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ABO Blood Groups and Malaria Prevalence in a Referral Hospital in Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author MNW designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author FON managed the analyses of the study. Author KTW managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A cross-sectional randomized study was carried out to evaluate the relationship between malaria prevalence and ABO blood groups in a referral hospital in Rivers State, Nigeria. Venous blood samples were collected from all consenting study participants, films (thick and thin) were made from each blood sample, stained with 10% Giemsa stains and viewed microscopically with oil immersion objective to detect *Plasmodium* species using standard parasitological techniques. Agglutination technique using monoclonal Antisera A, B and D was used to determine the ABO blood groups. Data generated were statistically analyzed using Chi-square test and significance level was set at $P<0.05$. An overall malaria prevalence of 43.1% was observed among study participants. Blood groups A and O had higher malaria prevalence of 61.1% and 42.6% respectively while blood groups B and AB had lower prevalence of 28.0% and 0% respectively ($P<0.05$). Malaria parasite density levels >1000 parasites/µL in relation to ABO blood groups showed a higher prevalence of 46.7% and 22.7% in blood groups A and B respectively while lower prevalence of 0% and 15.7% occurred in blood groups AB and O respectively ($P<0.05$). The

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findings of this study showed that individuals with blood group O were susceptible to contracting uncomplicated malaria but had a higher resistance to developing severe malaria compared to non – O blood groups (A and B). More detailed molecular researches are needed to fully establish the relationship between malaria parasitaemia and ABO blood groups, therefore malaria interventions and control strategies should be directed equally among individuals irrespective of their blood groups.

Keywords: Malaria; ABO; prevalence; Rivers State.

1. INTRODUCTION

Malaria is a parasitic disease caused by *Plasmodium* species, it is transmitted mainly via the bites of infected female *Anopheles* mosquitoes during a blood meal and this disease has plagued man for centuries [1]. Malaria is a serious public health concern in sub-Saharan Africa, causing high morbidity and mortality rates [2,3]. Some individuals in malaria-endemic zones are less susceptible to malaria infection despite the prevailing high morbidity and mortality rates compared to others who experience frequent malaria bouts. Some factors such as G-6-P-Dehydrogenase activity levels, sickle cell trait, host immune response and ABO blood groups have been linked to individuals with less or increased malaria susceptibility [4]. ABO blood groups are genetic traits with different frequencies possessed by humans and are transferred from one generation to the next but some factors such as sexual relationship, race, ethnic group, socio-economic status and alleles affect the frequencies of the ABO blood groups among populations [5]. In developing new malaria control strategies and scaling up existing ones, understanding the relationship between ABO blood groups and malaria parasitaemia could aid in effectively combating malaria especially in endemic regions of sub-Saharan Africa. This study was conducted to evaluate the relationship between ABO blood groups and malaria prevalence among randomly selected consenting study participants in University of Port Harcourt Teaching Hospital (UPTH), Rivers State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area and Population

A cross-sectional study was carried out in UPTH (Latitude 4°53'58"N and Longitude 6°55'43"E) in Obio – Akpor L.G.A., Rivers State, Nigeria using 1000 randomly selected consenting study participant using computer generated random sequence by Statistical Analysis System (SAS) software and minimum sample size determination was done using Leslie – Kish formula [6]. The study population was made up of males and females as well as individuals of different age groups. Inclusion criteria for this study was that study participants attended the selected healthcare centres, had suspected body temperatures ≥38℃ for less than 10 days, were examined by a physician and gave their oral or written consent to be part of the research. Exclusion criteria included individuals undergoing malarial treatment (or took antimalarial drugs within two weeks before the research), diagnosed with mental illness, measles, chickenpox, infected wounds, pneumonia and those with suspected body temperatures ≥38℃ but did not give their consent to be part of the study. Ethical clearance was obtained from the Rivers State Ministry of Health and UPTH Ethics Committee before the commencement of the study.

2.2 Data Collection and Analysis

The consent (oral or written) of all study participants (consent was obtained from guardians or parents of participants below 18 years) was obtained. Five milliliter (5ml) of venous blood was collected from each study participant for *Plasmodium* species detection using Giemsa microscopy technique and ABO blood grouping by agglutination technique [7]. For *Plasmodium* species detection, blood films (thick and thin) were made, air dried, stained with 10% Giemsa stains for 10 minutes and then observed microscopically using oil immersion objective [7]. ABO blood grouping was done with monoclonal antisera A, B and D (Agappe Diagnostics Ltd, India) and each blood group was determined by agglutination technique [7]. The degree of *Plasmodium* species density was graded as uncomplicated (1 – 1000 parasites/µL) and severe (>1000 parasites/µL) [8]. Data obtained in this study were compared with Chi square (χ^2) test (McNemar chi-square for paired and Pearson independence chi-square for unpaired comparisons) using statistical package

for social sciences (SPSS) version 17. The data were presented in frequencies, percentages and means while a p-value less than 0.05 was considered significant.

3. RESULTS

An overall prevalence of 43.1% was recorded in the study and *Plasmodium falciparum* was the only malaria parasite species identified (Table 1). Among study subjects examined, individuals with blood group O had the highest population while those with blood group AB had the least population (Tables 1 and 2). Individuals with ABO blood groups B and AB had lower malaria prevalence of 28.0% and 0% respectively while those with blood groups A and O had higher malaria prevalence of 61.1% and 42.6% respectively (P<0.05) (Table 1). Malaria parasite density levels >1000 parasites/µL in relation to ABO blood groups showed an overall prevalence of 19.0% with higher parasitaemia of 46.7% and 22.7% in individuals with blood groups A and B respectively compared to 0% and 15.7% in individuals with blood groups AB and O respectively (P<0.05) (Table 2).

4. DISCUSSION

Data obtained in this study showed that study subjects with blood groups AB and O had the least and highest population respectively. This observation is comparable to some other similar researches conducted in Nigeria and Ethiopia [4,9,10]. Malaria prevalence was highest in blood groups A (61.1%) and O (42.6%) but lower in blood groups AB (0%) and B (28.0%). This finding is comparable to similar studies that reported higher malaria parasitaemia among individuals with blood groups A and O when compared to those with blood groups B and AB [11,12,13]. Malaria parasite density levels >1000 parasites/µL showed significant higher prevalence in blood groups A and B compared to blood groups AB and O. This finding agrees with the reports of similar researches [10,14-17]. *Plasmodium falciparum* infected erythrocytes bind with some serum molecules whose levels are linked with the ABO locus and these are used as biomarkers for inflammatory processes and damaged vascular endothelial cells [18,19]. *Plasmodium falciparum* – infected erythrocytes form stronger and larger rosette (clustering of cells) with uninfected erythrocytes in non – O blood groups (A and B) but weaker and smaller rosettes in blood group O [20]. Also, blood groups A and B antigens are good rosetting receptors on the surface of *Plasmodium falciparum* – uninfected erythrocytes [20] and these antigens are held by PfEMP1 which is expressed on the surface of *P. falciparum* infected erythrocytes [21]. Therefore, the high severe malaria observed among individuals with blood groups A and B could be attributed to the presence of more cellular factors (e.g. complement receptor 1 and glycoproteins) in their erythrocytes which aid invasion by *P. falciparum* and rosetting.

Table 1. Malaria prevalence in relation to ABO blood groups

ABO blood groups	Number examined	Number infected (%)
A	90	55 (61.1)
B	75	21 (28.0)
AB	1	0 (0)
O	834	355 (42.6)
Total	**1000**	**431 (43.1)**

χ^2 = 18.970, Df = 2, P – value = 0.000 (P<0.05)

Table 2. Malaria parasite density levels >1000 parasites/µL in relation to ABO blood groups

ABO blood groups	Number examined	Number infected (%)
A	90	42 (46.7)
B	75	17 (22.7)
AB	1	0 (0)
O	834	131 (15.7)
Total	**1000**	**190 (19.0)**

χ^2 = 51.253, Df = 2, P – value = 0.000 (P<0.05)

5. CONCLUSION

More detailed molecular researches are needed to completely establish the relationship between malaria parasitaemia and ABO blood groups. Therefore, malaria therapeutic interventions and control measures should be directed equally at all individuals irrespective of their blood groups in malaria endemic regions.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee

has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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