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Prevalence and transmission pattern of *plasmodium falciparum* infection in Osogbo metropolis, Southwest, Nigeria

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Summary

Plasmodium falciparum malaria is an endemic disease especially in tropical areas with heavy rainfall that spread round the year. We therefore sought to investigate the prevalence pattern and clinical presentation of *falciparum* malaria in Osogbo, southwest Nigeria. A total of 646 children with febrile illness and axillary temperature of >37.5°c were assessed and screened for *plasmodium falciparum* infection by clinical assessment and microscopy using both thick and thin blood smears over a period of 12 months- August 2004 and July 2005. The prevalence of *Plasmodium falciparum* infection was found to be 52.8 % with 341/646 of the patients been positive for *Plasmodium falciparum* parasite based on microscopy. Three hundred and five (47.2%) were *aparasitaemic* of which 162 (25.1%) had bronchopneumonia, 99(15.3%) had upper respiratory tract infection, 32(5.0%) had gastroenteritis and 12 (1.9%) had *Otitis* media. Between August and November 2004, 250 patients were screened and 160 (57.6%) of these patients were positive, while 180 patients were screened between December 2004 and March 2005 and 51 (28.3%) were positive. Between April 2005 and July 2005, 216 patients were screened and 130 (60.2%) of the patients were positive. When compared, the differences in the percentage of patients with positive microscopy in December to March with April to July and August to November were found to be significant (P<0.0001), whereas the percentage difference in patients with positive microscopy in August to November and April to July was not significant (P=0.442). The result of this study clearly shows that there are two distinct peaks of malaria transmission pattern in consonance with the rainfall pattern in the area.

Keywords: *Prevalence, clinical presentation, plasmodium falciparum, Osogbo, southwest, Nigeria.*

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Résumé

Le paludisme du au Plasmodium falciparum est une maladie endémique spécialement dans les zones tropicales avec des forte pluies durant l'année. Nous envisageons investiguer la fréquence et la présentation clinique du paludisme à Oshogbo, au Sud Ouest Nigeria. Au total 646 enfants ayant la fièvre et une température axillaire >37.50c étaient évaluées et dépistée d'infection du plasmodium *falciparum* pour une évaluation clinique et microscopique utiliser les gouttes épaisses durant 12 mois- Août 2004 Juillet 2005. Le taux d'infection du *Plasmodium falciparum* était de 52.8 % avec 341/646 des patients positive au Plasmodium *falciparum* basée sur la microscopie. Trois cent cinq (47.2%) étaient sans parasitemie parmi lesquels 162 (25.1%) avaient la bronchopneumonie, 99(15.3%) d'infection du tronc supérieur de la respiration, 32(5.0%) avaient la gastro-entérite et 12 (1.9%) l'*Otite* media. Entre Août à Novembre 2004, 250 patients étaient examinés et 160 (57.6%) de ceux ci étaient positive, alors que 180 patients étaient examines entre Décembre 2004 et mars 2005 et 51 (28.3%) étaient positive. Entre Avril 2005 et Juillet 2005, 216 patients étaient examinés et 130 (60.2%) avaient leur lames épaisses positive à la microscopie. Lorsque les différences pourcentages des patients ayant une examination microscopique positive Décembre à Mars avec de Avril to Juillet et d'Août à Novembre étaient comparés, ils avaient une différence importante (P<0.0001), alors que la différence de pourcentage entre les patients ayant une examination microscopique positive entre Août et novembre et entre Avril et Juillet n'était pas importante (P=0.442). Le résultat de cette étude montre clairement qu'il y'a deux pic distincts dans la transmission du paludisme faisant rapport avec les pluies dans la région

Introduction

Malaria, one of the most threatening health diseases in the world, claims millions of lives each year. Global figures for deaths from malaria range from 1.5 to 2.7 million each year, most of whom are children

under 5 years of age and pregnant women. *Plasmodium falciparum* is the malaria parasite that causes the most severe disease in humans. This burden of mortality is not equally shared falling most heavily on sub-Saharan Africa where > 90% of these death occur and 5% of the deaths occur in children [1, 2]. It is an endemic disease especially in areas with heavy rainfall that spread round the year. It has also been established that socioeconomic factors can also influence the prevalence and the pattern of transmission of the disease [3]. This is evident when there is delayed diagnosis and treatment as a result of poor economic resources and vulnerability of the people [4].

Malaria can be transmitted by several species of female anopheline mosquitoes that differ in behaviour and this and other factors contributes to the varying epidemiological patterns of the disease seen worldwide [5]. Also war and civil unrest has led to an upsurge of malaria in many parts of Africa where health services have broken down [5]. The importance of climatic warming in regards to malaria epidemiology is been debated [6, 7]. Malaria and HIV interact in several ways; malaria could adversely affect HIV infection by increasing viral load [8], whereas HIV increases malaria fevers [9, 10] and interacts adversely with malaria during pregnancy [11]. However, the main cause of the worsened malaria situation recorded in recent years has been the spread of drug-resistant parasites, which has led to rising malaria-associated mortality, especially sub Saharan Africa [5, 12].

Determining the local epidemiological profile of malaria, including malaria transmission patterns, parasite genotypes, and the seasonal dynamics of the infections, malaria attack rates, and morbidity trends is seen as an important first step towards evaluating the efficacy and effectiveness of therapeutic agents in malaria endemic areas [13]. This study was therefore conducted over one year with the aim of determining the transmission, prevalence patterns and seasonal dynamics of malaria infection in this environment.

Patients and Method

Study Site

Osogbo metropolis is the capital of Osun state, one of the six states that make up the Southwest Nigeria. The mean annual rainfall is 1250mm – 2000mm, with 60% -70% relative humidity and temperature range between 28°C – 32°C. In 2005, Osogbo had an estimated population of well over 400,000 inhabitants based on 1991census figure of 210,000 inhabitants with a 3% yearly increase [14]. It is located about 100 km north of Ibadan the largest city Sub-Saharan Africa where malaria is hyper-endemic [15]. The vegetation is predominantly rain forest interspersed with derived grasslands. It has dual peaks of rainfall in May to July and September to November yearly, with a break in rainfall pattern during the month of August. The metropolis is half surrounded by Osun River, the course of which is occupied by thick vegetation and traversing part of the metropolis. Malaria transmission in southwest Nigeria is perennial but highly seasonal and peaks during the rainy season, which normally runs from April to November in some places and may be longer in the coastal towns of the southwest Nigeria.

Patients

The study took place at the Malaria research clinic and laboratory, LAUTECH Teaching Hospital (LTH) and General Hospital Asubiaro, both in Osogbo and was designed as an open controlled trial. Overall 646 patients were screened before enrollment between August 2004 and July 2005. To be enrolled the children had to be aged 6 months - 120 months, present with symptoms compatible with acute uncomplicated P.falciparum malaria with fever >37.5°C within the past 24- 48hrs preceding presentation. Present with pure P.falciparum parasitemia >2000 asexual forms/ ì l of blood.

Informed consent of parent or guardian was obtained for each child. The study received ethical approval from Joint College of Health Sciences/ Ladoke Akintola University Teaching Hospital ethical review committee and Osun State Hospitals Management Board ethic review committee. Before enrollment, a medical history of each patient was obtained from the parent or guardian, after which the child is examined physically. Body weight and axillary temperature were recorded, thick and thin smears were prepared from finger-prick blood samples. The smears were Giemsa-stained for parasite identification and quantification. Parasites quantification was done by counting maximum number of parasite per 200 leucocytes multiplied by 8000 by two independent microscopists. Filter paper blood samples were taken to confirm the genotype of the infecting parasite.

Statistical analysis

The statistical package used for data entry and analysis was Graph-pad instant of Graph pad

software incorporation USA. Significance was determined using chi-square test and Fishers Exact test. P value of <0.05 was taken as significance.

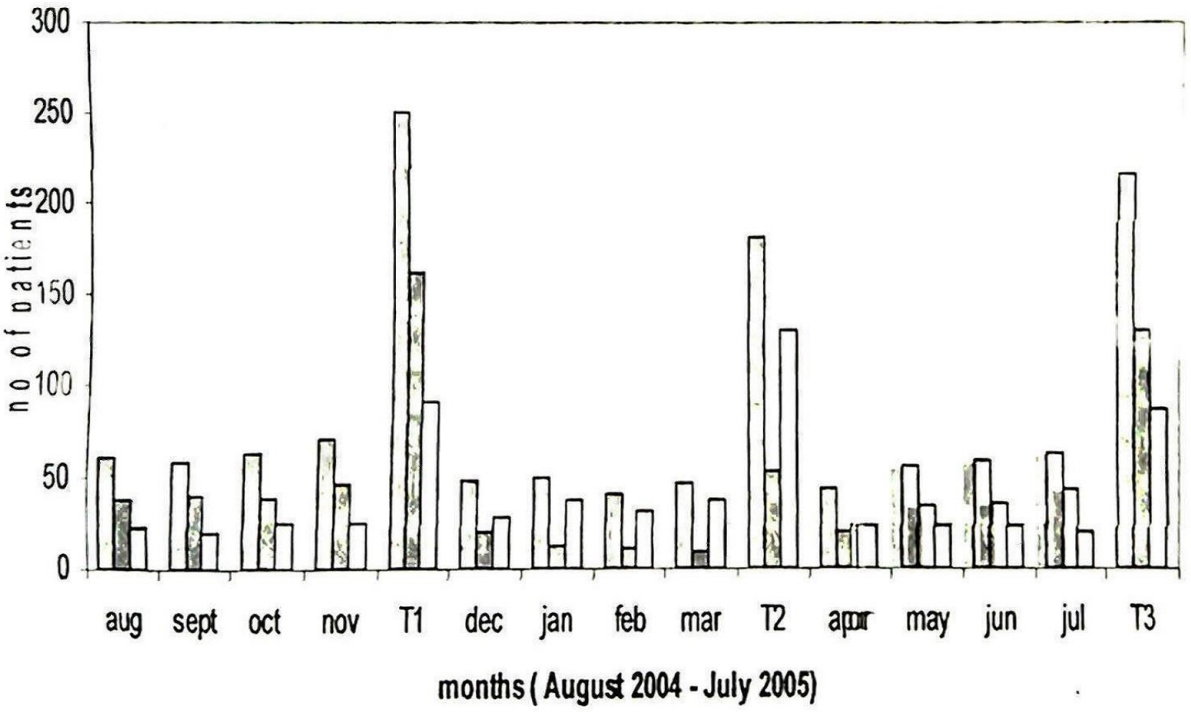
Results

Out of 646 patients with axillary temperature >37.5°c screened and examined for *Plasmodium falciparum* infection, 341 (52.8%) were positive on microcopy, while 305 (47.2%) were negative. The mean age distribution of those with positive microscopy was 38.18± 31.15 months, while those with negative microscopy were 33.00± 28.05 months with a range between 6.0–120 months. The mean weight of those with positive microscopy was 11.48±4.97kg, while those with negative microscopy were 11.01±5.03kg with a range between 4.5 – 29.0kg and 4.0–29.0kg respectively. The mean temperature for those with positive microscopy was 38.4±0.8°C with a range of 37.5–41.0°C, while those with negative microscopy were 37.6±0.6°C with a range of 37.5–39.0°C. The differences in mean age and mean temperature in patients with positive microscopy and those with negative microscopy at presentation were found to be statistically significant (P< 0.0286; P< 0.0001) while the differences in mean weight among the two groups were not significant (P> 0.22) Table 1.

Table 1: Showing the main characteristics of all the patients at recruitment into the study.

Characteristics	Positive parasitemia	Negative parasitemia	P – value <0.05
No of patients(n)	341	305	
Mean age ± sd range (months)	38.18 ± 31.5 (6 – 120)	33.00 ± 28.05 (6 – 120)	P=0.028
Mean weight ± sd range (kg)	11.48 ± 4.97 (4.5 – 29.0)	11.01 ± 5.03 4.0 – 29.0)	P=0.229
Mean temp °c ± sd range (°c)	38.37 ± 0.83°c (36.9 – 41.0°c)	37.56 ± 0.61°c (36.0 – 39.9°c)	P<0.0001
Male : Female	184 : 157	163 : 142	P=0.958

Fig. 1: The monthly prevalence pattern and seasonal variation of *plasmodium falciparum* malaria and other febrile illnesses in Ogwuebu, southwest Nigeria



Key: A = total number of patients seen per months, B – total number of patients with positive malaria microscopy; C= total number of patients with negative malaria microscopy;

The monthly prevalence pattern shows a gradual increase in the prevalence from 47.6% in April which herald the onset of raining season, to 60% and above from May to June. July recorded the highest incidence of 67.7% of positive cases. There was a slight drop in the prevalence pattern in August by about 4% from the peak incidence. The prevalence rose to 67.4% in September, with a slight drop in the pattern to above 5% in October and less than 5% in November. There was a sharp drop in the pattern in December to about 40% and a further drop to 25% and below in the months of January to March. Figure 1.

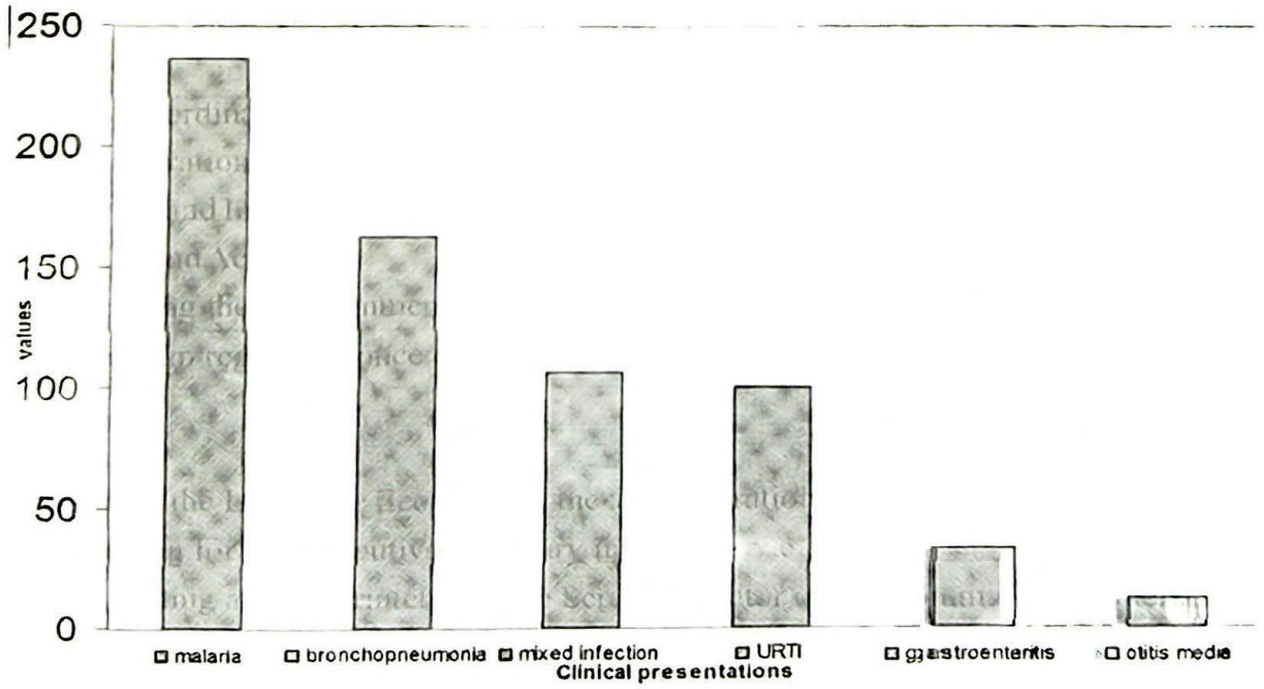
them were positive by microscopy and 90 (42.4%) were negative. Between December 2004 and March 2005, 180 patients were screened, 51 (28.3%) were positive by microscopy and 99 (71.7%) were negative. Between April and July 2005, 216 patients were screened, 130(60.2%) were positive by microscopy and 86 (39.8%) were negative. When compared, the differences in the seasonal variation pattern in the percentage of patients positive by microscopy in August to November and April to July with December to March, was found to be significant (P<0.0001), whereas the differences between that of August to November and April to July was not significant (P=0.442).Table 2.

Table 2: The prevalence pattern of *Plasmodium falciparum* infection within the three groups of rainfall pattern in Osogbo metropolis southwest, Nigeria.

Months	No with positive parasiteamia	No with negative parasiteamia	Total no per quarter	Inter-group P-value
August –November (A)	160(57.6%)	90(42.4%)	250	P<0.0001*
December -March (B)	51(28.3%)	129(71.7%)	180	P<0.0001**
April –July (C)	130(60.2%)	86(39.8%)	216	P=0.442***
Total	341	305	646	P=0.958

*A : B- P<0.0001; **B : C –P<0.0001; ***A : C- P =0.442.

Fig. 2: The prevalence pattern of plasmodium falciparum infections and other infections in Osogbo metropolis southwest Nigeria



The 305 (47.2%) patients that were *aparasitaemic*, presented with other diseases that are also common among children. 162(25.10%) of them had bronchopneumonia, 99(15.30%) presented with upper respiratory tract infection which was predominantly viral infection, 32(5.0%) had gastroenteritis, and 12(1.9%) had otitis media. Among the 341 that were parasitaemic, 236 (36.5%) had pure *Plasmodium falciparum* infection, 126 (19.5%) were recruited into chloroquine efficacy study and the result had been reported elsewhere [16]. While 110 (17.0%) have taken various antimalarial drugs like chloroquine, *sulfadoxine-pyrimethamine* (fansidar), maloxone and co-trimoxazole before attending the clinic, 105 (16.3%) who were also positive by microscopy had other concomitant mixed infections especially bronchopneumonia and viral upper respiratory tract infections at the time of presentation. Figure 2.

Discussion and conclusion

This study demonstrates both micro-geographical and seasonal variations of malaria transmission pattern in Osogbo. The study shows dual peaks of rainfall pattern with mean annual rainfall of 1250mm – 2000mm in the area, beginning within the months of April and extending to the month of July. There was a clear evidence of 'little' dry season in the month of August due to presence of prominence of easterly winds that is relatively empty of moisture, this herald the onset of the second peak of rainfall in September extending to the month of November (April – November). The intensity of rainfall and frequency begins to wean at the beginning of December with sporadic but heavy rainfall that ends in that month. Malaria transmission in Osogbo occurred mostly during the wet season and fell to very low levels during the dry season within the months of December to March. This differ to other coastal areas of the southwest and south-south areas of Nigeria that records extended mean annual rainfall from 2000mm to 4000mm in the rainy season with relative humidity of 80% and temperature of 26 ^{0}-30 ^{0}C from March to November, such areas experience an intense malaria transmission that is perennial and hyper-endemic with higher morbidity and mortality [17, 18].

Within the period of this study, the total prevalence rate of all the cases infected by *Plasmodium falciparum* was 52.8%. In a similar study in the south-south areas of Nigeria, the prevalence was shown to be 60.3% in the rainy season [18-20]. The contact with mosquito vectors is much reduced during the dry season as shown by the prevalence and transmission pattern and the mean rate of parasitemia per quarter in our study. Unlike areas where irrigation is practiced with high intensity of transmission even in the dry season, an estimated exposure to over 2000 sporozoites inoculations is seen in children by the time they are six years old [13]. Forty-seven percent of the patients who are febrile at screening were not carrying P. falciparum. This reveals other causes of febrile illnesses like bronchopneumonia, gastroenteritis, otitis media and upper respiratory tract infections which are predominantly viral infection and these cases are more prevalent during the dry season. It therefore shows that a high proportion of febrile illnesses that are due to other causes are hitherto being treated as malaria. In Africa 70% of such fever cases in children are diagnosed as cases of malaria and treated with antimalarial at home, giving rise to shockingly high rates of over-diagnosis especially in areas that have intermittent malaria transmission [21].

From our study therefore, it can be concluded that the prevalence of *Plasmodium falciparum* infection is about half of all febrile illnesses and three out of five patients presenting at various health care delivery posts in the metropolis is due to *falciparum* infection. More intense transmission pattern was observed in the wet season and one out of four febrile illnesses is due to *falciparum* malaria in the dry season with less intense transmission pattern. This finding will help in reducing presumptive prescription of antimalarial drugs for non-malarial illness especially in the dry season, and help in stemming the tide of resistance development to the newly introduced *artemisinin* based-combination therapies.

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