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Full Length Research Paper

Association of ABO blood group and *Plasmodium falciparum* malaria among Children in the Federal Capital Territory, Nigeria

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ABSTRACT

The ABO and Rhesus blood group systems are very important clinical tools that are commonly used in blood transfusion and their associations with various disease conditions have been widely reported. This study investigated the distribution of these blood group systems and assessed the association of malaria infection with the ABO blood groups among children in Federal Capital Territory, Abuja. Blood specimens from deep finger pricks of 730 children aged between 0-2 years were examined for malaria parasites using Field stains method. ABO and Rhesus blood group antigens tests were also performed using standard tile protocols. Of all the children admitted into the study, 445 were sick while 285 were apparently healthy. The prevalence of malaria parasites was significantly higher (P = 0.00047) among the sick children (69.8%) than the apparently healthy children (30.2%). The most prevalent blood group was O (55.7%) and the Rhesus D antigen was positive for 98.4% of all the children. The prevalence of blood group B among the sick children was significantly lower (P = 0.00373) than the other blood group types. There is no association between malaria infection and ABO blood groups but the prevalence of higher malaria parasite density was significantly greater (P = 0.0404) in children with blood group A (7.7%). In conclusion, blood group O was the most prevalent blood group in the study and children with blood group A appeared to be more susceptible to higher level of malaria parasitemia.

Keywords: Blood groups, ABO, Rhesus, Malaria Parasitemia, Children, Abuja

INTRODUCTION

Malaria is one of the oldest and most frequently occurring infectious diseases in humans. It is widespread in tropical and subtropical regions of the world. Malaria is the second leading infectious disease that causes death in Africa, after HIV/AIDS and it is the first leading cause of death in Nigeria (Murray *et al.*, 2012; Murray *et al.*, 2014).

A blood group is a classification of blood on the basis of the presence or absence of inherited antigenic

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substances on the surface of red blood cells (RBCs) (Storry and Olsson, 2009). An individual usually has the same blood group for life which can rarely be changed through the addition or suppression of an antigen in infection or autoimmune disease, but bone marrow transplantation in many leukemias and lymphomas diseases is a common cause of change in blood group (Kremer *et al.*, 2007).

ABO blood groups are the most medically important blood types that are very useful in assuring safe human-blood transfusions. The ABO blood groups are four principal types: A, B, AB, and O which have two antigens and two antibodies. The specific combination of these four components determines an individual's blood group type (Storry and Olsson, 2009).

The Rh system is the second most significant blood-group system in human-blood transfusions. The D antigen is the most significant Rh antigen which usually provokes an immune system response. Its proper blood group matching is particularly important in the prevention of Rh haemolytic disease which is a common occurrence in feto-maternal blood transfusion between a D-positive fetus and D-negative mother (Basu *et al.*, 2011; Bennardello and Curciarello, 2013; Varghese *et al.*, 2013).

There have been various studies on the associations of ABO antigens with infections since their discovery as the most functional genetic polymorphism in humans. Their association with malaria has been the subject of numerous investigations, since the sickle-cell hemoglobin was discovered to afford protection against falciparum malaria infection (Wolofsky *et al.*, 2012; Tadesse and Tadesse, 2013). Several researchers including some from Nigeria have reported different views on the origin, distribution and relative proportion of ABO blood groups in humans including their association with *Plasmodium falciparum* infection. This report is a similar study but among the very few that was carried out using children in the north central part of Nigeria.

MATERIALS AND METHODS

Study Population.

The study was carried out with children in ages between 0-24 months who reported at the paediatric unit of the University of Abuja Teaching Hospital, Gwagwalada for various complaints of illnesses ranging from malaria to diarrhoea infections (case group) and those of the same age bracket who reported for the National Immunization Programme (control group) at the Township Clinic in the same town. Gwagwalada, the study centre is a fast growing satellite town in the Federal Capital Territory, Abuja having its geographical coordinates as 8° 56' 29" North and 7° 5' 31" East in the North Central of Nigeria. A total of 730 children whose mothers gave informed consents participated in the study which spanned over a period of one year (April 1, 2008 to March 31, 2009) and ethical approvals were obtained from the participating institutions before the commencement of the study.

Samples Collection and Determination of Malaria parasites density

Blood specimens were obtained from deep finger pricks of all 730 children for the determination of their blood groups and the preparation of thick blood films The film slides were air-dried and stained with Field stains A and B and then examined under a light microscope using the oil immersions by an experienced microscopist. The number of parasites on each slide was calculated per 200 white blood cells (WBC) assuming 8000 WBC/µl of blood [8]. The level of parasitemia was designated as single (+) when 1-10 parasites were counted per 100 microscopic fields (mild/scanty parasitemia); or double (++) when 11-100 parasites were counted per 100 fields or triple (+++) when the count per 100 fields was 101-1000 (Cheesbrough, 2002).

Blood group determination

Each child's ABO blood group was typed by agglutination using commercially available anti-sera A, B and D (Biotech. Ltd, UK). Two drops of whole blood were placed in three different places on a grease-free clean glass slide and a few drops of blood group A, B and Rhesus factor (D) anti-sera was applied onto each of the three different spots on the glass slide. The blood cells and the antigens were mixed with applicator stick. The slide was then tilted to detect any agglutination and the results were recorded accordingly (Cheesbrough, 2002).

Statistical Analysis: The data obtained were compared using Chi square or Fisher's exact tests (two tailed) with the SPSS statistical program. All reported *P*- values were two-sided and ($P \leq 0.05$) was considered to be statistically significant

RESULTS

A total of 337 females and 393 males, all from 445 sick and 285 apparently healthy children were admitted into this study. The prevalence of malaria parasitemia among the children on gender basis was 116 (46.8%) and 132 (53.2%) for female and male respectively. The observed

difference was not statistically significant ($P = 0.813$) (Table 1). The distribution of malaria parasitemia among the two main categories of children in this study (Table 2) showed that the sick children (69.8%) had significantly higher prevalence of malaria parasitemia than the apparently healthy children (30.2%) ($P = 0.00047$).

The overall distribution of ABO blood groups among all the children in the study showed a total of 155 (21.2%) of A, 143 (19.5%) of B, 25 (3.4%) of AB and 407 (55.7%) of O while the frequency of Rhesus blood group was 98.4% Rhesus positive (Table 3) and the proportion of Rhesus negative among the female and male was 1.8% and 1.5% respectively.

The frequency of malaria infection among the subjects with ABO blood group system showed group A to be highest (37.4%) and group AB to be lowest (24.0%) but the observed differences among the various blood groups were not statistically significant ($P > 0.05$) (Table 4). However, the frequency of higher malaria parasitemia among subjects with blood group A was significantly higher ($P = 0.0404$) when compared with the other blood group types (Table 5).

Table 1:
The distribution of malaria parasitemia among the children on gender basis

Gender	Sample No.	Category of Subjects		Malaria Parasites (%)		P. value
		Sick	Apparently Healthy	Yes	No	
Female	337	193	144	116 (46.8)	221 (45.9)	0.813
Male	393	252	141	132 (53.2)	261 (54.1)	
Total	730	445	285	248 (34.0)	482 (66.0)	

Chi-square (χ^2) = 0.056; $p = 0.813$

Table 2:
The distribution of malaria parasitemia among the subjects' categories

Category of Subjects	Sample No.	Malaria Parasites (%)		P. value
		Yes	No	
Sick	445	173 (69.8)	272 (56.4)	0.00047*
Apparently Healthy	285	75 (30.2)	210 (43.6)	
Total	730	248 (34.0)	482 (66.0)	

* = Statistically significant ($P \leq 0.05$). Chi-square (χ^2) = 12.22; $p = 0.00047$

Table 3:
Blood Groups Distribution among the subjects' categories

Category of Subjects	Sample number	Blood Groups					
		A	B	AB	O	Rh +ve	Rh -ve
Sick	445	99 (22.2)	72 (16.2)	16 (3.6)	258 (58.0)	436 (98.0)	9 (2.0)
Healthy	285	56 (19.6)	71 (24.9)	9 (3.2)	149 (52.3)	282 (98.9)	3 (1.1)
Total	730	155 (21.2)	143 (19.6)	25 (3.4)	407 (55.8)	718 (98.4)	12 (1.6)
Chi-square (χ^2)		0.701	8.411	0.101	2.286		
P-value		0.402	0.00373*	0.7606	0.131		

Comparison of Group B with Non-B {Chi-square (χ^2) = 8.41; $p = 0.00373$}
* = Statistically significant ($P \leq 0.05$).

Table 4:
The relationship between malaria parasitemia and blood group system

Malaria Infection	Sample Number	Blood Groups					
		A	B	AB	O	Rh +ve	Rh -ve
Infected	248	58 (37.4)	42 (29.4)	6 (24.0)	142 (34.9)	243 (33.8)	5 (41.7)
Uninfected	482	97 (62.6)	101 (70.6)	19 (76.0)	265 (65.1)	475 (66.2)	7 (58.3)
Total	730	155	143	25	407	718	12
Chi-square (χ^2)		1.042	1.679	1.148	0.345	0.322	0.322
P-value		0.3074	0.1951	0.284	0.5570	0.5704	0.5704

Table 5:
The Prevalence of malaria parasitemia among subjects with ABO blood groups

Malaria Parasitemia	Sample Number	Blood Groups			
		A	B	AB	O
Higher Parasitemia	34	12 (7.70)	4 (2.80)	1 (4.0)	17 (4.2)
Lower Parasitemia	214	46 (29.7)	38 (26.6)	5 (20.0)	125 (30.7)
Uninfected	482	143 (92.3)	139 (97.2)	24 (96.0)	390 (95.8)
Total	730	155	143	25	407
Chi-square (χ^2) for higher parasitemia		4.216	1.386	0.025	0.479
P-value for higher parasitemia		0.0404*	0.239	0.874	0.488

Comparison of higher parasitemia in Group A with Non-A {Chi-square (χ^2) = 4.22; p = 0.0404}
* = Statistically significant ($P \leq 0.05$).

DISCUSSION

The ABO and Rhesus blood group systems are very important tools that are commonly used in blood transfusion, and they have special roles in genetics and hereditary diseases (Garratty, 2005; Anstee, 2010; Liumbruno and Franchini, 2013; Rizzo *et al.*, 2014). Some types of blood groups have been reported to offer protection to common diseases like malaria whilst some have been shown to be particularly susceptible to certain infections (Wolofsky *et al.*, 2012; Tadesse and Tadesse, 2013; Güven *et al.*, 2014).

The results of the prevalence of malaria parasites in the study showed that the sick children had a significantly higher malaria parasitemia than the apparently healthy children who came to the centres for immunization. This implies that malaria is one of the main causes of frequent hospital visit among children of these age groups and suggests therefore that malaria parasites can predispose an individual to other underlying infections or diseases. This finding therefore supports the WHO reports that malaria is responsible for the highest hospital visits and it is the first leading cause of morbidity and mortality in Africa especially among children (Murray *et al.*, 2012).

The distribution of ABO blood groups varies from population to population in the world and the ratio of group O to A is higher in geographic regions where there is present or past history of malaria endemicity (O'Neil, 2011). A very high prevalence of group O is found throughout sub-Saharan Africa, where *P. falciparum* persists whilst group A is the predominant blood group in the colder regions of the Earth where malaria is not endemic (Murray *et al.*, 2012; Wolofsky *et al.*, 2012). The ABO blood group distribution in this study showed group O to be the predominant group occurring in 55.8% of all the subjects. It occurred in more than twice the frequency of each of groups A (21.2%) and B (19.6%) while the AB blood group (3.4%) was the least frequently encountered. Most studies in Nigeria reported the frequencies of ABO blood group as 21% for group A, 17% for group B, 2% for group AB and 58% for group O; which are in agreement with the result of this study (Jeremiah, 2006; Pennap *et al.*, 2011). This therefore suggests that group O has predominance over the other blood groups in Nigeria.

An interesting observation in the distribution of blood groups among the sick and apparently healthy categories in this study is that the frequency of blood group B among the sick volunteers was significantly lower (P = 0.00373) when compared with other blood groups. This suggests that the children with blood group B in this study were less susceptible to the common infections or ailments that make the sick children visit the hospital. The reason for this observation is unknown but studies have shown that people with blood group B are more resistant to cholera than those with blood group O, and a study in Scotland showed that patients of group O were more susceptible to gastrointestinal infections caused by *Escherichia coli* O157 than the non-O group (Blackwell *et al.*, 2002; Harris *et al.*, 2005).

The frequency of Rhesus D positive antigen was found in 98.4% of all the children. This finding is in agreement with the previous studies in Nigeria which reported 94 – 98% of Rhesus D positive antigen in adult individuals (Jeremiah, 2006; Pennap *et al.*, 2011). The low prevalence of Rhesus negativity among the female population in this study (1.8%) suggests a very low risk of the development of haemolytic disease of newborn that is associated with Rhesus–mismatched marriages. The prevalence of Rhesus D negative in other parts of the world is documented as 3.4% in Nepal (Pramanik *et al.*, 2004), 6% in Kenya (Mwangi, 1999) and 16% in Sweden (Bergstrom *et al.*, 1994). Furthermore, it is believed that the prevalence of Rhesus negative is often low in parts of the world where malaria is endemic (Basu *et al.*, 2011).

The results of this study on the relationship between ABO blood groups and malaria showed that children with blood group A experienced malaria attacks more frequently than those in the other blood groups but the observed differences in the prevalence of malaria

infection among the children of the various blood groups were not significant ($P > 0.05$). This therefore suggests that there is no significant association between ABO blood groups and malarial infection. This observation further supports the reports of Uneke (2007) in Southeast, Nigeria, Zerihun *et al.* (2011) in Southern Ethopia, and Kuadzi *et al.* (2011) in Ghana. However, the prevalence of higher level of malaria parasitemia (moderate and heavy infestation) was significantly higher among children with blood group A than those of the other blood group types ($P = 0.0404$) whilst the comparison of the lower level of malaria parasitemia showed no significant difference ($P > 0.05$). The level of malaria parasite density may not however determine the severity of malaria but the observation in this suggests that higher level of parasitemia might be a possible tool to measure the severity of malaria since it has been widely reported that individuals with blood group A significantly suffer more severe malaria than those of other blood group types (Doumbo *et al.*, 2009; Tekeste and Petros, 2010; Zerihun *et al.*, 2011; Tadesse and Tadesse, 2013).

In conclusion, the results of this study show that blood group O is the most prevalent blood group type in the area and there is no significant association between ABO blood group and malaria infection but the children with blood group A appeared to be more susceptible to higher level of malaria parasitemia. This information is therefore relevant to the proper management of malaria infection.

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