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AN ASSESSMENT OF THE ROLE OF ABO BLOOD GROUP ON MALARIA INFECTION IN A HETEROGENOUS COMMUNITY, KADUNA – NIGERIA

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ABSTRACT

Malaria is a global public health concern considered a leading cause of morbidity. A cross-sectional study was carried out to assess the role of ABO blood group on malaria between April and June 2024. A total of 120 blood samples were collected from patients aged five and above, except pregnant women undergoing malaria test at Primal Diagnostic Service in Kaduna state. Blood samples were collected from patients and stained with Field stain using standard parasitological techniques. Agglutination techniques using monoclonal anti-sera A, B and D were used to determine the ABO blood groups and a full blood count analysis was carried out to check some hematological parameters. Data generated was analysed using ANOVA test and statistical significance level was set at $P<0.05$. An overall malaria prevalence observed showed 53.3% and 30% of the study population had low and moderate malaria parasite densities respectively. About 42.5% and 40% of the population were females and males respectively with malaria parasites. The population of blood group O (43%) patients was higher compared to A (25%), B (18%) and AB (14%) groups respectively. Similarly, group O had the most number of confirmed malaria parasitaemia of 41.4% followed by groups A, B and AB with 26.3%, 16.2% and 16.2% respectively. There was a significant decrease $P<0.05$ in red blood cell count of malaria-infected patients which was pronounced in blood group O compared to the other blood groups. Data from this study does not show variation in RBC counts in ABO blood group during malaria.

Keywords: Malaria, ABO Blood group, Parasitaemia, Parameters

INTRODUCTION

Malaria infection is a major public health concern worldwide and is still considered the leading cause of morbidity globally. Approximately 3.3 billion people are at risk of malaria across 83 countries (WHO, 2024). In 2023, an estimated 263 million cases of malaria and 597,000 malaria deaths were recorded worldwide and 94% of all worldwide malaria fatalities transpire within WHO African area with Nigeria bearing the burden of the disease at 30.9% (WHO, 2024). Malaria is mosquito borne and infectious , it is caused by an obligate intracellular protozoan parasite of the genus Plasmodium (Tazebew, 2021). Malaria is caused by five protozoan species – *Plasmodium falciparum*, *P. vivax*, *P. malaria*e, *P. ovale* and *P. knowlesi*. *P. falciparum* causes the most significant menace to public health (Snow, 2015) and is transmitted by the female *Anopheles* mosquito vector (Varo *et al*., 2020). Malaria transmission is seasonal and heterogeneous, and it exerts a burden in areas with congested households (Mosha *et al*., 2014). The malaria parasites raids and reproduce in the liver and red blood cells (RBCs) during their life cycle in the human body causing symptoms like headache and fever, and in severe cases, progress to coma and death (Tazebew, 2021). The red blood cells in the blood that the parasite invades tend to differ in some humans which lead to the development of human blood grouping system with the ABO blood grouping system being the most important classification system widely used medically.

In ABO blood grouping, erythrocyte are classified based on the expression of carbohydrate antigens on their surface (Afoakwah *et al*., 2016). The different blood groups based on the ABO blood grouping classification are Blood group A, B, AB and O having the A, B and H antigens respectively (Gupte *et al*., 2012). Blood antigens are characteristic traits that vary among individuals and populations due to polymorphism. The polymorphisms have been associated with certain diseases, as their corresponding antibodies greatly affect how well the body defends itself against diseases such as HIV and skin cancer (Abegaz, 2021; Cihan *et al*., 2013; Okorie Hope *et al*., 1988). There have also been numerous reports and evidence on the association of ABO blood grouping with resistance to malaria infection, suggesting that ABO blood groups might influence the infection status of individuals with specific blood groups (Afoakwah *et al*., 2016) *Plasmodium falciparum* has been linked to the ability of infected erythrocytes to bind to uninfected erythrocytes, a phenomenon called rosetting (Tekeste & Petros, 2010). Blood groups A, B, and AB have been demonstrated to display polymorphism and reduced clearance of parasitised RBCs, which is a consequence of rosetting and cytoadherence (de Mattos, 2011). Blood group O, on the other hand, display an increase in clearance of RBC by reducing rosetting and cytoadherence (Yeda *et al*., 2022). However, rosetting capacities of blood group 'A', 'B' or 'AB' have remained controversial (Panda *et al*., 2011). Research from previous studies have shown that the body might have a strong immune response against *P. falciparum* (Oue *et al*., 2004) ,and this immunity tends to vary based on genetic background of different individuals .The study of heterogeneity in respect to different groups of people with different genetic backgrounds who are exposed to malaria can help us understand how this disease affect them differently. This study was to assess the impact of ABO blood groups on malaria infection in a heterogeneous population

MATERIALS AND METHODS

Description of The Study Area

The study was carried out at Primal Diagnostic Services, a diagnostic centre in Kaduna State, Nigeria. The site selected was Northern Kaduna, which is a local government and also the heart of Kaduna State, with an area of 70.2 km^2. Kaduna North has a density of 7,672/km^2 and a population of about 538,600.

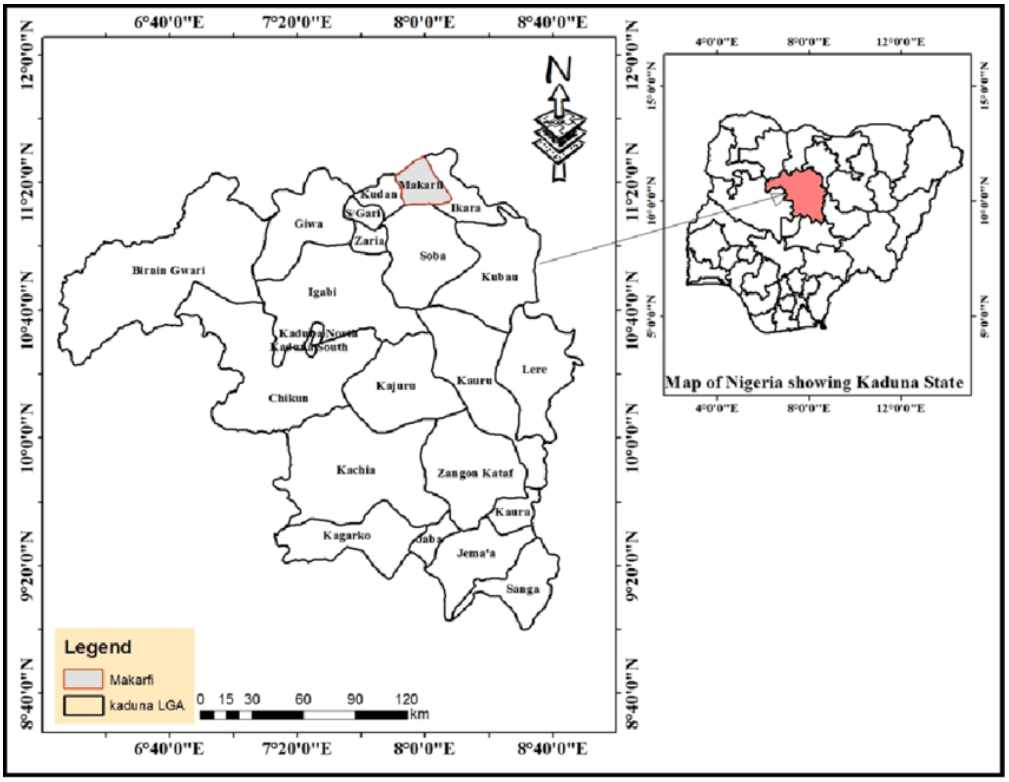

Figure 1: A map showing the study location in Northern Kaduna. Source (Oloko & Ekpo, 2018)

Collection of Samples

The study examined malaria patients of both genders; a total of 120 blood samples were collected between April to June 2024. The study participants comprise patients who came for malaria tests from age five and above. Pregnant women were excluded from the study.

Ethical Clearance

Ethical protocol for this study was approved by the Kaduna state ministry of health, permission was also sought from the diagnostic center management board of the diagnostic center used (Primal diagnostic services Kaduna state). A verbal informed consent and accent was sought from all the subject or from their guardians and all participants information were kept confidential.

Blood Collection and Typing

A cross-sectional study which examined 120 blood samples from patients undergoing malaria parasite tests in Primal Diagnostic Service in Northern Kaduna state. The blood samples were collected from the patients by a medical laboratory scientist using the standard procedure with a sterile disposable plastic syringe. The blood samples were collected from an antecubital area, after sanitised with methylated spirit. Venipuncture was made using a 5 ml syringe, and samples collected immediately and gently released into a vacutainer and rocked gently to prevent lysing of the blood

Clinical And Laboratory Diagnosis (Parasite Density Determination)

Blood was obtained from pricking patients undergoing malaria parasite test, with a metal lancet and spotted on to produce thin and thick smears on microscopic glass slides and allowed to dry. The slides were stained with field stain A and B, with a rinsing step in between the stains according to the routine standard. The stained slides were examined under a light microscope using 100 × oil immersion. To determine parasite density 200 leukocytes were first counted whilst observing the malaria present. If less than 10 parasites were observed after counting 200 leukocytes the count was continued till 500 leukocytes were counted.

Parasite density was calculated using the formula to yield the total parasites per µl of blood (Baffour *et al*.,2023)

$$\frac{Number\ of\ parasites}{Number\ of\ leukocytes} \times 8000$$

The parasite density was classified as low when there was less than 1000 parasite/µL of blood, Moderate when parasitaemia was between 1000 and 9999 parasite /µL and severe when parasitaemia was greater than or equal to 10,000 parasite/µL of blood. Parasite density was recorded as the number of parasite/µL of blood , assuming an average leucocyte count of 8000/µL of blood was used for every individual (Awosolu *et al*.,2021) .While the level of parasitaemia was designated as (+) when 1 to 30 parasites were counted per 100 fields (mild or scanty parasitaemia); (++) double when 31 to 75 parasites were counted per 100 fields and triple (+++) when counted per 100 fields was above 75.

Blood Grouping

ABO blood group was typed using Anti Sera reagent (Anti A, Anti B and Anti D). Two drops of whole blood from each participant was placed on three different spots on a grease-free clean glass slide. A drops of blood group A, B, and Rhesus factor (D) anti-sera were added on each of the three different spots on the glass slide. The blood cells and the antigens were mixed with an applicator stick then the entire glass slide was rocked for a few seconds before it was observed to detect any agglutination and the results were recorded accordingly

Full Blood Count

Whole blood was analyzed for full blood count using an automated heamalogical analyzer and the result was used to

estimate the white blood cells and red blood cells of each patient.

Statistical Analysis

The results were analysed using SPSS 20.to conduct a one-way ANOVA.

RESULTS AND DISCUSSION

Parasitaemia Frequency Distribution Among Gender

Out of 120 blood samples collected, 57 (47.5%) and 63 (52.5%) are males and females respectively as presented in Figure 2. The distribution pattern for infection in the total samples collected showed low (64; 53.3%), moderate (36; 30%) and absence (20; 16.7%) of malaria parasite with no significant corresponding differences across both females and males. About 26.7% and 25.8% of the samples are females and males with low parasitaemia, while 15.8% and 14.2% of the samples are females and males with moderate parasitaemia respectively. The result also indicates that 10% and 7.5% of the samples are females and males respectively with no parasite detected. Similar studies in Ghana, Kenya and Nigeria demonstrated that females are prone to falciparum malaria compared to males (Jenkins *et al*., 2015; Osisiogu *et al*., 2023; Tela *et al*., 2015). The propensity of malaria in females portends their potential role as a reservoir for malaria transmission that could be of interest to the global malaria eradication and control drive (Jenkins *et al*., 2015). In contrast to the findings of this study, a study in Pakistan investigating *P. vivax* malaria demonstrated that males are more prone to the disease compared to females (Shan *et al*., 2024). This may have been a consequence of multiple factors including climatic, genetic and speciation of the parasite, which could be responsible for the contrasting outcomes in Africa and Asia. Only low and moderate parasitaemia were observed in the study with no high parasitaemia detected. This could be indicative of the fact that the study was conducted during the low malaria transmission season in the northern part of Nigeria, or perhaps because samples were obtained from a diagnostic facility whose clients are mostly outpatients and not inpatients on admission.

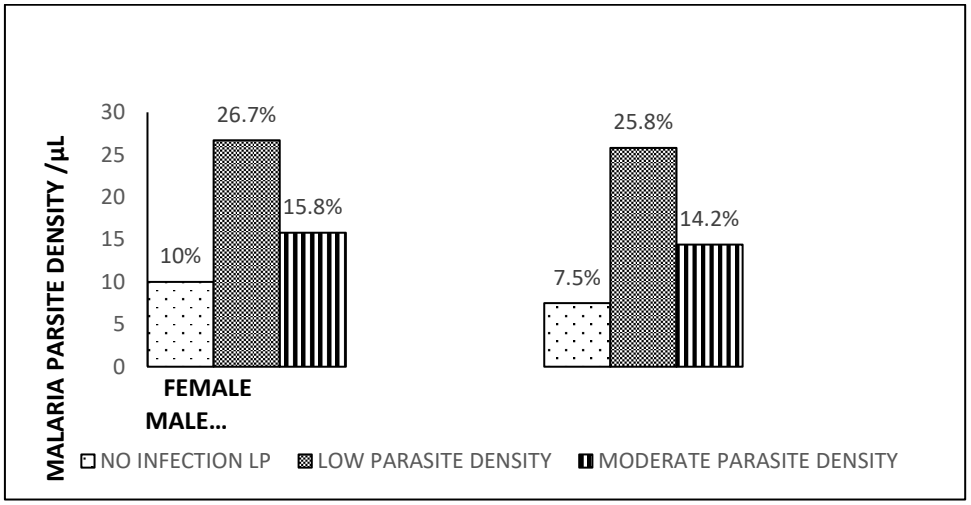

Figure 2: Parasitaemia Frequency Distribution Among Gender

Distribution of ABO Blood Group

Data from Figure 3 indicates the distribution of the four ABO blood groups from the study sample of 120 to be 43% blood group O, 25% blood group A, 18% blood group B and 14% blood group AB. Similar distribution pattern for the ABO blood groups was observed where the O and AB blood groups were the most and least prevailing blood types from the respective study population (Osisiogu *et al*., 2023; Tela *et al*., 2015). The finding from this study alludes to an earlier study that suggests blood group O to be the preferred blood malaria parasite *in vitro* (Theron *et al*., 2018).

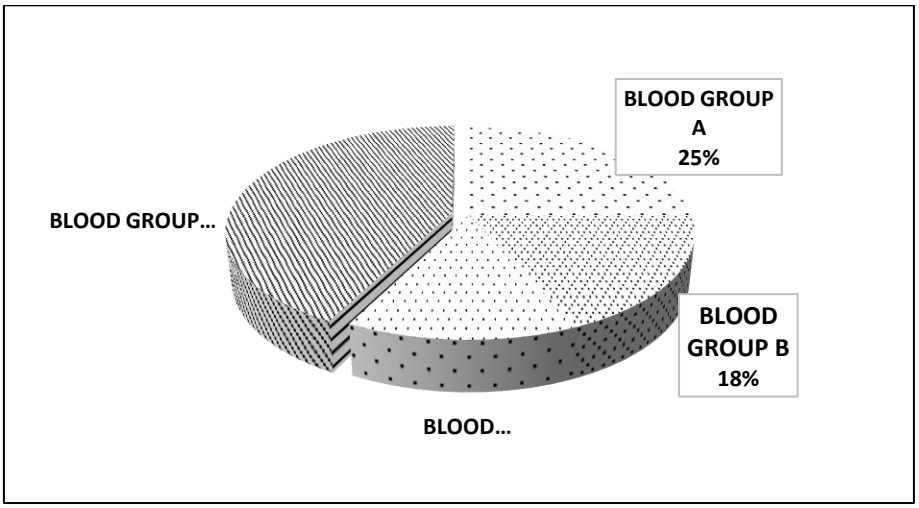

Figure 3: Distribution of ABO Blood Group

Prevalence of Parasitaemia Across Various Blood Groups

As shown in Figure 4, about 62.6% (62/99) of confirmed malaria cases had low parasite density, while 37.4% (37/99) of the cases had moderate parasite density. Blood group O had the most number of confirmed malaria parasitaemia with 41.4% (41/99) followed by blood groups A, B and AB with 26.3% (26/99), 16.2% (16/99) and 16.2% (16/99) respectively. It is not surprising that no high parasitaemia was recorded in this study, this perhaps could be attributed to fact that Nigeria is a malaria hotbed, where majority, if not all the population has been exposed to malaria. Unlike malaria naïve persons, prior exposed malaria individuals often acquire some level of immunity that prevents the progression of parasitaemia to severe malaria cases (White, 2022; WHO, 2024). The findings of this study suggestive that blood group O is most likely amongst other groups to be prone to malaria is in concordance with an independent study also in Nigeria (Tela *et al*., 2015). Contrastingly, blood group O individuals are less likely to have severe malaria (Pathirana *et al*., 2005). The underlying factors responsible for the variations amongst blood groups is yet to be fully understood. However, a strong macrophage clearance of *P. falciparum*-infected O erythrocytes had been demonstrated as the likely occurrence that prevents progression to severe malaria in the blood type Wolofsky *et al*., 2012).

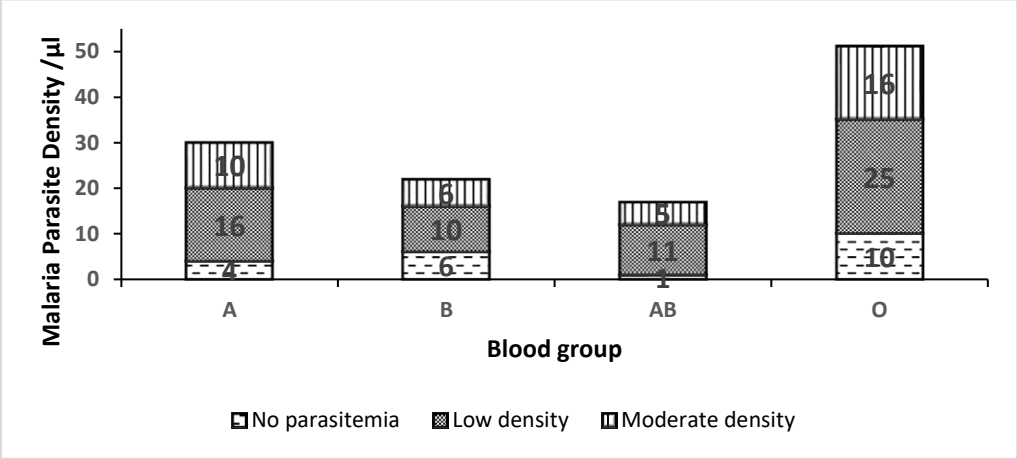

Figure 4: Prevalence of Parasitaemia Across Various Blood Groups

Red Blood Cell Count Frequency Distribution in Malaria Among Blood Groups

The red blood cell count frequency distribution across the blood groups was assessed in malaria. There was no significant difference across the blood groups (Figure 5). However, low RBC levels were observed across the blood groups in malaria. Anaemia is one of the common complications in malaria resulting from the parasites primarily targeting RBC for destruction (Bartoloni & Zammarchi, 2012). The data from the current study does not provide discerning evidence of variations in RBC counts in ABO blood group during malaria. Perhaps the sample size used for the study is the limiting factor, or the fact that the study was conducted during the low malaria transmission period of the year.

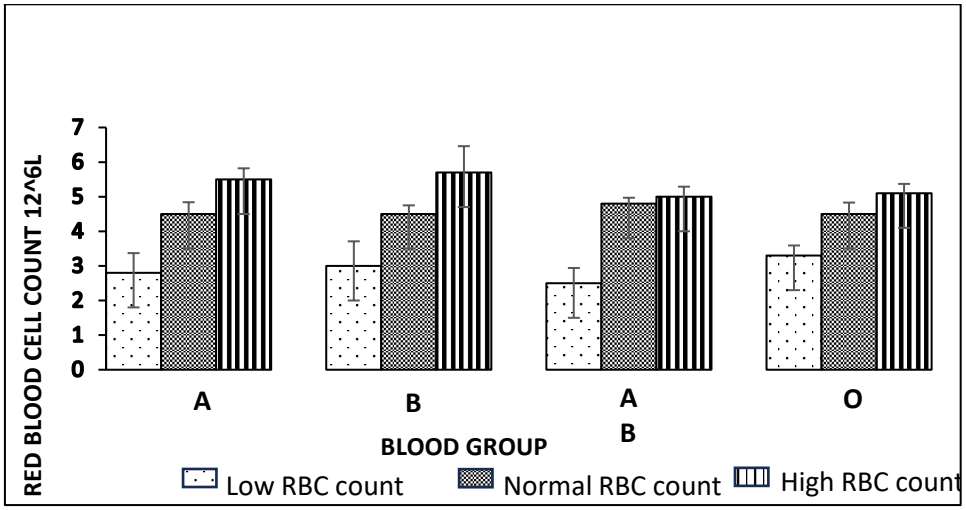

Figure 5: Red blood cell count Frequency Distribution Among Blood Group.

CONCLUSION

The outcome of the study implied that females are potentially serving as reservoirs for malaria transmission in Nigeria. Only low and moderate parasitaemia was detected with no incidence of high parasitaemia, suggestive of the absence of severe malaria infection from the samples. The blood group O was shown to be the predominant blood type of the ABO blood groups presenting uncomplicated malaria infection. Data from this study does not show variation in red blood cell counts in ABO blood group during malaria. A large sampling

population could provide more convincing information on the impact of ABO blood group on malaria.

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