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Assessment of Demographic Factors Associated with *Falciparum* Malaria among Hospital Patients in Zaria, Kaduna State Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author GYB designed the study, performed the laboratory work, statistical analysis and wrote the first draft of the manuscript. Authors BB, JA and LML managed the analysis and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: Malaria is a mosquito-borne disease caused by parasites that belong to the genus *Plasmodium*. It is responsible for the death of millions of people worldwide. This study was aimed at assessing some demographic factors associated with *falciparum* malaria among hospital patients in Zaria, Kaduna State Nigeria.

Methods: A cross sectional study was carried out involving three hundred consenting participants. A structured questionnaire was used to obtain demographic data from the participants; blood samples were collected from them and screened for *Plasmodium falciparum* by Rapid Diagnostic Test. Giemsa stained thick and thin blood films were prepared and examined under the microscope to confirm the presence of the parasite. The data obtained were analyzed and *P* values ≤0.05 were considered statistically significant.

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Results: The prevalence of malaria in males [22.6%] was slightly higher than females [21.7%]. The age group ≤10 had the highest prevalence followed by age groups 31-40 [31%], 11-20 [23.3%], 21-30 [12.6%] and ≥41 [9.1%] [p=0.002]. Participants who were married had higher prevalence [31.1%] than those who were divorced [0.0%] and single [13.2%] [p=0.000].
Conclusion: The research shows that *Plasmodium falciparum* is still prevalent in the study area. Age and marital status are important determinants of malaria prevalence as highlighted in this study. Children less than 10 years are at high risk for malaria, preventive measures should therefore target this group.

Keywords: Malaria; Plasmodium; prevalence; blood; microscopy.

1. INTRODUCTION

Malaria is a mosquito-borne disease caused by parasites that belong to the genus *Plasmodium*. People with malaria often experience fever, chills, and flu-like illness. Left untreated, they may develop severe complications and die [1]. Of the five *Plasmodium* species that cause human infection, *Plasmodium falciparum* is the most virulent and is responsible for the large majority of infections in sub-Saharan Africa [2,3]. Infection with *P. falciparum* results in one of three possible outcomes: asymptomatic parasitemia, defined as the presence of asexual parasites in the blood without symptoms; uncomplicated malaria, which entails febrile illness not associated with signs of severe disease; and severe malaria, characterized by various syndromes of organ dysfunction, which if not treated promptly may result in death [4,3]. In children, severe malaria most commonly manifests as either severe anemia or cerebral malaria [5]. Malaria occurs mostly in poor tropical and subtropical areas of the world. In many of the countries affected by malaria, it is a leading cause of illness and death. In areas with high transmission, the most vulnerable groups are young children, who have not developed immunity to malaria yet, and pregnant women, whose immunity has been decreased by pregnancy. The costs of malaria – to individuals, families, communities, nations – are enormous [1,6].

In recent years, the burden of malaria has fallen in many parts of sub-Saharan Africa, often coinciding with the introduction of effective treatments and the scale-up of long-lasting insecticide-treated net ownership and use [7]. Patterns of clinical disease vary by age and transmission intensity: in highly endemic areas, the disease burden is greatest in infants and young children, while in areas of lower transmission many cases also occur in older children and adults [8]. With declining transmission, there have been shifts in cases to older ages.

An estimated 219 million cases of malaria occurred worldwide in 2017 [9]. Data from the period 2015-2017 highlight that no significant progress in reducing global malaria cases was made in this timeframe. Ninety two percent of the malaria cases in 2017 were in the WHO African region. Nigeria, Madagascar and the Democratic Republic of the Congo had the highest estimated increases of malaria cases in 2017 [9].

Malaria imposes substantial costs to both individuals and governments. It is a social and economic burden that creates a significant barrier to economic development. For example, over a quarter of family income can be absorbed in the cost of malaria treatment, apart from the cost of prevention or the opportunity cost of labor lost to illness. Malaria also prevents investment and tourism into new regions, further hampering economic development [10]. Costs to individuals and their families include purchase of drugs for treating malaria at home; expenses for travel to, and treatment at, dispensaries and clinics; lost days of work; absence from school; expenses for preventive measures; expenses for burial in case of deaths [1]. Costs to governments include maintenance, supply and staffing of health facilities; purchase of drugs and supplies; public health interventions against malaria, such as insecticide spraying or distribution of insecticide-treated bed nets; lost days of work with resulting loss of income; and lost opportunities for joint economic ventures and tourism. Direct costs [for example, illness, treatment, premature death] have been estimated to be at least US$ 12 billion per year [1].

Demographic, socioeconomic, and behavioral factors and distance from residence to health facilities are known determinants of delayed seeking of appropriate care among children with malaria [11]. However, their contribution to severe malaria is unclear, with available studies yielding conflicting results [12,13]. Variations in findings may be attributable to differences in study design and analysis, varied impacts of complex host–parasite interactions that affect disease presentation and small sample sizes [14]. The primary objective of this study was to assess demographic factors associated with *falciparum* malaria among hospital patients in Zaria, Kaduna State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted at Hajiya Gambo Sawaba General Hospital, Zaria, Kaduna State, Nigeria. Zaria is a major city in Kaduna state, as well as being a Local Government Area. It is located at 11.11 latitude and 7.72 longitude and it is situated at elevation 644 meters above sea level. Zaria has a population of 975,153 making it the second largest city in Kaduna [15]. It has a tropical savanna climate with warm weather year-round, a wet season lasting from April to September, and a drier season from October to March. Hajiya Gambo Sawaba General Hospital is located in Zaria City where the Emir's palace is also located. There is great variety in the architecture of Zaria, with buildings made of clay in the Hausa style juxtaposed with modern, multistoried university and government buildings [16]. Zaria's economy is primarily based on agriculture. Staples are guinea corn and millet. Cash crops include cotton, groundnuts and tobacco [17]. Not only is Zaria a market town for the surrounding area, it is the home of artisans from traditional crafts like leather work, dyeing and cap and furniture making [18].

2.2 Study Design and Sample Size

The study was a cross sectional study that lasted for 6 months (from January to June 2019). All febrile patients presenting symptoms of malaria, who were directed to the laboratory for malaria parasite (MP) test, were included, while patients directed to the laboratory for laboratory tests other than MP test were excluded [3]. The sample size was determined using a previous prevalence of 22.4% [19] in Kaduna State, and the formula described by Naing, et al. [20] as follows:

$$n=\frac{Z^2p[1-p]}{d^2}$$

n= number of samples
p=prevalence rate of previous study =22.4%=0.224
z=standard normal distribution at 95% confidence limit=1.96
d=absolute desired precision of 5%=0.05
z=1.96

$$n=\frac{1.96^2 * 0.224[1-0.224]}{0.05^2}$$

$$n=\frac{3.8416 * 0.224 * 0.776}{0.0025}$$

n= 267 samples (A total of 300 blood samples were collected for this study).

2.3 Administration of Structured Questionnaire and Sample Collection

A structured questionnaire was administered to individuals who met the inclusion criteria after obtaining their consent to participate in the study. This was used to obtain bio-data and other information relevant to the research. Sampling was done randomly as patients visited the hospitals' laboratory. Venipuncture technique was employed for blood sample collection. Soft tubing tourniquet was fastened to the upper arm of the patient to enable the index finger feel a suitable vein. The puncture site was then cleansed with methylated spirit (methanol) and venipuncture made with the aid of a 21 G needle attached to a syringe. When sufficient blood (2 ml) was collected, the tourniquet was released and the needle removed immediately while the blood was transferred into an EDTA bottle.

2.4 Screening of Blood Samples for *Plasmodium falciparum*

Blood samples were screened by CareStart™ Malaria HRP2 Rapid Diagnostic Test (RDT) Kit (Access Bio, Inc, Somerset, NJ), specific for the detection of *Plasmodium falciparum.* The RDT test was carried out according to manufacturer's instructions and positive samples were confirmed by microscopy as described by Cheesbrough [21].

2.5 Statistical Analysis

The data gathered were analyzed using Statistical Package for Social Sciences (SPSS) version 21 (SPSS Inc, Chicago, IL). Chi square and odds ratio were used to determine association. *P* value ≤0.05 was considered statistically significant.

3. RESULTS

Three hundred participants were enrolled in this study; 115 males and 185 females. Blood samples were collected from all participants and screened for *Plasmodium falciparum.* Gender-related malaria prevalence is presented in Table 1. Males had higher prevalence (22.6%) than females (21.1%). The difference was not statistically significant p>0.05, OR (95%CI) =1.094 (0.624-1.918). Table 2 shows the age-related prevalence of malaria. The age group ≤10 had the highest prevalence followed by age groups 31-40 (31%), 11-20 (23.3%), 21-30 (12.6%) and ≥41 (9.1%). The p value (p=0.002) was statistically significant. Table 3 shows the prevalence of malaria according to marital status of participants. Participants who were married had higher prevalence (31.1%) than those who were divorced (0.0%) and single (13.2%). The difference observed was statistically significant (p=0.000). Based on occupation of participants (Table 4), Traders had the highest prevalence (24.5%) followed by farmers (20.0%), unemployed (22.8%), civil servants (14.3%), Artisans (18.2%) and other jobs (18.2%) (p=0.836). Malaria prevalence based on the educational level of participants is shown in Table 5. The highest malaria prevalence was found among participants who were not yet in school (30.6%) followed by those who only passed through Adult Literacy education (28.6%). Those with only primary and secondary education had 27.0% and 12.9% respectively. We did not record any positive case among those who had informal education.

Table 1. Gender-related malaria prevalence

Gender	Number examined	Number positive	% Prevalence	χ^2	*P* value	OR	95% CI
Male	115	26	22.6	0.098	0.755	1.094	0.624-1.918
Female	185	39	21.1				
Total	300	65	21.7				

Key: χ^2=*Chi square, %=percentage, OR= Odds ratio, CI=Confidence interval*

Table 2. Age-related prevalence of malaria

Age	Number examined	Number positive	% Prevalence	χ^2	*P* value
≤10	75	25	33.3	16.768	0.002
11-20	73	17	23.3		
21-30	87	11	12.6		
31-40	32	10	31.3		
≥41	33	03	9.1		
Total	300	65	21.7		

Key: χ^2=*Chi square, %=percentage*

Table 3. Malaria prevalence according to marital status of participants

Marital status	Number examined	Number positive	% Prevalence	χ^2	*P* value
Married	148	46	31.1	16.032	0.000
Divorced	8	0	0.0		
Single	144	19	13.2		
Total	300	65	21.7		

Key: χ^2=*Chi square, %=percentage*

Table 4. Malaria prevalence based of occupation of participants

Occupation	Number examined	Number positive	% Prevalence	χ^2	*P* value
Farmers	5	1	20.0	2.092	0.836
Traders	49	12	24.5		
Artisans	11	2	18.2		
Civil servants	35	5	14.3		
Unemployed	189	43	22.8		
Other Jobs	11	2	18.2		

Key: χ^2=*Chi square, %=percentage*

Table 5. Malaria prevalence based on the educational level of respondents

Educational level	Number examine	Number positive	% Prevalence	χ^2	*P* value
Primary	74	20	27.0	10.996	0.051
Secondary	79	20	25.3		
Tertiary	93	12	12.9		
Adult Literacy	7	2	28.6		
Not in School	36	11	30.6		
Informal education	11	0	0.0		

Key: χ^2=Chi square, %=percentage

4. DISCUSSION

In some societies, men have a greater occupational risk of contracting malaria than women if they work in mines, fields or forests at peak biting times. Leisure activities and sleeping arrangements may also be a contributing factor, as men are more likely to sleep outdoors or be found outdoors during the active biting hours of *Anopheles* mosquito [22,23]. The slight difference in malaria prevalence between males and females in the current study was not statistically significant; however, males had higher prevalence than females. A similar finding was reported by Nmadu et al. [24].

This study found a statistically significant association between the age of participants and malaria. Malaria is endemic in Nigeria and transmission is perennial. In highly endemic settings, children under five years and pregnant women are most affected, constituting the most target population of new malaria control strategies as recommended by World Health Organization [25]. The highest prevalence of malaria in this study was among children less than ten years. Children under five years of age are one of the most vulnerable groups affected by malaria. In Africa, about 285 000 children died before their fifth birthdays in 2016. Partial immunity to the disease is acquired during childhood in high transmission areas. The majority of malarial diseases in such settings, particularly severe disease with rapid progression to death, occur in young children that have not developed acquired immunity to the disease [9]. A study in Gabon reported an increased risk of malaria among children older than five years who are becoming the most at-risk population [26]. Aliyu et al. [19] reported higher malaria prevalence in participants less than 18 years in Kaduna State compared to those above 18 years of age. In the current study, children less than ten years had the highest prevalence of malaria while participants who were 40 years and above had the least malaria prevalence. The high prevalence in children less than 10 years may be due to insufficient partial immunity to malaria [1] which is acquired in high transmission areas during childhood [6]. Conversely, the reduced prevalence of malaria among participants who were above 40 years of age may be due to increased acquired immunity to malaria which made persons of that age range to be more resistant to the disease [27].

Marital status was significantly associated with malaria in the current study. Married participants had higher malaria prevalence than unmarried and divorced participants. Zaria is in the Northern part of Nigeria with mostly polygamous families. Polygamous families have been reported to be large, with many children [28]. Sometimes families with many children don’t get enough ITNs for all members of the family. Parents are therefore more likely to give their ITNs to their children, thereby exposing themselves to mosquito bites.

5. CONCLUSION

This research shows that *Plasmodium falciparum* is still prevalent in the study area. Age and marital status are important determinants of malaria prevalence as highlighted in this study. Children less than 10 years are at high risk for malaria, preventive measures should therefore target this group. We did not find a statistically significant association between malaria and gender, occupation and educational level of participants in this study.

CONSENT AND ETHICAL APPROVAL

Full ethical approval was obtained from the Health Research Ethical Committee (HREC) of Kaduna State Ministry of Health and Human Services and Participants’ written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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