	*45	21543	*263
2011	58231	328 184(M) 144(F)	33203	**39	25028	**289

**p value = 0.000 (Highly significant); M: Male*
*** p value = 0.000 (Highly significant); F: Female*

Table 3. Proportion of *P. vivax* and *P. falciparum* cases in year 2010 and 2011

	Mono infection		Mixed infection
Year	*P. vivax*	*P. falciparum*	
2010	298 (96.7%)	6(1.9%)	4 (1.2%)
2011	326 (99.3%)	2 (0.6%)	Nil

Fig. 1 shows month wise slide positivity rates of active and passive surveillance with seasonal fluctuation. Malarial transmission was recorded in all the months of 2010 except January when no positive case of malaria was observed. The rate of positivity showed a gradual increasing trend from April to September in both passive & active surveillance from September onwards, it again showed decline till the month of December. Almost similar trend was observed during the year 2011.

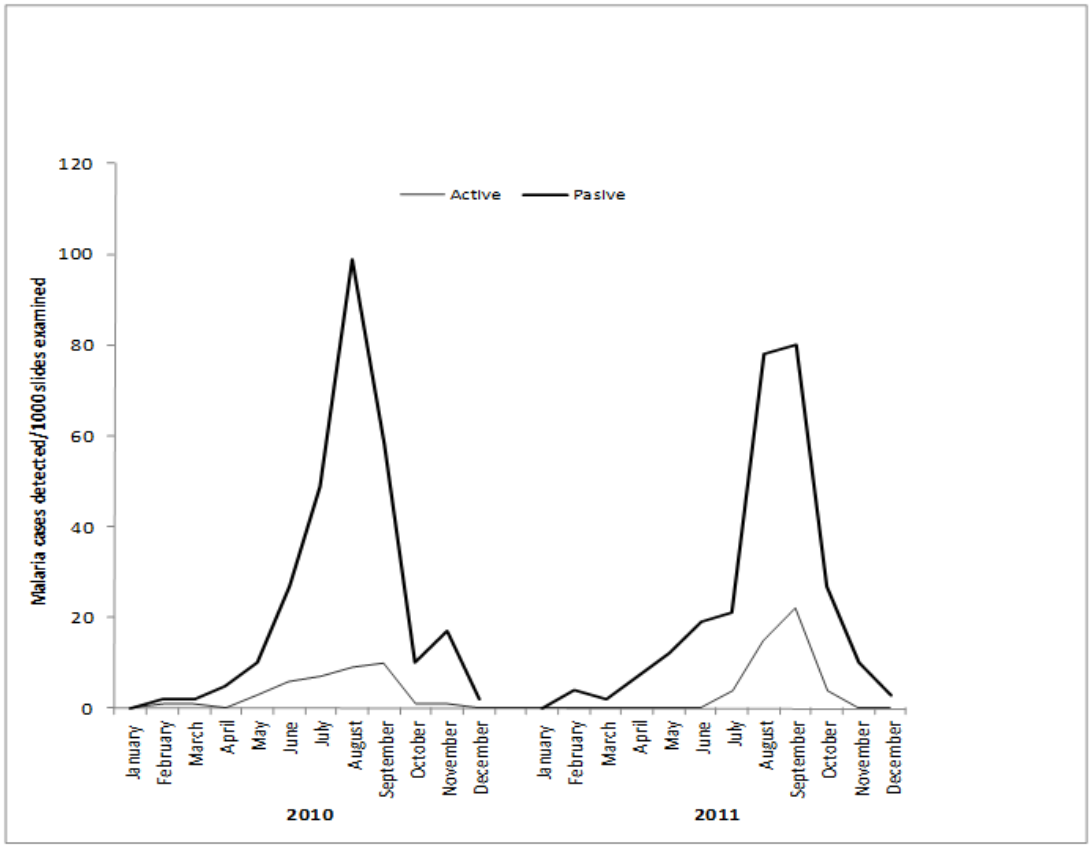

Fig. 1. Monthly malaria case detection rates in active and passive surveillance in district Faridkot during 2010 to 2011

Out of 308 malaria positive cases 175 were males and 133 females (2010) while out of 328 positive malaria cases in year 2011, 184 were males and 144 were females. Out of positive males and females, 80 were children in 2010, while their number was 73 in 2011. No death was reported due to malaria during both the years of the study.

Out of passive surveillance samples, 995 (417 and 578 in 2010 and 2011 respectively) were also analyzed by RDT OptiMAL®. Of the 39, 38 samples were positive by both the methods while 1 sample showed discordance which was positive by microscopy and negative by OptiMAL® rapid device.

The results demonstrated malaria rapid device sensitivity of 97.4% and specificity of 100% when compared with gold standard microscopy. The positive predictive value (PPV) of 100%

and negative predictive value (NPV) of 99.8% was shown by RDT (OptiMAL® test) over microscopy.

4. DISCUSSION

Principal indicators of malaria surveillance are annual blood examination rate (ABER), annual parasitic incidence (API) and slide positivity rate (SPR). Malaria surveillance of the district Faridkot during the years 2010 and 2011 showed ABER value of 9% and 9.7% respectively. Other Indian studies have reported the value of this indicator as 1% to 8% in 14 states and 10 to 40% in 15 other states of India[1]. On the assumption that all or most of the fever cases are examined for malaria and 10% of the populations in a year have fever at one point of time, 10% ABER is considered adequate to reflect the true picture of malaria according to National Vector Borne Disease Control Program [3]. This value in our study (9% and 9.7 %) is slightly less than that. Of all the indicators of malaria surveillance, annual parasitic incidence (API) is the most important to assess the eradication programme. In the present study the observed API was 0.5 during both the years of study. NVBDCP reports the same in most of the states of India. API 2-5 and >5 per 1000 population have been recorded only from scattered regions of the country [1].

In India, key strategies for malaria control are early case detection and prompt treatment, active and passive case detection through fever treatment depots and village link workers in the inaccessible and remote areas [4]. In the present surveillance of Faridkot district, there is statistically significant (p= 0.000) difference between case detection rate of active and passive surveillance with predominance of passive. This is similar to the report from Jodhpur [5]. Due to inadequate blood examination rate because of poor active surveillance in many endemic states, the actual burden of malaria remains elusive in India [1].

In the present study proportion of *P. vivax* was 96.7% and 99.3% and that of *P. falciparum* was 1.9% and 0.6% in 2010 and 2011 respectively. This proportion varies in different regions of India. In Indo-gigantic plains, northern hilly states, north western India and southern Tamilnadu, *P. falciparum* infection is <10% and the rest are *P. vivax* infections [1]. This calls for a change in paradigm shift from focus on *P. falciparum* to the neglected *P. vivax* malaria. Recently numerous studies of severe disease and even deaths due to *P. vivax* mono infections have been reported [6-9].

The peak transmission of malaria was observed in months of August and September in both the years of study which collaborates the findings of Saifi from Aligarh [8]. It could be because of availability of plenty of water bodies supporting breeding of vector species after rainy season. Moderate temperature (26-28^{o}C) and optimum humidity (77-78%) during these months which are ideal for the mosquito breading might had influenced increase in vector population and transmission of disease as observed earlier also in Delhi [10].

In our study, the disease burden was observed more in males than in females. This could be due to under reporting in females because of varied access to health care services, exposure to mosquitoes, and division of labor [3,11-13]. In highly endemic areas, disease mainly affects children than the adults because adults have protective immunity, where as in areas of low to moderate endemicity, it is other way round [4].

In the present study, the results of microscopy were compared with that of rapid diagnostic test (OptiMAL®), in 995 cases; it was observed that the results of both the tests were comparable. High sensitivity and specify of RDT's have been reported by others also [14-

15]. In only one case discordance was observed which was positive by microscopy but negative by RDT. It may be due to insufficient quantity of enzyme PLDH released by the parasite. The major advantage of RDT is that it can be used for on the spot diagnosis and treatment of malaria. In many cases, it could be life saving as well as useful tool for transmission control at the community level. There is a strong need for integrated laboratory and field studies as well as the use of mathematical models to interpret the complex dynamics of disease.

5. CONCLUSION

It can thus be concluded that malaria is a persistent problem in this region with variation in transmission dynamic with in the year. *Plasmodium vivax* is the main species of malarial parasite existing in the region. Strengthening of the active surveillance, focus elimination and strong will at all levels of health system can make eradication of malaria possible. Use of RDTs should be encouraged to evade the over use of anti-malarials in non-malarial cases and to promote changes in anti malarial prescription behavior.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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