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Evaluation of Malaria and Clinical Forms of *Plasmodium* Species in School Aged Children Attending Lokoja Specialist Hospital in Relation to Their Socioeconomic Status and Blood Group (Abo) Kogi State, Nigeria

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ABSTRACT

Malaria is a serious malady of public well-being issue, more especially among children of under-five years, pregnant women, and people with compromised immune system (such HIV and Tuberculosis patients). It is an acute febrile illness caused by protozoan parasites of the genus *Plasmodium* that is disseminated by infected female Anopheles mosquito. The harmfulness of *Plasmodium is* associated with the amplitude of the infected red blood cells to adhere to some uninfected RBCs, a method called rosetting, which has been linked to occurrence of severe illness drug resistance and emergence of malaria after full treatment. The disease transmission is also associated with socio-economic status of an individual, environmental factors, climatic factors and seasons. A cross fragmentary hospital based study was accompanied on consenting the participants or their parents. Three hundred and thirty blood samples were collected, from which thin and thick Giemsa smears were prepared, and was scrutinized under a light microscope using 100X objective. The different blood types (ABO) were determined by adhesiveness using commercial antisera. The species of malaria encountered were identified by the laboratory scientist. The socio-economic factors considered were age, gender, occupation and prevalence of malaria in relation to blood type. Out of the 330 children examined, 29 of them were found to be infected with malaria parasite. Twenty one were found to be infected with *Plasmodium falciparum*, while the remaining eight (8) infected individuals were found to be positive for *P. malariae*. In this study, female 15(9.38%) patients prove to be more infected than their male 14(8.24%) counterparts, even though statistically this finding revealed no significant difference (P>0.05) observed among the sexes. The results also depicts that children between 9-11 years had the highest incidence 15(14.29%) of malaria contagion, followed by those between age group 6-8 years old 5(11.11%), while children within age group 13-14 years old were list infected. In addition, the occupational information of the respondents shows that majority (45.76%) were civil servants, followed by traders (27.88%) and the least we're fisher men (10.61%). The result indicates that most of respondents were civil servants and traders. It is noticed that all participants were endangered to malaria infection. The fishermen proved to be more exposed to malaria risk factors. The study revealed that malaria infection is prevalent among the school aged children examined in the study area. It is a fact that malaria has negative impact on education, student growth and economy of the society. No any blood type, educational status, age group or occupational group that is immune to malaria infection once you are to bite of infected Anopheles mosquito you will definitely fall down with malaria. Prevention intervention and regular treatment with antimalarial drug is key to reduce the burden due to malaria. So the government and other stakeholders should equip the health facility of higher

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institutions with enough drugs, including antimalarial drug and also make sure each student have access to treated mosquito net. Also mass health education on possible ways of preventing malaria transmission should not be left out.

Keywords: *Plasmodium,* Malaria, Infection, Subjects, Participant, Determine

INTRODUCTION

Malaria is one of the serious mosquito-borne diseases of mankind and some animals caused by exploitative protozoans of a member of genus *Plasmodium* (Hume, J. C. *et al*. 2003). Malaria is caused by different species of *Plasmodium* that includes *Plasmodium vivax,, Plasmodium malariae*, *Plasmodium falciparum*, *Plasmodium knowlesi* and *Plasmodium ovale* (Njimah, J. A*., et al*. 2019, Garba, B. *et al* 2022). *P. falciparum* is the most prevalent species of plasmodium found in most part of Africa.. The main organism responsible for the transmission of this specific species of plasmodium covering all of the African countries is *Anopheles (An.) gambiae s*s which accounting up to 67.1% as observed in Niger with *An. funestus* as a minor vector as also observed in some many countries (WHO, 2021). Nigeria is not an exceptional to this discovery, some research conducted in Nigeria also revealed *A. gambiae* as the main vector for malaria transmission in almost all the states, followed Anopheles funestus as reported by Olabimi, I. O. et al., 2021.

Malaria is a serious life frightening illness more especially in tropical regions. It is of public health concern. It has been approximated to about 3.2 billion people out of 7 billion world population are living in malaria danger zones (WHO, 2016). Malaria is preventable and curable, increased effort of malaria education and distribution of insecticide treated nets are dramatically reducing the malaria prevalence in so many countries. However, Sub-saharan Africa carries commensurately high share of the global malaria burden (WHO, 2016). Malaria is endemic almost all over Nigeria, with seasonal variation in different geopolitical zones of the country. Malaria is more prevalent during the raining season than dry season (Olayinka, R. S., *et al*. 2021). About 97% of the Nigerian population is living in malaria danger zone as reported by (WHO, 2023). Only 3% of Nigerian populations live in free malaria zone (those live on the high plateau like Mambila). According to malaria world report, Nigeria ranked highest in the world with twenty seven percent (27%) of global malaria cases and also proved to have the highest death rate of 32% of global malaria deaths in 2020. It also accounts for 55.2% malaria cases in 2020. Malaria parasites are more prevalent among young children less than five years and pregnant women. Beyond their prevalence in children and women, it affects the general public (Roll Back Malaria, 2005).

History thought us, people with antecedent malaria parasites infection show gradual improve of partial immunity which has reduce the manifestation of clinical symptoms. This type of control by the immune system happens greatly quick as the infections are regularly as in steady malaria transmission. And which in the later stage of teenage age it is periodically. Some human inherent risk risk factors have been also revealed to have an effect on the vulnerability to malaria. These inherent factors comprise of “sickle cell trait (HbAS), Glucose -6- phosphate dehydrogenase (G6PD) deficiency, erythrocyte variation as well as the blood group ABO types”. These components act either as regulator to the parasitic burden or

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manifestation of the clinical symptoms of malaria infection (Kuete, T., *et al*. 2016).

Concerning the ABO blood group types, there are so many controversies among studies from different researchers from different countries around the world on relationship between different blood group types and their susceptibility to malaria infection. Many of the researches carried in different part of the world revealed Blood type O subjects were comparably immuned from acute other blood groups (Rowe, J. A., *et al*., 2007; Bedu-Addo, G., *et al*. 2014). Tekeste and Petros, 2010 report of their study conducted in Ethiopia shows blood type O were more vulnerable to malaria parasites than other patient's with other blood groups. In contrast to these reports that gave lower infection rate to blood group O than patients with other blood groups, some reports has demonstrated high susceptibility of the same blood group O (73.24%) as compared blood group A (33.33%) as reported by Lema, S. Y. *et al.* (2021). Another report has also revealed high frequency of malaria infection has also observed among group O individuals as compared to other blood groups (Obisike and Makwe, 2020).

Significant associations between blood group and malaria parasites infection have been reported from all over the world. These include case control studies in Brazil by Belguelman, *et al*. (2003), Gabon by Migot-Nabias, *et al*. (2000) and India by Pant, C. S., *et al.* (1992), whereas studies from Colombia, In few researches conducted in India, Nigeria did not encounter any statistical significant association between malaria parasite and the different blood groups. This speculation is generally believed by good population of Nigerians and on the other hand there are no scientific records to support this general believe. The fact that such data are scarce in Lokoja and Nigeria at large, this study will go a long way to determine the infection relationship between the different types of blood group and the different species of malaria parasites among different age group of patients who attend Kogi specialist hospital during the period of the study.

MATERIALS AND METHODS

Study Area

The study was carried out in Kogi specialist hospital, Lokoja, Kogi State. Lokoja Local Government Area lies between latitude and longitude of 7.8023^0N and 6.7333^0E respectively and elevation of 89 meters above sea level. Lokoja is situated in the savannah region of Nigeria and temperature remains hot all year round (January-December). The town has United Nation projected population of 839, 046 (Loseertales and Brain, 2006; UN, 2022). People of Lokoja are predominantly farmers and some fishermen. Their sanitary conditions are below standard because they lack good toilets system and they also lack proper knowledge of waste disposal. The study site lack pipe borne water supply, they depend sufficiently on River and well water for most of their occupational and domestic activities. Majority of the population use pit latrine toilets and they also lack proper way of solid disposal. These situations largely contribute to the proliferation of mosquitoes breeding sites which are reported to be serious vector of many infectious diseases of public health interest.

Study Design

Two basic instruments used for this research were questionnaire, and clinical diagnosis. Both primary and secondary data were used for this study. Here data on school children who attend Kogi Specialist Hospital were collected via well-structured questionnaires for the primary data and data on prevalence of malaria parasites among the interviewed

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students which were later diagnosed using thick and thin smear methods. Socioeconomic factors such as age, gender, and malaria prevalence were considered. Statistical technique used for the study was Chi-square analysis.

Number of Sample Decision

The number of samples for this study was decided using sample number decision formula for cross-sectional population study as adopted Naing *et al* 2006.

$$n=\frac{z^2p\,(1-p)}{d^2}$$

n = minimum sample number required; z = 1.96, which is the standard normal deviation at 95% confidence interval limit; d = 0.05 = which refers to the acceptable error; p = 0.5 is the estimated proportion of malaria prevalence as there was no similar study in the study area.

$$n=\frac{(1.96)^2x0.5x0.5}{0.0025}=313.9984=314$$

In Anticipation of non-response from the anticipating participants, 5% was added to the above calculated number of participants for the present study, making 330 participants for the final sample size. Based on these presumptions simple random sampling methods was applied until the required number acquired.

Malaria Parasites Diagnosis

Blood Malaria parasites were ascertained and sum up using Giemsa stained blood smear produced from freshly collected whole blood samples. Blood samples were applied on each individual clean glass slide and were allowed to air dried before 10% giemsa stain were used to stain them as adopted from Kuete, *et al* 2016. The prepared blood smears were inspected under a light microscope by using 100X oil immersions by professional laboratory technician. Parasitaemia was ascertained per 500 red blood cells (RBCS) with assumption that each respondent had a mean of 7500 RBC/ul of blood (WHO, 2015). Parasitic load were grouped according to asexual stages load as follows: 1) less parasitic load for samples with less than 2000 trophozoites /ul of blood; 2) medium parasitic load for samples with range of 2000 – 5000 trophozoites; 3) excessive when the parasitic load is over 5000 trophozoites /ul of blood

Blood types examining: ABO blood types were ascertained by agglutination methods using antisera as adopted from Godet and Chevilote, 2013. Two drops of whole blood were placed into two different places of a grease-free clean glass slide. A drop of antiserum for blood group A was added to one of the group spot and a drop of blood group B and antiserum was added to the second blood spot. Each blood spot and antiserum was mixed with a sterile discardable applicator stick. The slide was then tilted to detect agglutination and the result recorded accordingly (Godet, and Chevillote, 2013).

Data Analysis

Data collected were evaluated for any relationship connecting malaria parasites infection and the different types of blood group using chi-square (χ^2). Statistical significance was looked at 95% confidence limit and P -value less than 0.05. The same chi-square statistical techniques was also used for socio-economic analysis.

Ethical Clearance

The ethical clearance (study protocol) was assessed and endorsed by the Ethical assessment Committee of the state ministry of health Lokoja, Kogi state. Before the blood samples were collected from the donors, their guardians were ask to fill and sign a consent form for their children to participate in the

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study, after they were fully informed on the reason and significance of the study.

RESULTS

Prevalence of Malaria parasites infection and *Plasmodium* species in relation to gender

Out of the 330 children examined 29(8.79%) were infected with malaria parasites. In total the female 15(9.38%) patients were more infected than their male 14(8.24%) counterparts (Table 1). The result showed no significant difference (P>0.05) between the two gender used for the study, since χ^2 (0.033267) is less P (0.8676) in the overall prevalence of malaria infection in relation to gender. For this reason gender is not liable factor in relation with the malaria parasites. *Plasmodium falciparum* 15(51.72%) and *Plasmodium malariae* 14 (48.28%) prove to be the prevalent malaria species encountered during this study, where *P. falciparum* showed to be the most prevalent parasite species of the study area, even though when it was evaluated statistically, it showed no significant difference (P > 0.05) between the species with χ^2 (0.44392) less than P (0.5186). More infection were in female 15(51.72%) patients than male 14(48.28%).

Prevalence of Malaria Parasites Infection and *Plasmodium* species in Relation to age Group

Table 2 depicts those children of 9-11 age had the most incidence 15(14.29%) of infection rate followed those by those between 6-8 years old 5(11.11%), while children within 13-14 years were just few infected. Children between 0-2 years old showed no plasmodium infection (Table 2). The general incidence of malaria parasitic infection in relation to age showed significant difference (P<0.05). Children within age group of 3-5 years old had the highest prevalence (100%) of *P. falciparum* followed by those within 9-11 and 12-14 year old.

Prevalence of Malaria Infection in Relation to Blood Group

The table 3 depicts those children with blood type B 12(41.38%) had the highest number of malaria infected individuals in the study area followed by those with blood group AB 9(31.03%). The least level of infection was shown by children with blood group A, 4(13.79%) (Table3). The overall result when subjected to statistical test, it showed no significant difference (p>0.05) in the prevalence of malaria infection in relation to blood group.

Prevalence of Malaria in Relation to educational Status

Table 4: shows malaria infection on the bases of education status. The result showed malaria has no regard for educational status of an individual, the subject of upper class showed highest parasite density 123449 even though they have the least percentage (4.20%) of number infected. The second highest parasitic density was recorded in children that their parents lack formal educational and they prove to have the highest percentage of prevalent among the educational status considered. The least parasite density (22600) was observed in children of parents with secondary certificates. The results showed no significant differences (P>0.05) in the incidence of malaria infection in relation to education status..

Table 5 shows the occupational information of the respondents where majority 151(45.76%) of them were civil servants, followed by traders 92(27.88%), while 35(10.76%) were fishermen and they proved to have least population among all occupations considered.

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Table 1: Prevalence of Malaria parasites infection and *Plasmodium* species in relation to gender

Gender	No. Examined	No. Infected (%)	Malaria Parasites		Total (%)
			P. falciparum (%)	*P. malariae* (%)	
Female	160	15(9.38)	11(6.88)	4(2.50)	15(51.72)
Male	170	14(8.24)	10(5.88)	4(2.35)	14(48.28)
Total	330	29(8.79)	21(72.42)	8(27.59)	29(100)

χ^2=0.033267, df =1, p =0.8676: prevalence of malaria infection in relation to gender

χ^2=0.44392, df =1, p =0.5186: prevalence of species of *Plasmodium* parasites in relation to gender

Table 2: Prevalence of Malaria Parasites Infection and P*lasmodium* species in Relation to Age Group

Age group (years)	No. Examined	No. Infected (%)	Malaria Parasites		Total
			P. falciparum (%)	*P. malariae* (%)	
0-2	30	0(0.00)	0(0.00)	0(0.00)	**0(0.00)**
3-5	40	3(7.50)	3(100)	0(0.00)	**1(3.35)**
6-8	45	5(11.11)	3(60)	2(40.00)	**5(17.24)**
9-11	105	15(14.29)	11(68.75)	4(31.25)	**15(51.72)**
12-14	110	6(5.45)	4(66.66)	2(33.34)	**6(20.69)**
Total	**330**	**29(8.79)**	**21(72.41)**	**8(27.59)**	**29(100)**

P<0.05 = statistical different

Table 3: Prevalence of Malaria Infection and Plasmodium species in Relation to Blood Group

Blood group	No. Examined (%)	No. Infected (%)	Malaria Parasites		Total
			P. falciparum (%)	*P. malariae* (%)	
A	23(6.97)	4(17.31)	2(50.00)	2(50.00)	**4(13.79)**
AB	77(23.33)	9(11.68)	6(66.66)	3(33.44)	**9(31.03)**
B	150(45.45)	12(8.00)	9(75.00)	3(25.00)	**12(41.38)**
O	80(24.24)	5(6.25)	4(80.00)	1(20.00)	**5(17.24)**
Total	**330**	**29(8.79)**	**21(72.41)**	**8(27.59)**	**29(100)**

P<0.05

Table 4: Prevalence of malaria in relation to educational status

Educational status	No. Examine	No. Infected (%)	Parasite Density (ul)	X	P-value
Tertiary	119	5(4.20)	123449		
Secondary	130	14(10.77)	22600	4.33	0.487
Primary	70	6(8.57)	29230		
Illitrate	11	4(36.36)	32444		
Total	330	29	207723		

Table 5: Prevalence of malaria in relation to Occupational status

Occupational status	No. Examine	No. Infected (%)	Parasite Density (ul)	X	P-value
Farming	52	5(9.62)	123449		
Civil service	151	4(2.65)	22600	4.73	0.427
Trading	92	5(5.43)	29230		

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Fishing	35	15(42.85)	32444
Total	330	29	207723

DISCUSSION

This study showed low prevalence (8.79%) of malaria parasites infection in the study Area. This could be as result of public health education on mosquito, mosquito control measure employed by the respondents. This may also be due to increase of idea of proper waste management, use of insecticides treated nets, use of pesticides, draining of water from gutters, clearing of bushes and prompt treatment of infected individuals with malaria parasites. These activities reduce mosquitoes breading sites and malaria parasites density load which may also reduce the rate of malaria transmission. This may be responsible for the low prevalence of the malaria parasites observed in the study Area. This result is low compared to report by (Njimah, J. A., *et al*. 2019; Naphtali, R. S., *et al*. 2017; Olusunkanmi, O I. *et al* 2013) who reported prevalence of 35.9%, 27.10% and 31.0% in Taraba, Adamawa and Abeokuta respectively as compared 8.79 recorded in this specific research. This study is in agreement with the report by Yohana, V. A., *et al*. (2019), of his findings recorded 8.6% from his study conducted in Plateau, Nigeria. From his research, malaria proved to be more prevalent among female children (9.38%) than male children (8.24%) even though the incidence has not demonstrated significance difference ($p > 0.05$). This result did not agree with report of Yohana, V. A., *et al*. (2019) who recorded more malaria infection in male (9.8%) than their female (7.7%) counterpart, even though the prevalence was not statistically significant different ($P>0.05$), but it is in agreement with the report of (Ngwaorgu, 2011) who reported more malaria infection rate in female (54.9%) children than their male (47.0) counterparts. The variability observed by many researchers indicated no scientific evidence exists to prove that susceptibility to *Plasmodium* parasites is gender based. The present study also demonstrated no difference in the infection rate based on gender ($P > 0.05$). This implies that infection depends on the children exposure to infectious bites of mosquitoes.

In addition, the business details of the parents or guardians of the participants recorded, revealed that majority of the population of the study area (45.76%) were government workers, followed by petty traders (27.88%) and the least were fisher men (10.61%). The results indicates that majority of respondents were civil servants and traders. It is notable that all respondents were vulnerable to malaria infection without regard to your working place, education status, gender and again we should have at the back of our mind one bite from the infected female mosquito is enough for the plasmodium transmission. This could also be due to the environment where factors supporting the mosquito to breed favourably, the factor include favourable temperature, availability of stagnant water, clogged gutter (Kazwaini, M and Wahyuni, U. C., 2021). Similar finding was reported by Ibor and Okoronkwo (2017) that reported no significance difference was observed based on the occupational status. Even though there was no statistical difference among the different occupation considered during the study period, but based on value obtained, fishing occupation (42.85%) prove to be the most infected, and this could be due to the nature of their business which is always within the breeding sites of mosquitoes.

This study discovered that *Plasmodium falciparum* prove to be the most prevalent (72.42%) species in the study area. This finding is in agreement with what reported by researchers (Yohana, J. A. *et al*., 2019; Lell,

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B., *et al*., 1999) who recorded *P. falciparum* (71.0%) and (100%) respectively. This study showed no statistical significant difference based on gender. The tall incidence of blood group B in the population of Lokoja is surprising, as no similar reports have been recorded in other parts of the country and the world at large was encountered during the course of this study. What is well known all over the world, as the most common blood group type is type O, which is around 37% as reported by by researchers (Rowe, J. A., *et al*. 2007;, Pathirana, S, L. *et al.*, 2005) in their separate individual studies.

Malaria parasitaemia was shown in all the blood groups but prevalence varied within the different groups. However in respect to infection rate, children in blood group A proved to be the most susceptible (17.31%) and blood group O the least (6.25%) which indicated participants with blood A are more susceptible to malaria infection and they are prone to show malarial symptoms. This study is in consensus with the report of researchers (Tekeste and Petros, 2010;, Degarege, A., *et al*., 2019; Afoakwah, R., *et al*., 2016) who also reported blood type A was found to be more vulnerable to *Plasmodium falciparum and* on the other hand blood type O is said to be more resistant to complex *P. falciparum* malaria instances. These observations give credence of previous studies (Tekeste and Petros, 2010; Pathirana, S, L. *et al*., 2005; Fischer and Boone 1998). Persons with complex malaria issues, about two/third of them are expected to be from blood type A or B when weigh up to blood type O. A similar study recorded ABO blood group malaria parasitaemia prevalent being highest (64.00%) in blood group A (Godet and Chevillote 2013; Fischer and Boone 1998; Maina, A. T. *et al.,* 2017). There was no statistical significance difference between prevalence of malaria parasites infection and ABO blood group (P>0.05).

Children from the none educated class are living in poor housing environments were assumed to be at more risk of having malaria infection but on the contrary it were not so with the present study. With this study malaria has no regard for economic and educational status of an individual once you get exposed to the infected female anopheles you will definitely fall down with malaria unless if your immune system was able intervene successfully. The study showed subject of tertiary class has the highest parasite density of 123449, even though they have the least percentage (4.20%) of number infected individuals. This could be they have high immune system acquired in good balance diet that make them to be asymptomatic to low parasites density, than those in too low class that lack balanced diet which may lead to compromised immune system.

CONCLUSION

The evidence suggests that malaria infection is strongly associated with low socio-economic status. Investing in strategies that addresses socio-economic differences and improving the quality of housing could in the long distant time reduce the burden due to malaria in the poorest communities. Prevention intervention and regular treatment with antimalarial drug is key to reduce the burden due to malaria. So the government and other stakeholders should equip the health facility of higher institutions with enough drugs, including antimalarial drug and also make sure each student have access to treated mosquito net. Also mass health education on possible ways of preventing malaria transmission should not be left out.

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