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Changing trends in prevalence of different *Plasmodium* species with dominance of *Plasmodium falciparum* malaria infection in Aligarh (India)

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ABSTRACT

Objective: To determine the prevalence of malaria in Aligarh and analyze species dominance in different years over a decade. **Methods:** Diagnosis of malaria was done using microscopy as gold standard, rapid antigen detection assays and quantitative buffy coat (QBC) assays. Giemsa stained blood smear examination was done, thick and thin films were examined for presence of different *Plasmodium* spp. Rapid antigen detection assays employing detection of HRP-2 and parasite lactate dehydrogenase antigen (pLDH) by immunochromatography was done in patients whose blood smear found to be negative by conventional Giemsa slide examination. QBC was done in cases where there is strong clinical suspicion of malaria with blood smear negative, in patients with chronic malaria, splenomegaly, or in those patients who had inadequate treatment and for post-treatment follow up. **Results:** *Plasmodium vivax* and *Plasmodium falciparum* were only species detected in our hospital. Overall prevalence of malaria in Aligarh was found to be 8.8%. The maximum prevalence of 20.1% was observed in year 2008 and lowest 2.3% in 2002. **Conclusions:** High prevalence of malaria is observed in this part of country with dominance of both species particularly *Plasmodium falciparum* should be monitored and factors accounting for occurrence should be studied to employ effective control measures.

1. Introduction

Malaria a disease of antiquity has proved to be responsible for morbidity and mortality till date in tropical and subtropical countries. Recent estimates indicate 300-500 million clinical cases and between 1.5-2.7 million deaths, occur worldwide[2]. Malaria affects 19 countries and about 36% of world population is exposed to risk of getting infection by *plasmodium*, and in India alone 1.2 billion are exposed to risk[9]. India alone contributed to 76% of total clinical cases in South East Asia as estimated by WHO in 2005. The epidemiology of malaria in India is complex because of geoecological diversity multiethnicity, and wide distribution of anopheline vector[7] transmitting different *Plasmodium* sp. In 2008 malaria positive cases reported 1.5 million, *Plasmodium* 49% in both 2007 and 2008 from previously reported 44% in 2005. The number of deaths due to *Plasmodium falciparum (P. falciparum)* was 963 in 2005 and further increased to 1 311 in 2007 and death reported in provisional data for 2008 was reduced to 935[7].

2. Materials and methods

2.1. Study area and population

The study was conducted in Department of Microbiology, Jawaharlal Nehru Medical College and Hospital, Aligarh Muslim University, Aligarh, is a small city in North India, which lies in the shadow of the New Delhi. The city's population has increased from 0.4 million in 1991 (Census of India, 1991) to 0.8 million in 2001 (Aligarh Municipal Board, 2001)[1]. The climate is characterized by three distinct seasons: summer (April-June), monsoon (July-October), and winter (November-March). The average temperature, rainfall, and relative humidity during the three seasons are as follows: summer: 20 ℃-42 ℃, 0.1-71 mm, and 17%-58%; monsoon: 18 ℃-39 ℃, 1-494 mm, and

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34%–83%; winter: 6 ℃–29 ℃, 0.3–123 mm, and 30%–86%. The average annual temperature is 26 ℃ and at an average humidity of 76%. Anopheles culicifacies is the predominant vector in this region[12]. The study comprise of all patients attending medicine and pediatric outpatient departments and those who were admitted with pyrexia of unknown origin accompanied by chills and rigors, which are the characteristic features of malarial infection.

2.2. Detection of cases of malaria

Diagnosis of malaria was done using microscopy as gold standard, rapid antigen detection assays and quantitative buffy coat assays (QBC). Giemsa stained blood smear examination was done, thick and thin film were examined for presence of different *Plasmodium* species, double blinded. QBC, HRP-2 and parasite lactate dehydrogenase antigen (pLDH) detection by immunochromatography was done in patients whose blood smears were found to be negative by conventional Giemsa stained blood smear examination. QBC was found to be an effective diagnostic technique especially in patients who had inadequate treatment and for post-treatment follow up. Where antigen detection assays can be false positive.

2.3. Diagnosis of plasmodium species

Thick and thin Giemsa stained blood smear examination was done. 100 fields were seen and parasites were counted in relation to 200 WBCs. A centrifugal hematology test was done where parasite examined in buffy coat. Antigen detection assays, were done for detection of pLDH and HRP-2 Ag by standard protocol given by manufacturer.

2.4. Data analysis

All data were recorded on standardized case report forms and exported for analysis in SPSS (SPSS Inc, USA). All statistical tests were two tailed and significance was defined as $P<0.05$.

3. Results

Analysis of malaria data over a period of decade (1999–2009), showed prevalence of only two species of *Plasmodium* *i.e.* *Plasmodium vivax* (*P. vivax*) and *Plasmodium falciparum* (*P. falciparum*). In year 1999, prevalence of malarial infection were 7.5% (95% *CI*), *P. falciparum* and *P. vivax* 3.8%, 3.9% (95% *CI*) respectively. In 2000 there was sudden increase in incidence of malaria prevalence to 10%,(*P. falciparum* 6.6%, and *P. vivax* 3.6%). From year 2001 to 2009 total prevalence of malaria infection ranged from 2.3% to 20.1%, with *P. falciparum* prevalence range from 0.5% to 7.8% and *P. vivax* 0.5% to 5.1%. In 2002 prevalence of *P. vivax* infection showed increasing trend while there is decline in *P. falciparum* malaria with resultant decrease in prevalence. Again in 2003 there was decrease in prevalence of *P. vivax* and rise of *P. falciparum* to 2.3% while the incidence of *P. falciparum* infection remained almost same in 2004, but *P. falciparum* infection rose to 12.8% in 2005.

Overall prevalence of malaria in Aligarh, a district of North India in state of Uttar Pradesh was found to be 8.8%. The maximum prevalence of malaria infection 20.1% was observed in year 2008 and lowest 2.3% in 2002. Maximum number of cases of *P. falciparum* that was detected by using different diagnostic modalities such as blood smear examination, quantitative buffy coat assay and rapid antigen detection assays was found to be 80.8% in year 2003 while minimum number of cases were recorded in year 2002 *i.e.* 23.6%. Minimum number of cases of *P. vivax* were detected in year 2003 (18.4%) and maximum in year 2002 (76.3%). The average difference in malaria prevalence between *P. falciparum* and *P. vivax* was found to be 1.59% (P=0.068, paired t test).

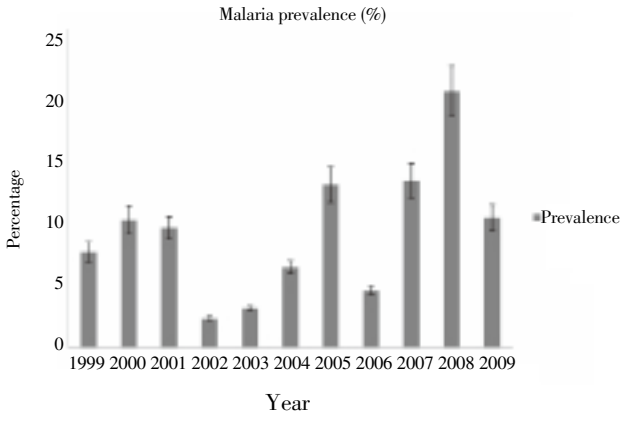

Figure 1. Malaria prevalence in Aligarh.
Histogram shows year wise prevalence of malaria in Aligarh region.

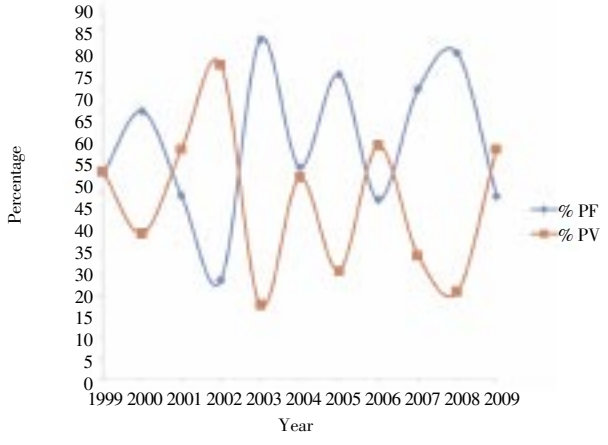

Figure 2. Trends of *P. falciparum* and *P. vivax* in Aligarh (Year wise distribution).
PF: *P. falciparum*; PV: *P. vivax*.

Table 1
Species wise prevalence of malaria in Aligarh (1999–2009).

Species	Year wise prevalence % (95% *CI*)										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Both species (BSE)	7.7	10.2	9.3	1.8	2.8	5.6	10.0	3.9	8.2	9.5	4.6
Both species (With QBC & RDT)	7.5	10.0	9.4	2.3	3.1	6.3	12.8	4.5	13.1	20.1	10.2
P. falciparum	3.8	6.6	4.2	0.5	2.3	2.8	7.2	1.8	6.3	7.8	1.9
P. vivax	3.9	3.6	5.1	1.2	0.5	2.8	2.7	2.0	1.9	1.4	2.6
Mixed infection (PF & PV)	0.0	0.0	0.0	0.0	0.9	0.0	0.2	0.0	1.1	3.9	1.2

BSE: Blood smear examination.

4. Discussion

There is regular fluctuation in prevalence rates over these years with dominance of *P. falciparum* infection. Records obtained from meterological service in this area suggest fluctuations in mean average rainfall in Aligarh from year to year over past ten years. High prevalence recorded in 2008 was followed by lowering of prevalence in next few years due to extreme preventive measures taken up by Municipal Corporation of Aligarh. There is no data available from any other sources regarding the prevalence of malaria in this region. High prevalence rate of *P. falciparum* with high rain fall was recorded[4], who also proposed association of *P. falciparum* infection with rainfall.

In vivo resistance to chloroquine was seen in our patients as similar rates of high level *in vivo* resistance in *P. falciparum* infection seen[6]. Retrospective study of record suggests higher prevalence of *P. vivax* in 1990s in this area but there is a shift towards *P. falciparum* leading this to dominant species responsible for malarial infection. As *P. falciparum* infection is associated with adverse clinical outcomes like cerebral malaria[3,8], renal failure[5,10,11] due schizogony in deep internal organs, this infection needs special attention with regard to control measures that lead to high breeding of mosquito vector. Different strategies are to be designed to reduce the prevalence rates in this area and monitor the growing rate of *P. falciparum* infection and measure should be taken for proper treatment so as to prevent recrudescence or relapse of malarial infection.

There is a regular fluctuation in prevalence rates of different *Plasmodium* species with high prevalence of *P. falciparum*, a species which is responsible for high mortality and morbidity associated with its complication. Different epidemiological factor responsible for these fluctuation and dominance of *P. falciparum* need to be studied to implement effective control measure to combat severe form of malaria in this area of high malarial transmission.

Conflict of interest statement

We declare that we have no conflict of interest.

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