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Studies on *Plasmodium falciparum* Infection Rates among Children (≤10 years of age) attending Federal Medical Centre Makurdi, Benue State, Nigeria

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ABSTRACT

Child malaria remains a vital concern in Nigeria, especially amongst children with little or no access to the use of Insecticide Treated Nets (ITNs). A total of 300 randomly selected children aged 0-10 years, comprising 134 males and 166 females, were investigated in a study at the Federal Medical Centre, Makurdi, Nigeria to determine the infection rates of malaria parasites from August to November 2017. Thick and thin blood films were prepared using standard techniques and examined for the presence of *Plasmodium species*. The overall infection rate was found to be 68.7% and all cases observed were due to *Plasmodium falciparum*. The study has revealed a high rate of *Plasmodium falciparum* infection (68.7%) among the children (≤10 years) in the study area. There was a significant difference (P < 0.05) in the infection rates between Insecticide Treated Nets (ITNs) users (33.8%) and non-ITNs users (60.7%). Based on our findings, it was concluded that the rate of *Plasmodium falciparum* infection was higher among the younger children and those whose parents did not use ITNs to protect them against mosquito bites than the older ones, and those who were protected under ITNs. The epidemiological and public health implications of the findings have been discussed.

Key words: Malaria, *Plasmodium falciparum,* Children, Makurdi, Nigeria

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INTRODUCTION

Malaria is of important public health concern in Nigeria, especially because of its impact on child and maternal health (Orimadegun et al., 2007). The large majority of the malaria burden is experienced by children less than 5 years (WHO, 2008). Indeed, malaria is one of the leading killers of children under age five, accounting for almost 1 death in 10 (8 percent) worldwide and nearly 1 death in 5 (18 %) in sub-Saharan Africa (Bates et al., 2004). It has been reported that there were an estimated 247 million malaria cases among 3.3billion people at risk in 2006, causing nearly one million deaths, mostly of children under five years (Bates et al., 2004). The disease causes widespread premature death and suffering, imposes financial hardship on poor households, and holds back economic growth and improvements in living standards (Kmietowicz, 2000). A typical Nigerian child will have two episodes of malaria every year. An estimated 56 million episodes are in Nigerian children under the age of five per year. Annually some 26,000 children aged five years and below die from malaria-related cases translating to 72 deaths daily (Snow et al., 1998). Some children suffer an acute attack of cerebral malaria that quickly leads to coma and death; others succumb to the severe anaemia that follows repeated infections, or to the consequences of low birth weight caused by malaria infection in the mother's womb (UNICEF, 2004). Malaria hampers children's schooling and social development. Many children who survive a serious attack of malaria develop physical and mental impairment. One hundred and nine countries were endemic for malaria in 2008, 45 within the WHO African region (WHO, 2008). Malaria contributes to child malnutrition, an underlying cause in

more than half of deaths among children under age five globally. Although the precise causal links are unclear, nutritional status is affected by vomiting and appetite suppression during bouts of malaria and by malaria-related anaemia (Bates et al., 2004).

In Nigeria, malaria is endemic and stable, being a major cause of morbidity and mortality, resulting in 25% infant and 30% childhood mortality (FMoH, 2005). It was ranked as the highest cause of death in 1978 and 1982 (Osisanya, 1985). Tragically, the health status of children under the age of five and women has remained a major barrier to Nigeria's development. It is estimated that about 100 children under one year and 203 children under-five years out of 1000, respectively, die annually (NDHS, 2003). In other words, one out of every five Nigerian children dies before his/ her fifth birthday (RBM, 2000).

Among pregnant women, malaria is responsible for more than one in 10 deaths and accounts for a considerable proportion of low birth weight babies born to these mothers. These babies born with low birth weight are usually at higher risk of dying from infant and childhood illnesses (RBM, 2005). Evidence in Nigeria was given by the malaria report of 2005 shows that malaria incidence throughout the country had been on the increase over the years, ranging between 1.12 million at the beginning of 1990 and 2.25 million by the turn of the millennium 2000 and 2.61 million in 2003.

With regard to malaria prevention, insecticide-treated nets (ITNs) have a track record of reducing malaria-related morbidity and mortality (Lengeler, 2009), and hence are increasingly being utilized in sub-Saharan Africa and other malaria-endemic areas. For example, sleeping under an ITN can decrease severe malaria by 45%, reduce premature birth rates by 42%, and significantly lower all cases of child mortality (WHO, 2009). Compared with a control situation in which there were no mosquito nets, use of ITNs in Africa increased mean birth weight by 55 g (95% confidence interval [CI] 21–88), reduced low birth weight by 23% (relative risk [RR] 0.77, 95% CI 0.61–0.98), and reduced miscarriages/stillbirths by 33% (RR 0.67, CI 0.47–0.97) in the first few pregnancies (WHO, 2009). Malaria-infected mosquitoes bite at night, and these nets provide a sleeping individual a physical barrier against the bite of an infected mosquito. In addition, a net treated with insecticide provides much greater protection by repelling or killing mosquitoes that rest on the net—an additional and important protective effect that extends beyond the individual to the community. The protective effect to non-users in the community are difficult to quantify but seems to extend over several hundred metres (Bates et al., 2004).

Effective control of malaria in Nigeria is aggravated by rapid and uncontrolled urban developmental activities, negative socio-cultural beliefs and practices, ignorance and poverty at household and community levels, increasing resistance to drugs and insecticides, weak health systems, and weak support for malaria control efforts, especially at the Local and State Government levels (Mouchet et al., 2004). The use of insecticide-treated nets has been advocated for the prevention of the vector-borne transmitted disease (malaria) by the World Health Organization and UNICEF for more than a decade now through the roll back malaria (RBM) program. In spite of this, malaria continues to significantly impact negatively on the health of Nigerian children, thus signifying no reduction in the transmission of the disease (Oyedeji et al., 2009). This paper presents the prevalence of malaria parasite among children (≤ 10 years) attending the Federal Medical Centre, Makurdi, in Benue State, Nigeria.

The distribution of malaria in relation to age and sex, parent's occupational status and their use of insecticide-treated nets are also presented. This information is important in widening the knowledge base in the treatment, prevention and effective control of malaria among children (≤ 10 years) in the study area.

MATERIALS AND METHODS

Study area

The study was conducted in the Federal Medical Centre, Makurdi. The subjects comprised of children (≤10years), who attended the hospital from August to November 2017.

Makurdi in which the Federal Medical Center is located in the capital of Benue State and is located in the middle belt, North Central Nigeria, between longitude 8°35'E and 8°41'E and latitude 7°45'N and 9°52'N, characterized by undulating rolling plains with irregular river valleys and ridges with steep slopes. According to the Federal Republic of Nigeria official gazette of 2006 population census, published in 2007, Makurdi had the population of 297,398 people (comprising 157,295 males and 140,103 females); and the town is placed 106.4m above sea level (National Meteorological Agency, 2011 personal communication).

There is also the characteristic high temperature in Makurdi, (30°C-39°C), which aids in the speedy development and hatching of mosquito eggs. Moreover, Manyi et al. (2014) reported that the temperature might have an impact on malaria transmission in the study area throughout the year. Other detailed geographical and regional indices of the study area have been provided by Udo (1981) and Nyagba (1995), and the map of the study area is depicted in Figure 1.

Ethical Clearance

Ethical Clearance was sought for and obtained from the Ethical Committee of the Hospital and Consent of the

Figure 1. Map of Makurdi, showing the Study Area - Federal Medical Centre (FMC).

Table 1: Infection Rates of *Plasmodium falciparum* among Children attending Federal Medical Centre Makurdi in Relation to Age.

Age (years)	Number Examined	Uninfected (%)	Infected (%)	Total (%)
≤1-3	87	25(28.7)	62(71.3)	87(29.0)
3-5	61	14(23.0)	47(77.0)	61(20.3)
5-7	67	25(37.3)	42(62.7)	67(22.3)
7-9	42	12(28.6)	30(71.4)	42(14.0)
9-10	43	18(41.9)	25(58.1)	43(14.3)
Total	300	94(31.3)	206(68.7)	300(100)

P > 0.05, No significant association exist.

parents/ guardians of the children were obtained before blood sample collection for the tests.

Microscopy

Thick and thin blood smears were prepared according to standard techniques (Giles, 1993). These were allowed to air-dry and were stained with 10% Giemsa solution for 30 minutes. The thin blood smear was fixed in absolute methanol for about 2 minutes before staining. Afterward, the stain was washed in running tap water, allowed to air-dry in a slanting position and examined under oil immersion for malaria parasites. At least 200 high power fields were examined before a patient test was recorded as negative. Both thick and thin blood films were examined for each patient. Thin films were used for the species identification of *Plasmodium* parasites.

Data Analysis

Simple percentages were used to estimate infection rates and the Predictive Analytical Software (PASW) Version 18 was used in running Chi-square (χ^2) test on the data collected to determine differences in infection rates. Significant levels were measured at 95% confidence level with significant differences considered at P > 0.05.

RESULTS

A total of 300 children under the age of 10 were tested with Giemsa stained blood smears where 206 (68.7%) of them were found to be infected. The age group 3-5 years recorded the highest prevalence of 47 (77.0%) while the age group ≤ 9-10 years recorded the lowest prevalence of 25 (58.1%) (Table 1). Infection rates among other age groups included: ≤1-2 (71.3%), ≤5-6 (62.7%) and ≤7-8 (71.4%) respectively. However, there was no significant difference (P > 0.05) between the rate of infection and the age of the children. The female gender recorded the highest infection rate of

Table 2: Infection Rates of *Plasmodium falciparum* among Children attending Federal Medical Centre Makurdi in Relation to Age and Sex.

	Male		Female			Total		
Age (Years)	**Number Examined (%)**	**Number Infected**	**Number Examined**	**Number (%)**	**Infected**	**Number Examined**	**Number (%)**	**Infected**
≤1-3	38	18(47.4)	49	44(89.8)		87	62(71.3)	
3-5	23	19(82.6)	38	28(73.7)		61	47(77.0)	
5-7	29	16(55.2)	38	26(68.4)		67	42(62.7)	
7-9	19	11(57.9)	23	19(82.6)		42	30(71.4)	
9-10	25	9(36.0)	18	16(88.9)		43	25(58.1)	
Total	134	73(54.5)	166	133 (80.1)		300	206(68.7)	

P > 0.05, No significant association exist.

Table 3: Infection Rates of *Plasmodium falciparum* among Children attending Federal Medical Centre Makurdi in Relation to the Occupational Status of their Parents and their use of Insecticide Treated Nets (ITNs).

		Use of ITNs and Infection Rate (%)				
Occupation	**Number Examined**	**Others**	**No. Infected**	**Net Users**	**No. Infected**	**Total Infected**
Farmers	193	156 (80.8)	137 (70.9)	37 (19.2)	9(24.3)	146 (75.9)
Traders	81	58 (71.6)	39 (48.2)	23 (28.3)	10(43.5)	49 (60.5)
Civil servants	26	15 (57.7)	6 (23.1)	11 (42.3)	5(45.5)	11 (42.3)
Total	300	229 (76.3)	182 (60.7)	71 (23.7)	24 (33.8)	206 (68.7)

P < 0.05, Significant association exist in terms of occupation and use of ITNs.

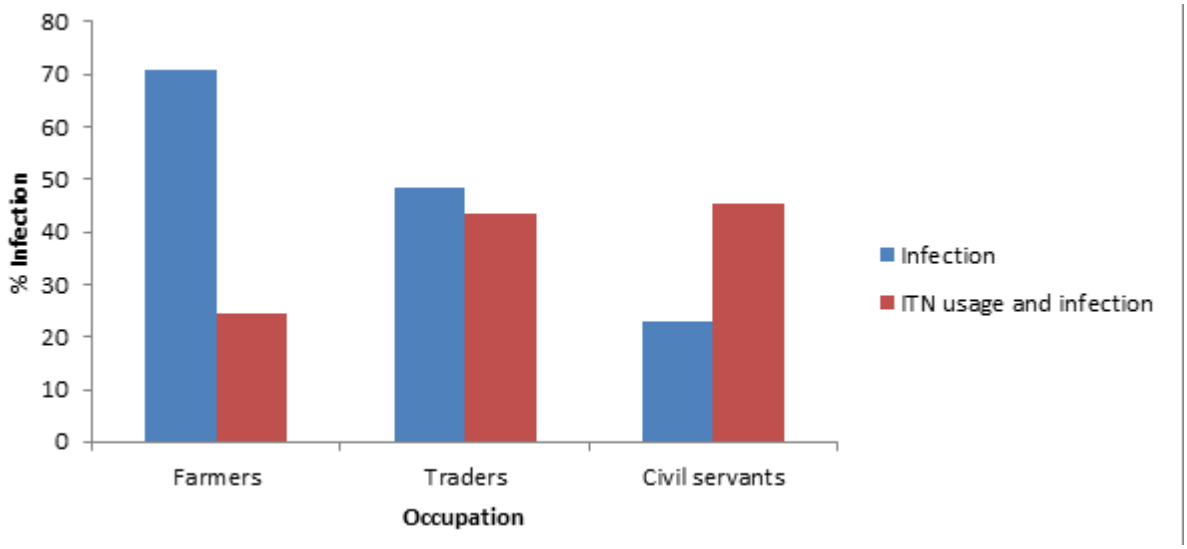

Figure 2. Pictorial Representation of Percentage *Plasmodium falciparum* Infection Rates in Children attending Federal Medical Centre, Makurdi with respect to Occupation and ITNs.

80.1%, while the males recorded the lowest infection rate of 54.5% (Table 2).

The rate of *Plasmodium* infection in the female gender did not differ significantly (P > 0.05) with that of the males. The results showed that children whose prents used insecticide-treated nets were less infected 24 (33.8%) than those who did not use mosquito nets 182(60.7%). There was a significant difference (P < 0.05) between the infection in children whose parents used Insecticides Treated Nets and those who did not. In terms of the occupational status of the parents of the children, the results showed a highest infection rate of 146 (75.9%)

among the farmers, followed by traders 49 (60.5%) while civil servants had the lowest infection rate of 11 (42.3%) (Table 3). There were also significant differences ($P < 0.05$) in the distribution of infection in the children across the occupational status of their parents. The infection rate in terms of occupational background and ITNs usage as found in this study is shown in Figure 2.

DISCUSSION

The result obtained in this study showed a high *Plasmodium falciparum* infection rate of 68.7% among the children within the ages (≤10 years) attending Federal Medical Centre Makurdi, Benue State. Studies on malaria infection in children have become increasingly important because of the alarming mortality rate among children and their susceptibility to malaria parasites (WHO, 2008).

The infection rates recorded in the present study are higher than those reported by Abdullahi et al. (2009) who reported 43.77% infection in children between 0-5 years and 38.59% in children between 6-10 years respectively in Sokoto, Nigeria.

The results of this study are at variance and higher than the 40% annual infection rate reported in Nigeria by the Federal Ministry of Health (FMoH, 2005). The present study also shows that the groups most affected by malaria infection are those under the age group (≤ 5 years) which is in line with several other studies in Nigeria (Umar and Hassan, 2001; Salako et al., 1990). Children under age five are most likely to suffer from the severe effects of malaria because they have not developed sufficient naturally acquired immunity to the parasite. A severe infection can kill a child within hours (Bates et al., 2004). Children born to immune mothers are protected against the disease during the first half year of life by maternal antibodies. As they grow older, after continued exposure from multiple infections with malaria parasites over time, they build up an acquired immunity and become relatively protected against the disease and blood stage parasites (Perlmann and Troye-Blomberg, 2000), hence lower infection rate of malaria among the age (≤6-10 years) groups.

The females were more infected with the rate of 33.1% across the age groups than their male counterparts who had an infection rate of 12.3% and the infection was statistically significant. This was in contrast to similar reports which had indicated higher infections in males than females (WHO, 2005; WHO, 2006), but there was no scientific evidence to prove the higher infection rate being related to gender as susceptibility to malaria infection is not influenced by gender (Gilles and Warrell, 1993). The high prevalence rate could be by chance; child's refusal to sleep under insecticide-treated nets or because of ignorance on the part of their parents concerning the use of insecticide-treated nets which make the females more prone to infective mosquito bites as compared to their male counterparts.

The use of insecticide-treated bed-nets have been shown to reduce malaria illness by 50 percent in areas of high transmission, yet less than 5 percent of African children sleep under a net (Hawley et al., 2003). Insecticide-treated nets and insecticides are effective tools recommended by the RBM movement for this prevention (Yamey, 2004). A Cochrane review concluded that, when full coverage is achieved, Insecticide Treated Nets (ITNs) reduce all-cause child mortality by an average 18% (range 14–29%) in sub-Saharan Africa. The general implication of this is that 5.5 lives could be saved per year for every 1000 children under 5 years of age protected. It was also concluded that ITNs reduce clinical episodes of malaria caused by *Plasmodium falciparum* and *P. vivax* infections by 50% on average (range 39–62%), as well as reducing the prevalence of high-density parasitemia (Bates et al., 2004).

The result of this study shows that a higher number of farmers' children were examined, and they were also most infected on the use of insecticide-treated net with a prevalence rate of 24.3%. The Civil Servants' children had the least number of children examined and were also least infected with a prevalence rate of 42.3%. Previous studies have shown that there is a high level of unavailability of treated nets by those who desired to procure them (Osero et al., 2005) and also lack of awareness concerning this tool and poor distribution coverage of treated nets in African communities (Miller et al.,2007). The proportion of children across sub-Saharan Africa sleeping under insecticide-treated nets is 8 percent. However, the regional average for sub-Saharan Africa is driven in part by a few populous countries with low insecticide-treated net coverage, such as Ethiopia, Kenya and Nigeria (Bates et al., 2004). Another reason may be the cost of procuring the treated nets (Molyneux and Nantulya, 2004). In addition, previous studies (Noor et al., 2006; Molyneux and Nantulya, 2004) have shown that some elitist mothers complained that the bed nets restricted freedom of access and exit when necessary thus making the use of the tool a cumbersome daily exercise. Finally, some mothers complained of their children's refusal to sleep under the net because of the fear of the children developing a reaction to the treated net (Michelle et al., 2005).

CONCLUSION

This study has revealed that the disease incidence and prevalence rate amongst children (≤10 years) attending the Federal Medical Centre, Makurdi were generally high with malaria. It has also revealed that children under the age group (≤1-4) are highly vulnerable to malaria attack; hence they should be given free malaria diagnosis and treatment. Benue State Government should ensure that the population at risk sleep under insecticide-treated nets by distributing free or highly subsidized Long Lasting

Insecticidal Nets (LLINs), either directly or through voucher/coupon schemes. The government should achieve full LLIN coverage, including in high-transmission areas, by distributing LLINs through existing public health services. The Government could reduce the infection rate further down by embarking on health education campaigns and training on malaria prevention, develop and implement locally appropriate communication and advocacy strategies to promote effective use of LLINs; and particularly educating people on the importance of not providing conducive dwelling places for mosquitoes. There is, therefore, the need to evaluate the roadmap towards achieving effective malaria control and intensify efforts to sustain or scale up specified interventions to meet the stipulated goals.

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