

SJMLS-4(3)-013

The Association of ABO and Rhesus D Blood Groups with Malaria Parasitaemia among Residents in Sokoto, North Western, NigeriaIbrahim, A.B.¹, Abubakar, A., Erhabor, O.¹, Udomah, F.P.¹, Yakubu, A.¹, Ibrahim, K.K.¹, Buhari, H.A.¹, Onuigwe F.U.¹ and Abubakar, S.²*Department of Haematology, School of Medical Laboratory Sciences, Usmanu Danfodiyo University, Sokoto¹, Women and Children Hospital, Gombe State, Nigeria².**Author for Correspondence: aliyubagudo1@gmail.com/+234-706-276-6659.***Abstract**

Malaria is a life-threatening disease that is common in both tropical and subtropical regions of the world. This study investigated the association between ABO and Rh blood groups with malaria parasitaemia in Sokoto, Nigeria. A total of 221 blood samples were collected from subjects presenting with fever and suspected of having malaria infection using standards methods. Malaria parasite was identified by peripheral smear (thick film) and blood grouping was determined by forward and reverse grouping methods. Out of two hundred and twenty-one (221) subjects studied, 127 subjects were positive for malaria parasite. The distribution of ABO blood groups among the malaria parasitized subjects indicated that 36 were group A, 29 group B, 53 group O and 9 were group AB. The results of Rh blood group among the malaria parasitized subjects indicated that 33 were A+, 28 group B+, 9 group AB+, 47 group O+ and 3 group A-, 1 group B-, 0 group AB- and 6 group O- respectively. There was no statistically significant difference between ABO and Rh blood groups with malaria parasitaemia in Sokoto. Male subjects had the highest malaria prevalence of 72 (56.7%) compared to female subjects 55 (43.3%). Study subjects within the age group of 1-5 years had the highest prevalence rate of 44 (34.7%), while those between 36-40 years had the least prevalence rate of 3 (2.4%). Subjects with no formal education had the highest prevalence rate of 53 (41.7%), while the least prevalence rate was recorded among subjects educated to tertiary level 15 (11.8%). The highest prevalence of malaria positive subjects was observed among blood group O positive individuals followed by A positive, B

positive and AB positive. This study shows that blood group O positive individuals are more susceptible to malaria infection. The prevalence of malaria is higher among male and poorly educated subjects with no formal education.

Keywords: Malaria, ABO and Rhesus blood groups, Sokoto, Nigeria

Introduction

The ABO blood group system was first discovered in 1900 by Landsteiner (Avent and Reid, 2000; Greenweel, 1997). The ABO gene is located on the long arm of the ninth human chromosome (Al-Arrayed *et al.*, 2001). ABO blood group is divided into four major blood groups namely A, B, AB, and O group antigens present on the surface of their red blood cells (Conteras and Lubenko, 2001). All human population share the same ABO blood group system inherited from common ancestor but they differed by their frequency (Jorde and Wooding, 2004). Genotypic and phenotypic frequencies depend on the frequency of the alleles and mating. These vary among different race which furnish interesting question in population studies, anthropology and human genetic disease (Chakraborty, 2011).

The Rhesus factor is clinically the most important protein-based blood group system, with 49 antigens so far described. It is the largest of all 29-blood group systems, among which the five most important have been described (D, C, c, E, e). The unusually large number of Rhesus antigen is attributable to its complex genetic basis. The antigen proteins are located on two Rhesus protein-RhD and RhCE. Unlike proteins

of other blood groups, Rhesus proteins are expressed only in the membranes of red blood cells and their immediate precursor (Flegel *et al.*, 2003). Also, the human red blood cells that carry antigen D which is the most clinically significant may be either Rhesus positive (Rh⁺), while those without it are Rhesus negative (Rh⁻) (Conteras and Lubenko, 2001).

Malaria is caused by an obligate intracellular protozoan parasite of genus plasmodium of the four species that infect human (*plasmodium falciparum*, *plasmodium vivax*, *plasmodium ovalae*, *plasmodium malariae*). *P. falciparum* is responsible for high mortality (Pathirana *et al.*, 2005). Despite the high morbidity and mortality, certain individuals living in malaria endemic regions appears relatively protected compared to those who suffer frequent severe malaria attacks. Resistance to malaria infection is dependent on the development of an immune response by the host and to a varying extent, on a certain innate characteristic possessing protective value against infection (Cserti and Dzik, 2007).

Since the discovery of blood group, there have been enormous efforts to elucidate a possible association between ABO and Rh blood groups and different relationally-enriched disease. The virulence of *P. falciparum* has been associated with the capacity of the infected red cell to adhere to uninfected red blood cells leading to rosetting of cells (Carlson *et al.*, 1990). Blood group antigen A and B are trisaccharide attached to a variety of glycoprotein and glycolipid on the surface of erythrocytes and this are thought to act as receptors for uninfected erythrocytes and bind to parasite rosetting ligand such as PfEMP-1 and sequesterin (Martin *et al.*, 1979). However, blood group antigen A and B are not expressed in blood group O individuals. A rosette formed by blood group A or B erythrocyte (Daniel, 2005). Previous studies have implicated the blood group type in rosetting (Thakur and Verma, 1992). Clinical report of ABO blood and *P. falciparum* infection reveals a correlation between disease severity and ABO blood group. However, several studies carried out were unable to link ABO blood groups to the incidence of malaria or to the repeat attacks of malaria (Singh *et al.*, 2015; Facer and Brown, 1971). Hence, results of more studies on malaria

parasitaemia in different parts of the country would be needed before a more definite statement on the apparent trend could be made (Ilozumba and Uzozie, 2009).

Materials and Methods

Study Area

Sokoto state, which is in the extreme Northwest of Nigeria between longitude 05° 11' to 13° East and latitude 13° 00' to 13° 06' North. The state shares borders with the Republic of Niger to the North, Kebbi to the West and Southeast and Zamfara to the East. The state covers a land area of about 60.33km², and based on 2006 census, the state had a population of 3,696,999. Sokoto state has an annual average temperature of 28°C (82.9°F). Sokoto is, on a whole, a very hot area. However, maximum daytime temperatures are most of the year generally under 40°C (104.0°F). The warmest months are February to April when daytime temperature can exceed 45°C (113.0°F). The rainy season is from June to October during which showers are a daily occurrence, although rarely last long compared to that of the wet tropical regions. There are two major seasons; wet and dry which are distinct. The indigenous inhabitants of the area are the Hausas and Fulanis. Other ethnic groups resident in the area include Igbo, Yoruba, Ebira, Igala, as well as Buzus from the neighboring Niger Republic. Hausa is the commonly spoken language. Farming and crop production are the major occupation of the people living in the study area. Major crops grown include millet, sorghum, groundnut, cowpea and tobacco. Livestock reared include cattle, sheep, goat, donkey, camel, horses and poultry.

Study Population

The study consists of 221 subjects that presented Sokoto Specialist Hospital with fever. They were tested for malaria infection using Thick blood film light microscopy method.

Inclusion Criteria

All consenting individuals presenting with fever and suspected of having malaria infection were recruited as subjects for this study.

Exclusion Criteria

All subjects presenting without fever and not suspected of having malaria and those not

willing of giving a verbal informed consent were excluded from the study.

Sample Size Determination

The sample size for the study was determined using the standard formula for calculation of minimum sample size.

$$n = (Z^2 Pq) / d^2$$

Where: n = the minimum sample size

Z = the standard normal deviate, usually set at 1.96, which corresponds to the 95% confidence and P = the current prevalence rate of malarial parasitaemia is 17.5% (0.175) (Nmadu *et al.*, 2015).

$$q = 1 - p$$

d = degree of accuracy desired, usually set at 0.05

$$n = 1.96^2 \times 0.175 (1 - 0.175) / 0.05^2$$

$$n = 3.8416 \times 0.175 \times 0.825 / 0.0025$$

$$n = 0.55 / 0.0025$$

$$n = 221$$

The calculated sample size = 221

Study Design

This was a cross-sectional study that investigated the association between malaria parasitaemia and ABO and Rhesus D group among 221 consecutively recruited subjects presenting to Sokoto Specialist Hospital with fever and suspected of having malaria.

Ethical Approval

The ethical approval for this research was obtained from the Ethics and Research committee of Sokoto State Specialist Hospital, Sokoto.

Informed Consent

Written informed consent for inclusion into the study was obtained from each participant using a standard informed consent form.

Questionnaire

At the point of enrolment, a standard interviewer-administered questionnaire was used to collect the subject's socio-demographic and other bio-data.

Sample Collection

Two milliliters of venous blood were collected by venipuncture using aseptic technique from each subject. The blood was dispensed into Ethylene-Diamine-Tetra-acetic-Acid (EDTA)

container, it was properly mixed by standard method and labeled appropriately.

Laboratory Methods

Thick blood film

Thick blood films are prepared and stained with Giemsa stain, which contains essential azure B and eosin dyes, according to method described by (Cheesbrough, 2005).

ABO and Rh Blood Group Typing

The ABO and Rh blood group of each subject was determined using cell grouping Antisera (Agappe Diagnostic Ltd, India), using a slide method, according to method described by Cheesbrough (2005).

Principle of the method

The ABO antigens are primarily glycolipids which are found on the surface of human red blood cells as well as in association with other body tissues. The forward typing antigen-antibody reaction results in visible agglutination of red cells determining the A, B and AB. No agglutination with anti-A, anti-B, determines the group O (Arlington, 1985).

Statistical Analysis

The data collected was analyzed using Statistical Package for Social Sciences (SPSS) windows version 21. The association between Malaria parasitaemia and ABO and Rhesus D blood group was determined using Chi Square analysis. The percentage was also determined and the results were presented in tables. A p-value of ≤ 0.05 was considered statistically significant.

Results

A total of two hundred and twenty-one (221) subjects presenting to Sokoto Specialist Hospital with fever and suspected of malaria infection were recruited into the study. Out of the 221 subjected screened, a total of 127 individual tested positive for malaria parasitaemia given a prevalence rate of 57.5%. Table 1 shows the distribution of ABO blood group in association to malaria parasitaemia. The distribution of ABO blood group among subjects infected with malaria parasite indicated that blood group O subjects recorded the highest prevalence rate of 53 (41.7%), followed by blood group A 36

(28.4%), then blood group B 29 (22.3%). The least prevalence rate was recorded among blood group AB 9 (7.1%). There was no statistical significance difference between ABO blood group and malaria parasitaemia ($p>0.05$). Table 2 shows the distribution of Rhesus D blood group in association to malaria. The distribution of Rh D blood group among subjects infected with malaria parasite showed that the prevalence rate was highest in blood group O Rh positive 47 (37.0%), followed by blood group A Rh positive 33 (26.0%). While the least prevalence rate was recorded among blood group B Rh negative 1 (0.8%) and none was recorded among AB Rh negative 0 (0.0%). There was no statistical difference between Rh blood group and malaria parasitaemia ($p>0.05$).

Table 3 shows the distribution of malaria parasitaemia based on the gender of the subjects.

The prevalence rate was highest among males 72(56.7%) while the least was recorded among females 55 (43.3%). Table 4 shows the prevalence of malaria parasitaemia among different age groups. Individuals within the age group between 1-5 years had the highest prevalence rate of 44 (34.7%), followed by 6-10 years with 25 (19.7%), while the least prevalence rate was recorded among the age group between 36-40 years 3 (2.4%). Table 5 shows the prevalence of malaria parasitaemia in relation to educational status. The prevalence of malaria parasitaemia in relation to educational status showed that the highest prevalence rate was recorded among subjects with no formal education 53(41.7%), followed by primary education 37(29.2%) while the least prevalence was observed among subjects educated to tertiary level 15 (11.8%).

Table 1: The Distribution of ABO blood group in association to Malaria Parasitaemia

ABO Blood Group	Total No. of Subjects	Malaria negative	Malaria Positive	Percentage (%)	p-value
A	60	24	36	28.4	>0.05
B	53	24	29	22.8	
AB	13	4	9	7.1	
O	95	42	53	41.7	

Table 2: Distribution of Rhesus D Blood group in association to Malaria among Study Subjects

Rhesus D blood group	Total No. of samples	Malaria negative	Malaria positive	Percentage %	p-value
A Positive	53	20	33	26.0	>0.05
A Negative	7	4	3	2.4	
B Positive	49	21	28	22.0	
B Negative	4	3	1	0.8	
AB positive	11	2	9	7.1	
AB negative	2	2	0	0.0	
O positive	87	40	47	37.0	
O negative	8	2	6	4.7	

Table 3: Distribution of Malaria Parasitaemia based on Gender

Gender	Malaria infected	Percentage (%)
Male	72	56.7
Female	55	43.3
Total	127	100

Table 4: Prevalence of Malaria Parasitaemia among different Age group

Age (Years)	Frequency of malaria infected individuals	Percentage (%)
1-5	44	34.7
6-10	25	19.7
11-15	15	11.8
16-20	5	3.9
21-25	10	7.9
26-30	10	7.9
31-35	5	3.9
36-40	3	2.4
41-45	6	4.7
46 and above	4	3.1

Table 5: Prevalence of Malaria Parasitaemia in Relation to Educational Status of the Subjects

Educational status	Malaria positive	Percentage (%)
Non- formal education	53	41.7
Primary	37	29.2
Secondary	22	17.3
Tertiary	15	11.8
Total	127	100

Discussion

The present study was carried out to determine the association between the ABO and Rh D blood groups with malaria infection among study subjects. Out of two hundred and twenty-one (221) subjects tested for malaria parasite, one hundred and twenty-seven (127) subjects were positive for malaria. This study showed that the incidence of malaria infection was generally higher in blood group O (41.7%) than blood group A (28.3%), B (22.3%) and AB (7.1%) respectively. We observed that there was no statistically significant association between malaria parasitaemia and ABO blood group ($p > 0.05$). Our finding is contrary to the findings of Pathirana *et al.* (2005) in research conducted in Sri Lanka which reported that there was low percentage of blood group O (23.8%) and higher percentage of blood group A (32.5%) patients with severe malaria as compared to those with other blood groups. Our observation is possibly due to the fact that majority of the study subjects were blood group O. This study also shows that maximum number of malaria cases was recorded among blood group O positive (37.0%), followed by blood group A positive (26.0%), B positive (22.0%) and AB positive (7.0%) and least in blood group B negative (0.8%). Our observed high incidence of malaria in blood group O positive (37.0%) is consistent with previous reports (Singh *et al.*, 2015; Tewodros *et al.*, 2011). The incidence of A positive malaria parasitaemia (25.9%) in this study is in contrast to that reported in the study carried out by Singh *et al.* (2015). The incidence of malaria among blood group B positive subjects in this study was also at variance with those reported in a study carried out by Singh *et al.* (2015) and Deepa *et al.* (2011) with an incidence rate of 40.97% and 42% respectively. Similarly, fewer incidences were recorded in this study among O Rh negative (4.7%), A Rh negative (2.4%) and B Rh negative (0.8%) subjects. No malaria parasite was recorded in AB Rh negative. It was also found that there is no any statistical association between malaria parasitaemia and Rh D blood group ($p > 0.05$).

Generally, the rate of malaria infection was higher among males (56.7%) than females (45.28%). This study is similar with the results

obtained by the previous research of malariologist which found more malaria cases in males than in females (Gupta and Chowdhuri, 1980). This might be as results of males are always out for their day to day activities to cater for the family and therefore, they are more exposed to mosquito bites than females that are always indoor in this region of study. The study shows that there was high rate of malaria infection among the age groups 1-5 and 6-10 years and least rate at the age range of 36-40 years and 46 and above years. The finding is similar with the results obtained by Yahaya *et al.* (2012) but contrary with the result obtained by Tela *et al.* (2015) which showed a high rate of malaria among the age groups 26-35 and 16-25 years and least rate at the age range of 56-65 years. This difference might be attributed to the fact that considering the nature of their age, children and adolescents are more susceptible to malaria infection than adults due to their low immune system against malaria infection. Also, adults are more likely to protected against mosquito bites by ensuring they slept in insecticide-treated mosquito nets and insecticide treated rooms. These may be the reasons for the low prevalence of malaria infection among adults compared to children.

The prevalence of malaria parasitaemia in relation to educational status showed that highest prevalence rate was recorded among subjects with no formal education 53(41.7%), followed by primary education 37(29.2%), while the least prevalence was recorded among subjects with tertiary education 15 (11.8). This could be because the educated subjects are aware of the infection and know the possible ways to protect themselves against the infection than those with no formal education. They are more likely have access to finances to afford insecticides treated mosquito nets and prophylaxis to protect them from malaria infection. They are also more likely to be involved in environmental sanitation and live in clean environment that does not facilitate the breeding of mosquitoes.

Conclusion

In conclusion, ABO and RH blood groups of subjects in this study showed different susceptibility to malaria infection. The highest

number of malaria infection was observed among blood group O positive subjects followed by A positive, B positive and then AB positive subjects. The prevalence of malaria infection was higher among the male gender. Children and subjects with no formal education were more prone to malaria infection.

Recommendation

Based on the observation in this study we recommend that the susceptible blood groups to be careful of their exposure to mosquitoes' bites so as to prevent them to come down with malaria infection. There is need for the Nigerian and Sokoto State government to invest on enlightenment campaign to encourage people to keep their environment clean to prevent the breeding of mosquitoes. There is also the need to provide the people in the area long lasting insecticide -treated mosquito nets as well as prophylaxis particularly for young children and pregnant women against malaria.

Limitation

This study was not adjusted for confounding factors/ variables such as haemoglobinopathies and alpha-thalassemia. Also, this study was not case- controlled.

Conflict of Interests: Authors declare that no conflict of interests exists.

References

- Al-Arrayed, S., Shome, D.K., Hafadh, N., Amin, S., Al -Mukhareq, H. and Al-Mulla, M. (2001). ABO blood group and Rh d phenotypes in Bahrain: result of screening school children and blood donors. *Bahrain Medical Bulletin*;23: 27.
- Arlington, V.A. (1985). American association of blood banks 9th edition. Technical Manual; 25: 60-62.
- Avent, N.D. and Reid Marion, E. (2000). The Rh blood group system: a review. *Blood*; 95: 375-387.
- Carlson, J., Helmbly, H., Hill, A.V., Brewster, D., Greenwood, B.M. and Wahlgen, M. (1990). Human cerebral malaria: association with erythrocyte resetting and lack of anti-resetting antibodies. *Lancet*; 336: 1457-1460.
- Chakraborty, S. (2011). Heterozygosity and Fixation Index for ABO Gene in Barak Valley populations. *Notulae Scientia Biologicae*;3(1): 7-11.
- Chesbrough, M. (2005). Haematological test in: District Laboratory Practice in Tropical Countries (Part 2). Cambridge University Press: 267-347.
- Conteras M. and Lubenko S. (2001). Immunohaematology; Postgraduate Haematology. London UK; 4(11):164-181.
- Cserti, C.M. and Dzik, W.H. (2007). The ABO blood group system and *plasmodium falcifarum* malaria. *Blood*; 110:2250-2258.
- Daniel, G. (2005). The molecular genetics of group polymorphism. *Transplant Immunology*.14:143-153.
- Deepa, A.V.A., Rameshkumar, K. and Ross, C. (2011). ABO blood groups and malaria related clinical outcome. *Journal of Vector Borne Disease*; 48: 7-11.
- Facer, C.A. and Bruwn, J. (1971). ABO blood group and *falciparum* malaria. *Transaction of the Royal Society of Tropical Medicine and Hygiene*; 73:599-600.
- Flegel, W.A., Wagner, F.F., Eckhardt, C. and Kiefel, V. (2003). Blutgruppen: Alloantigene auf Erythrozyten Transfusions Medizin. *Springer*: 145-185.
- Greenwell, P. (1997). Blood group antigens; Molecular seeking a function. *Glycoconjugate Journal*; 14: 157-173.
- Gupta, M. and Chowdhuri Rai, A, N. (1980). Relationship between ABO blood groups and Malaria. *Bulletin of the World Health Organization*; 58(6): 913-915.
- Ilozumba, P.C.O and Uzozie, C.R. (2009). Prevalence of malaria parasitaemia and its association with ABO blood group in Odoakpu Area of Onitsha South Local Government Area, Anambra State Nigeria. *Nigerian Journals of Natural Science*. 8(2):1-8.
- Jorde, L. and Wooding, S. (2004). Genetics variation, classification and Race. *Natural Genetics*; 36:28-33.
- Martin, S.K., Miller, L.H., Hick, C.U., David, W.A., Ugbode, C. and Deane M. (1979). Frequency of blood group antigen in Nigerian children with *falciparum* malaria; *Transaction of the Royal Society of Tropical*

- Medicine and Hygiene*; 73: 216-218.
- Nmadu, P.M., Peter, E., Alexander, P., Koggie, A.Z. and Maikenti, J.I. (2015). The prevalence of malaria in children between the age of 2-15 Visiting Gwarinpa General Hospital Life-Camp, Abuja. Nigeria. *Journal of Health Science*; 5(2):47-51.
- Pathirana, S.L., Alles, H.K., Banadara, S., Phone-Kyaw, M., Penera, M.K., Wickremasinghe, A.R., Mendis, K.N. and Handunnelti, S.M. (2005). ABO blood group types and protection against severe malaria. *Annals of Tropical Medical Parasitology*; 99:119-124.
- Singh, G., Urhekar, A.D. and Singh, R. (2015). A study on correlation of malaria infection with A, B, O, Rh blood group system. *Journal of Parasitology and Vector Biology*. 7(4): 67-73.
- Tela, I.A., Moddibo, M.H., Adamu, L.H. and Taura, M.G. (2015). Prevalence of Malaria Infection Among ABO Blood Groups In Jama'are, Nigeria. *RA Journal of Applied Research*.1:255-262
- Tewodros, Z., Abraham D. and Berhanu, E. (2011). Association of ABO and *Plasmodium falciparum* malaria in Dore Bafeno Area, Southern Ethiopia. *Asian Pacific Journals of Tropical Biomedicine*;1(4):289-294.
- Thakur, A. and Verma, I.C. (1992). Malaria and ABO blood groups. *Indian Journal of Malariology*. 29:241-244.
- Yahaya, A., Aminu, F. and Tukur, A.I. (2012). Seasonal Variation of Malaria Infection among out-patients attending Wudil General Hospital, Kano State, Nigeria. *International Journal of Applied Research and Technology*;7: 79 – 84.

Citation: Ibrahim, A.B., Abubakar, A., Erhabor, O., Udomah, F.P., Yakubu, A., Ibrahim, K.K., Buhari, H.A., Onuigwe F.U. and Abubakar, S. The Association of ABO and Rhesus D Blood Groups with Malaria Parasitaemia among Residents in Sokoto, North Western, Nigeria. *Sokoto Journal of Medical Laboratory Science*;4(3): 100 - 107.

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