



MALARIA INFECTION: SPECIATION, PARASITE DENSITY, ABO BLOOD GROUP, AND HAEMOGLOBIN CONCENTRATION AMONGST THE INHABITANTS OF BILLIRI LOCAL GOVERNMENT AREA, GOMBE STATE

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ABSTRACT

The study determines malaria infection with relation to sociodemographic characteristics, parasite density, plasmodium species, ABO blood group, anaemia, and haemoglobin concentration of the participants in Billiri LGA, Gombe State. Informed consent was obtained, and a template was designed containing sociodemographic characteristics of the participants. 381 blood samples were collected and examined using thin and thick film. Out of which 148(38.8%) were infected. Female had the highest infection 82(55.4%) compared to their male counterparts 66(44.6%), with regards to age, those within the age group 11-15years had the maximum infection 41(27.7%) and the least were those within 0 – 5years 3(2.0%). The employment status revealed; others which include students, housewife, and applicants had 49(33.1%) malaria which is the maximum and the minimum was the public servants 25(16.9%), marital status also showed that singles had the highest prevalence 74(50.0%) and the lowest was the widows 8(5.4%), there was a highly significant difference in the sociodemographic characteristics of the participants, $p > 0.05$. With regards to parasitological indices; ABO blood group depicts, participants with blood group O had the maximum infection 60(40.5%) and the least are those with AB 22(14.9), the predominant Plasmodium species is *P. falciparum* 148(100%), those with moderate parasite density had the highest infection rate 75(50.7%), and 24(16.2%) from those with high, while haemoglobin concentration shows those that are not anaemic had 38(25.7%) infection, and those with critical were 19(12.8%), $p < 0.05$ in all the parasitological indices which is insignificant statistically. Based on this findings, malaria infection is moderate in the study area.

Keywords: Malaria, ABO Blood Group, Parasitological Indices.

INTRODUCTION

Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected female *Anopheles* mosquitoes. It is preventable and curable. In 2019, there were an estimated 229 million cases of malaria worldwide. The estimated number of malaria deaths stood at 409 000 in 2019. (WHO, 2020). The WHO African Region carries a disproportionately high share of the global malaria burden. In 2019, the region was home to 94% of malaria cases and deaths. Total funding for malaria control and elimination reached an estimated US\$ 3 billion in 2019. Contributions from governments of endemic countries amounted to US\$ 900 million, representing 31% of total funding (WHO, 2019).

Malaria is caused by *Plasmodium* parasites. The parasites are spread to people through the bites of infected female *Anopheles* mosquitoes, called "malaria vectors." There are five parasite species that cause malaria in humans, and two of these species are *P. falciparum* and *P. vivax* poses the greatest threat. In 2018, *P. falciparum* accounted for 99.7% of estimated malaria cases in the WHO African Region 50% of cases in the WHO South-East Asia Region, 71% of cases in the Eastern Mediterranean and 65% in the Western Pacific. *P. vivax* is the predominant parasite in the WHO Region of the

Americas, representing 75% of malaria cases. In 2019, nearly half of the world's population was at risk of malaria. Most malaria cases and deaths occur in sub-Saharan Africa. However, the WHO regions of South-East Asia, Eastern Mediterranean, Western Pacific, and the Americas are also at risk (WHO, 2021). Anaemia is a decrease in the total amount of red blood cells (RBCs) or haemoglobin in the blood, (Philadelphia and Williams, 2006), or a lowered ability of the blood to carry oxygen (Rodak, 2007). When anaemia comes on slowly, the symptoms are often vague and may include feeling tired, weakness, shortness of breath, and a poor ability to exercise death due to anaemia is about 7.82 million in 2015 (Janz, 2013).

Malaria is caused by a plasmodium parasite that spends its life in both humans and certain species of mosquitoes, four species of plasmodium that cause malaria in humans; are *Plasmodium falciparum*, *P. vivax*, *P. malariae*, and *P. ovale*. Of these, *P. falciparum* is the most important in most parts of the tropics and is responsible for the most severe illness and deaths. Malaria may have reached its maximum world dissemination between the 1855, when it was found in southern Canada and in 1922-1923 when it touched the arctic cycle in Russia. Presently, the disease ranks first in terms of morbidity and

mortality worldwide. The genus plasmodium has been found in man and mammals (Ilozumba and Uzozie, 2009). Despite the high morbidity and mortality, certain individuals are resistant to malaria infection due to different immune response by the host and to a varying extent, and certain characteristics possessing protective value against infection such as ABO blood group type, sickle cell trait (HBAS) and sickle cell disease (Otajevwo and Igoniwari, 2014). The association of genetic markers man has been the subject of numerous investigations since the protection afforded by sickle-cell hemoglobin against infection by the *falciparum* malaria parasite. A broad range of available evidence suggested that the origin, distribution and relative proportion of ABO blood groups in humans may have been directly selective genetic pressure from plasmodium falciparum infection. Clinical reports of ABO blood groups and *Plasmodium falciparum* infection reveals a correlation between disease severity and ABO groups (WHO, 2008).

MATERIALS AND METHODS

Study Area

The study was conducted in the Billiri local government area, Southern part of Gombe State, North-Eastern Nigeria. Billiri LGA is 56km away from the state capital with a population of 202144 people, and a total landmass of 655km² (3.9%) of the state land total mass. The geographical coordinates are latitude 9°53N 11°26E and longitude 9.883°N 11.433°E of Greenwich Meridian (Adebayo *et al.*, 1999). The rainy season commences from April to October, and the dry season is from November to March (NBS, 2007). The vegetation can be described as Sudan savanna with open grassland. The mean annual temperature is about 34°C. The inhabitants are civil servants, famers, traders, and livestock keepers.

Ethical Consideration

Ethical clearance was obtained from the Gombe State Ministry of Health ethical committee before this work, only those who consented to participate in the research were involved.

Study Design and Population

A community-based survey was carried out, where 381 people participated voluntarily, the sample size was determined using a sample size calculator, at a confidence level of 95%, and a confidence interval of 5. A template was designed containing sociodemographic information of the participants.

Blood Sample Collection

A tourniquet was used at the upper hand to enable the visibility of the vein clearly, methanol was used to clean the puncture site. A total of 381 blood samples were collected two miles each from the participants and transferred into an EDTA container then taken to the laboratory (Cheesbrough, 2010).

Parasitological Examination

Thick and thin blood smear was prepared according to the technique outlined by Cheesbrough, (2006) for malaria microscopy and stained with 10% Giemsa stain pH 7.2 for 10 minutes (WHO, 2000), and examined under the microscope

using x100 objective. A parasite identification key was used (Cheesbrough, 2006).

ABO Blood Group Determination

Blood group determination ABO was typed by agglutination using antisera A, B, and D, using white clean tile (Zoysa, 1985; Barranga *et al.*, 2000).

Haematology

Haematocrit was used to determine the Pack Cell Volume (PVC) using plain capillary with mixed EDTA anticoagulated blood as described by Cheesbrough (2010). Haemoglobin level was determined according to WHO (2011).

- < 4g/dl (critical)
- 4-5 (severe anemia)
- 6-7 (marked anemic)
- 8-7 (mild anemic)
- 12-14 (not anemic)

Parasite Density Determination

- <1000 (low)
- 1001-2000 (moderate)
- 2001> (severe)

DATA ANALYSIS

Data collected were analyzed using SPSS version 26.0. Data were presented on frequency distribution tables in percentage, and the association between variables was determined using Person Chi-square $p < 0.05$ was considered significant.

RESULTS

Table 1 depicts the sociodemographic characteristics of the participants, out of the 381 samples collected, 148(38.8%) were infected with malaria. Females had the highest malaria infection 82(55.4%) compared to their male counterpart 66(44.6%) $p > 0.05$. With regards to the age of the participants, those with the age group 11 – 15 years had 41(27.7%) the maximum infection rate, while the minimum is those within the age group 0 – 5 years 3(2.0%), $p > 0.05$. employment status of the study subjects showed others had the highest 49(33.1%) and those working with the public sector had the least 25(16.9%), $p > 0.05$. The marital status of the participants revealed the singles had the maximum infection of 74(50.0%) while the minimum is the widows with 8(5.4%) infection, $p > 0.05$. Table 2 indicates the distribution of malaria infection about ABO blood group, those with blood group O had the highest infection 60(40.5%), followed by those with A 34(23.0%), then those with B had 32(21.6%) infection, the lowest infection was observed from those with blood group AB 22(14.9%), $p > 0.05$. Table 3 displays the distribution of Plasmodium species, the predominant species is *P. falciparum* 148(100%), $P < 0.05$. Table 4 presents the distribution of parasite density of the participants, those with moderate are the highest with 75(50.7%), followed by those with low 49(33.1%), and the least are those with severe 24(16.2%) $p < 0.05$. Table 5 shows haemoglobin concentration (HB) of the participants, those that are not anemic are the highest

38(25.7%), and the lowest are those with critical 19(12.8%) $p < 0.05$.

Table 1: Malaria Distribution with Relation to Sociodemographic Factors

Variable	Examined (%)	Infected (%)	χ^2
Male	172(45.1)	66(44.6)	0.864
Female	209(54.9)	82(55.4)	
Total	381	148(38.8)	
Age (Years)			0.339
0 – 5	15(3.9)	3(2.0)	
6 -10	62(16.3)	22(14.9)	
11 – 15	85(22.3)	41(27.7)	
16 – 20	57(15.0)	22(14.9)	
21 -25	71(18.6)	29(19.6)	
26 – 30	33(8.7)	12(8.1)	
31>	58(15.2)	19(12.8)	
Total	381	148(38.8)	
Employment Status			0.125
Public	84(22.0)	25(16.9)	
Self Employed	103(27.0)	45(30.4)	
Private	62(16.3)	29(19.6)	
Others	132(34.6)	49(33.1)	
Total	381	148(38.8)	
Marital Status			0.504
Single	188(49.3)	74(50.0)	
Married	137(36.0)	56(37.8)	
Devoiced	16(4.2)	3(2.0)	
Separate	21(5.5)	7(4.7)	
Widow	19(5.0)	8(5.4)	
Total	381	148(38.8)	

Table 2: Malaria Distribution According to ABO Blood Group of the Participants

Blood Group	Examined (%)	Non Infected (%)	Infected (%)	χ^2
A	96(25.2)	62(26.6)	34(23.0)	0.253
B	92(24.1)	60(25.8)	32(21.6)	
AB	62(16.3)	40(17.2)	22(14.9)	
O	131(34.4)	71(30.5)	60(40.5)	
Total	381	233(61.2)	148(38.8)	

Table 3: Plasmodium Species in the Study Area

Plasmodium species	Frequency (%)	χ^2
<i>P. falciparum</i>	148(100)	0.000
<i>P. malariae</i>	0.(0.0)	
<i>P. ovale</i>	0.(0.0)	
<i>P. vivax</i>	0.(0.0)	
Total	148	

Table 4: Parasite Density Distribution

Category	Frequency (%)	χ^2
<1000 (Low)	49(33.1)	0.000
1001-2000 (Moderate)	75(50.7)	
2001> (Severe)	24(16.2)	
Total	148	

Table 5: Hemoglobin Concentration of the Participants

Category	Frequency (%)	χ^2
<4 (Critical)	19(12.8)	0.002
4 – 5 (Severe Anemia)	23(15.5)	
6 – 7 (Marked Anemic)	35(23.6)	
8 – 11 (Mild Anemic)	33(22.3)	
12 – 14 (Not Anemic)	38(25.7)	
Total	148	

DISCUSSION

The total prevalence of malaria in the study area was 38.8% which is moderate, the maximum prevalence was obtained from females, this is in agreement with the report of (Ukwubile *et al.*, 2018; Houmsou *et al.*, 2011; 2017; Nassai *et al.*, 2020), that reported the highest infection amongst female than male, this also reaffirm WHO report, (2007) that adolescent girls are particularly more vulnerable to malaria, but contrary to the work of (Sam *et al.*, 2014; Matouke and Houmsou, 2017; Kunhiya *et al.*, 2016) where they reported the highest malaria infection amongst male than the female variation between gender shows high significant difference $p > 0.05$. Prevalence of malaria with age shows that, the maximum infection occurred amongst participants within the age group 11 – 15 years old, this could be due to the activeness of this peer group and no proper attention on these children by their parents as is given to children under five, and are also vulnerable to malaria, this is in agreement with the report of (Philemon *et al.*, 2015) but disagree with the results of (Thomas *et al.*, 2018) who reported the highest prevalence from 18 years and above individuals, those within the age group 0 – 5 years had the least infection, this is a result of parents/guidance refusal to present their children within this age bracket to participate in the study, there is a highly significant difference, $p > 0.05$. Employment status of the study subject showed, those who are self-employed had the highest prevalence of malaria, the high prevalence of malaria in this group could as a result of the various activities done by those people that is not white-collar job which may expose them to contact with mosquitoes, the result disagreed with that of (Benjamin *et al.*, 2017; Mac *et al.*, 2019) that reported the highest infection amongst civil servant from Zaria and Abuja respectively, $p > 0.05$. With regards to the marital status of the participants, singles had the highest malaria infection this is because they formed the largest portion of the study subjects and they are the once easily access in the community since is a community-based study, the result is in contrary to the report of (Alexander *et al.*, 2013) who discovered the maximum infection amongst the married people, $p > 0.05$ which is highly significant. Malaria was present in all the blood groups, but prevalence varied, participants with blood group O had the highest malaria infection, this is in line with the findings of (Philemon *et al.*, 2015; Maina *et al.*, 2017; Yohanna *et al.*, 2019; Xuan, 2017; Otajewwo and Igoniwari, 2014) in a research conducted in same local government area, Kaduna Metropolis, East China, and Western Delta Nigeria respectively, where the most

prevalent are those with blood group O, this also confirm the that mosquitoes preferentially fed on people with blood type O (Seladi, 2020), but disagree with the result of (Matouke and Houmsou, 2017) where the highest malaria infection was recorded from those with blood group AB, there was no significant difference statistically, $p < 0.05$.

The predominant Plasmodium species observed is *P. falciparum* which is hundred percent, this could be due to the location of the study area which is in the tropics where the dominant Plasmodium species found is *P. falciparum*, this concur with the findings of (Bawa *et al.*, 2014; Philemon *et al.*, 2015) that reported *P. falciparum* as the dominant species in their findings, $p < 0.05$ which is insignificant. Table 4 depict the parasite density where those with moderate parasite density were the highest, followed by those with low, then those with severe had the least infection, this corresponds with the result of (Sarki *et al.*, 2018) who reported the same results; moderate, mild, and severe in Gombe local government area respectively, and this also could be as a result of moderate malaria prevalence obtained in the study area, but differs with the findings of (Ola *et al.*, 2012) who reported that those with severe parasite density had the maximum infection in an endemic area, there was no significant difference statistically, $p < 0.05$. With regards to the haemoglobin concentration of the participants, those who are not anaemic had the highest malaria infection, this disagreed with the result of (Sarki *et al.*, 2018) who discovered the maximum infection amongst those with mild anaemia. The findings also revealed that those with critical anaemia had the lowest infection, there was no significant difference, $p < 0.05$.

CONCLUSION

The study depicts a moderate prevalence of malaria in the study area, female had more malaria than male, those with blood group O had the maximum malaria infection compared to other blood groups. *P. falciparum* is the predominant malaria species encountered, also those with moderate parasite density had the highest malaria infection.

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