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EFFECT OF SOME ANTHROPOGENIC FACTORS ON THE PREVALENCE OF *Plasmodium falciparum* AMONG PATIENTS IN KADUNA STATE

***[1]Osagiede, O. N. and [2]Yayock, H. C.**

[1]College of Agriculture and Animal Science, Ahmadu Bello University, Mando, Kaduna – Nigeria.
[2] Department of Biological Sciences, Kaduna State University (KASU), Kaduna.

*Corresponding authors' email: nicozuyi@gmail.com Phone: +2348023433006

ABSTRACT

Clinical studies involving of blood samples were randomly collected from out-patients in selected hospitals in the three (3) Senatorial districts of Kaduna State were examined for Plasmodium falciparum. Blood samples were collected from 1,918 patients attending the General Out Patient Department ward from various State Government owned hospitals in the three (3) Senatorial districts. Information obtained from questionnaires administered to out-patients who tested positive for P. falciparum revealed inconsistencies in the use of Insecticide Treated Nets (ITNs) and Chemoprophylaxis to prevent malaria. The most commonly used anti-malaria drugs for self-medication among patients from the three senatorial districts shows that 56.6% of the respondents in Kaduna North uses chloroquine/fansidar, 71.5% in Kaduna South and 67.0% in Kaduna Central. Many of the patients investigated do not have sufficient access and knowledge to ITNs as provided by the Roll Back Malaria programme or State malaria campaigns.

Keywords: Plasmodium falciparum, ITNs, Chemoprophylaxis, Self-medication, Senatorial districts

INTRODUCTION

The WHO's 2023 World malaria report annual assessment of global trends in malaria control and elimination, noted that an estimated 249 million cases of malaria occurred in 85 malaria-endemic countries in 2022, a case incidence of 58 per 1000 population risk (Venkatesan,2024). These cases resulted in 608,000 deaths across the 85 countries where malaria is endemic. The highest number of cases, specifically 233 million, was reported in the WHO African Region (Venkatesan, 2024).

According to the 2022 World Malaria Report, Nigeria accounts for the highest percentage of the global malaria burden compared to any other country, with 27% of the global estimated malaria cases and 31% of the estimated deaths due to malaria (WHO, 2023). Despite committed elimination efforts, malaria has remained a major public health threat in Nigeria. As of January 2024, Nigeria recorded significant progress from previous years (Ogundipe, 2024). The malaria parasite rate further declined to an estimated 23%, with improved access to Insecticide-treated bed nets, ITNs, even as artemisinin-based combination therapies (ACTs) remain the cornerstone of malaria control (Ogundipe, 2024).

Malaria is caused by any of five species of protozoan parasite of the genus *Plasmodium*: (*P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale* and *P. Knowlesi (*Mace *et al*., 2022).

The WHO initiatives for malaria control such as roll back malaria (RBM) emphasizes the use of ITNs to reduce the mosquitoes contact as a key strategy for malaria prevention and control in Sub-saharan Africa (UNICEF, 2009).

In spite of the widespread problem of anti-malaria drug resistance, the use of drugs remains the most effective option for treatment of malaria (CDC, 2015; Van *et al*.,2019). Chloroquine, which is historically the first-line drug for the treatment of malaria is the most widely used anti-malarial in the world (CDC, 2015; Van *et al*.,2019). It is highly effective against clinical attacks of *P. vive*, *P. oval* and *P. malaria* and sensitive to infections by *P. falciparum.* Evidences have shown that Chloroquine has lost its efficacy due to the emergence of chloroquine-resistant strains of *P. falciparum* (CDC, 2015; Zou *et al*.,2021).

Artemisinin-based combined therapy (ACT), a newer treatment, is said to be extremely effective at combating malaria. It acts quickly and has few side effects. Artemisinin-based combination therapies (ACTs) is now recommended by the WHO as the first-line treatment for uncomplicated falciparum malaria in all endemic countries (Zou *et al*., 2021).

MATERIALS AND METHODS

Study Area

Kaduna State is located in the Sub-humid area of the guinea savanna. Geographically and politically, Kaduna state is in North-west, Nigeria and shares common borders with Zamfara, Katsina, Niger, Kano, Bauchi and Plateau States. The global location of the State is between longitude of 30'' east of the Greenwich meridian and also between latitude 0900 and 11 30'' North of the equator. The State occupies an area of approximately 48,473.2 square kilometers and has a population of more than 9 million (National Population Commission of Nigeria, 2022). It has 23 Local Government Areas which are divided each into three senatorial zones namely: northern, central and southern senatorial zones (Kaduna state census ,2006). Below is the map indicating the selected areas for the study which was done by simple random selection.

Figure 1: Map of Kaduna State showing all Local Government Areas and Sample sites (M.O.H. Kaduna State,2012)

Sample size estimation

In studies designed to measure a characteristic in terms of a proportion, the equation for sample size by (Daniel, 1999; 2018) was used:

$$N=\frac{4(Zcrit)^2P(1-P)}{D^2}$$

Where N= sample size, Zcrit= the normal variant with a value of 1.96, D= the margin of error which is 5% or 0.05, P= a pre-study estimate of the proportion for malaria which is 0.74, When these values were entered in the formula, an estimated sample size of 1,918 was used for the study.

Sample collection

Blood samples were collected from patients in 9 major hospitals which are Gwanna Awan General Hospital, Barau Dikko specialist Hospital, Sabon-Tashi General Hospital, Hajia Sawaba General Hospital, Sabon-Gari General Hospital, Markarfi General Hospital, Kachia General Hospital, Kagarko General Hospital and Jaba General Hospital selected by simple random sampling technique from the 3 senatorial districts of the state. Two milliliters (2.0mLs) of venous blood were taken from each of the 1918 patients for one full year (March 2011-February 2012). The blood was later transferred into labeled specimen tubes, preserved in an iced pack kit and transferred to the laboratory for analysis.

Preparation of thick and thin blood smears

Thick and thin films were made for each blood sample collected and stained with Leishman stain for 7 minutes, washed off and allowed to air- dry (Cheesbrough,2008). When completely dried, each slide was examined at 100X in oil immersion. The *Plasmodium* parasite observed in each blood smear was classified according to the categorization provided by Cheesbrough (2008). Accordingly: 1 parasite/field: Low density (scanty), 2-5 parasites/field: Medium density (+), 6-10 parasite /field: High density (++), >10 parasites/field: Very high density (+++).

Data analyses

The data generated from the present study was analyzed using PRISM software chi-square test was used for tests of significance for proportions of categorical variables. All tests of significance were done based on a p-level of 0.05.

RESULTS AND DISCUSSION

In the study of the three Senatorial districts, ITNs usage had values of 56.3% in Kaduna Central and 56.5% in Kaduna North Senatorial districts. In Southern Senatorial districts, ITNs usage scored the highest value of 74.5% (Table 1). The differences in *P. falciparum* prevalence with regards to the use of ITNs investigated were found to be significant ($P<0.05$) than those that did not use ITNs in the three Senatorial

districts of Kaduna State. ITNs recorded significant usage in the three Senatorial districts of Kaduna State.

Response from questionnaire analyzed indicates that the commonly used chemoprophylatic drugs are fansider and daraprim. Out of the 1,918 patients investigated 24% (456) used chemoprophylatics while the remaining 76% do not use chemoprophylatic drugs to prevent malaria. Among the 456 (24%) individuals who use chemoprophylactic drugs, only 15% (68) of the patients "always" used chemoprophylatic while the remaining 85% (388) used the chemoprophylatic drugs "occasionally" (Table 2). Among the 1,918 patients examined that used ITNs only 36% (426) of the patients "always" used the nets while the remaining 768(64%) used the nets "occasionally" (Table 2).

The most commonly used anti-malaria drugs for self-medication among patients from the Kaduna North, South and Central senatorial districts shows that chloroquine and fansider were the most used drugs (Table 3). Analysis of response data shows that 56.6% of the respondents in Kaduna North uses chloroquine/fansidar, 71.5% in Kaduna South and 67.0% in Kaduna Central also uses the same drugs for prevention of malaria. Relatively fewer respondents from the 3 senatorial districts uses ACTs for prevention of malaria. The use of ACT by respondents in the 3 senatorial districts were: Kaduna North: 37.3%; Kaduna South: 18.9% and Kaduna Central: 24.3%. However, less than 10% of the respondents in each of the 3 senatorial districts use other means of prevention other than the 3 drugs investigated.

Table 1: Relationship between the use of ITNs Usage and *Plasmodium falciparum*

Nos.	Senatorial Zone	Preventive Measure	Used the preventive measure		Did not use the preventive measure	
			No. Examined	No. Positive (+ve)	No. Examined	No. Positive (+ve)
1.	North	ITNs Usage	491(56.5%)	312(63.5%)	378(43.5%)	290(76.7%)
2.	South	ITNs Usage	366(74.5%)	208(56.8%)	125(25.5%)	93(74.4%)
3.	Central	ITNs Usage	310(56.3%)	219(70.7%)	241(48.7%)	197(81.7%)

Table 2: Usage and Frequency of Chemoprophylaxis and ITNS

Preventive Measures	No. Examined	Frequency of use		
		Always (%)	Occasionally (%)	Never (%)
Chemoprophylaxis	1918	456(24%)	388(85%)	1462(76%)
ITNs	1918	426(36%)	768(64%)	724(38%)

Table 3: Anti-malaria drugs commonly used by respondents for self-medication

Nos.	Senatorial Zone	Type of anti-malaria used for self-medication	Frequency	Percentage (%)
1.	North	1.Chloroquine/Fansider	496	56.6
		2.ACTs Drug	327	37.3
		3.Others e.g. herbs	53	6.1
		TOTAL	**876**	
2.	South	1.Chloroquine/Fansider	351	71.5
		2.ACTs Drug	93	18.9
		3.Others e.g. herbs	47	9.6
		TOTAL	**491**	
3.	Central	1.Chloroquine/Fansider	369	67.0
		2.ACTs Drug	134	24.3
		3.Others e.g. herbs	48	8.7
		TOTAL	**551**	
4.	Combined Senatorial zones	1.Chloroquine/Fansider	1216	63.3
		2.ACTs Drug	554	28.9
		3.Others e.g. herbs	148	7.7
		TOTAL	**1918**	

ACTs = Artemisinin Combination Therapies

Discussion

The use of ITNs as a very important malaria preventive measure was most prevalent in Kaduna South Senatorial Zone due to either corresponding availability or due to higher awareness of the populace in this area than in the North and Central Senatorial Zones. Also, this concurs with Thiévent *et al.*, 2018, that reported vector control using ITNs represents the cornerstone of malaria prevention, as ITNs provide a physical barrier between the user and mosquito vectors, and repel or kill mosquito vectors upon contact with the insecticide. Also, the authors reported that mosquito nets treated with pyrethroid insecticides provided a remarkable degree of protection against malaria in Africa. Furthermore, verbal communication with the questionnaire respondents indicates that some owners of the ITNs don't even use them regularly to protect them against mosquito bites.

In this study, it was observed that the frequency usage of Chemoprophylatic drugs was very low to fight against malaria. The previous attempts to control malaria in Nigeria and many endemic areas in the world involved the regular cheap supply, affordability and regular usage (weekly) of Daraprim, amodiaquine and fansider as an effective chemoprophylatic drugs (CDC, 2015).

The apparent high infection rates of *Plasmodium falciparum* in the tested subjects in the three Senatorial zones of Kaduna State may also indicates that the usage of chloroquine/fansider drugs which majority of the patients in the study still use or self-medication as first-line drug for the treatment of malaria

than the extremely effective artemisinin-based combination therapies had failed in combating the malaria parasites. Evidences have shown that Chloroquine and Sulfadoxine - Pyrimethamine has lost its efficacy due to the emergence of chloroquine-resistant strains of *P. falciparum* (CDC, 2015). Because of this, the Nigerian Federal Government on the 24th, January 2005 announced the ban of Chloroquine and Sulfadoxine - Pyrimethamine as first line drugs in the treatment of malaria due to increasing evidence of drug resistance, which has led to treatment failures (Ukwuoma, 2005). The Government adopted a malaria drug policy of World Health Organization-recommended Artemisinin-based Combination Therapy (ACT). These ACT are highly efficacious, though relatively expensive than Chloroquine (Ukwuoma, 2005).

CONCLUSION

The study shows that there were great effects of some of the anthropogenic factors like ITNs usage, Chemoprophylatic drugs and type of anti-malaria used for treatment on the prevalence of Plasmodium falciparum. In this study, it was observed that the ITNs recorded significant usage in the three Senatorial districts of Kaduna State. The frequency usage of Chemoprophylatic drugs was very low. The use of chloroquine/fansider drugs was the most common anti-malaria drugs most of the patients in the study still use as first-line drug for the treatment of malaria than the extremely effective artemisinin-based combination therapy in combating the malaria parasites.

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