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Frequency Distribution of Hemoglobin Variants, ABO and Rhesus Blood Groups among Students of African Descent

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Research Article

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ABSTRACT

Background: Hemoglobin variants, ABO and Rhesus blood groups are known to vary from one population to another. This study therefore sought to study the frequency of these indices among a cohort of Nigerian University students of African descent. The result will serve as a platform for instituting genetic counseling services with a view to reducing hemoglobinopathies.
Methods: Two hundred consenting students were recruited and screened for hemoglobin variants by standard alkaline cellulose acetate electrophoresis. ABO and Rhesus blood groups were determined by the hemagglutination technique.
Results: Of the 200 students aged 18 – 25 years that were screened, 123 (61.5%) were males and 77 (38.5%) were females. Those with blood group O were the most prevalent (45%) followed by groups A (25.5%), B (25%) and AB (3.5%). Only 2 genotypes HbAA (78.5%) and HbAS (21.5%) were reported in this study. Rhesus D antigen was positive for 94% and negative for 6% of the study population.
Conclusion: The frequency of ABO and Rhesus blood groups appeared to be stable and consistent with reports from previous studies in Nigeria. Blood group O was the most prevalent. This also means there is a large pool of ''apparently'' universal blood donors in this population. There was only one genotype variant reported (HbAS). This could imply a decline in hemoglobinopathies among Africans. Therefore the culture of genetic counseling must be encouraged and sustained.

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Keywords: Frequency, blood groups, ABO, Rhesus, genotype, hemoglobinopathies;

ABBREVIATIONS

HbAA - homozygous hemoglobin with two normal genes; HbAC - heterozygous hemoglobin with one normal gene and one variant gene that causes mild chronic hemolytic anemia; HbAS - heterozygous hemoglobin with one normal gene and one sickle cell disease gene; HbSC - heterozygous hemoglobin with one sickle cell disease gene and one variant gene that causes chronic hemolytic anemia; HbSS - homozygous hemoglobin with two sickle cell disease genes.

1. INTRODUCTION

Although about 400 blood grouping antigens have been reported, ABO and Rhesus (Rh) being the 1st and 4th to be discovered respectively are the most frequently studied genetic markers in humans (Enosolease and Bazuaye, 2008). Apart from their importance in blood transfusion practice, they are useful in genetic studies of populations and also resolving medico-legal issues like disputed parentage (Enosolease and Bazuaye, 2008). Some studies have also reported their association with certain pathological conditions; for example a higher prevalence of stomach cancer among people with blood group A (Akhigbe et al., 2009) and higher vulnerability to malaria among those with hemoglobin genotype HbSS (Uzoegwu and Onuorah, 2003).

Blood groups are based on antigens that are located on red blood cell (RBC) membranes and are coded by alleles on different loci on a chromosome. Individuals are divided into 4 major blood groups namely A, B, AB and O groups depending on the antigen present on their RBCs (Conteras and Lubenko, 2001; Knowles and Poole, 2002). Type A blood has type A antigens and type B antibodies while type B blood has type B antigens and type A antibodies. Blood type AB has both A and B antigens and none of their antibodies while type O blood has neither A nor B antigens but both A and B antibodies. These groups are not equally distributed among humans. In most cases group O predominates followed by group A (Adeyemo and Soboyejo, 2006).

The human red blood cells that carry antigen D are referred to as Rhesus positive (Rh+) while those without it are Rhesus negative (Rh-) (Conteras and Lubenko, 2001). This antigen is immunogenic inducing an immune response in 80% of D negative (D-ve) individuals when transfused with D-positive blood. It is also the major cause of hemolytic disease of newborns (Egesie et al., 2008). Generally only a few percentage of humans are Rh-ve. This condition has been reported to be 5.5% in South India, 5% in Nairobi, 4.8% in Nigeria and 7.7% in Rawalpindi (Adeyemo and Soboyejo, 2006). ABO and Rhesus blood groups are known to be clinically very important. Their frequencies give an insight into the underlying genetic and ethnic diversity of human population (Khan et al., 2009). Another important blood component is the hemoglobin genotypes that determine hemoglobinopathies. Hemoglobin is the oxygen carrying pigment of the red blood cells. Defects in its genes can produce abnormal hemoglobin which leads to conditions known as hemoglobinopathies. Hemoglobin genotypes include the normal hemoglobin and the most occurring referred to as hemoglobin A (HbA) genotype and other abnormal ones like hemoglobin S (HbS), which is a variant form of hemoglobin. The variation is in the β –chain

gene, causing a change in the properties of hemoglobin which results in sickling of red blood cells. Another variant is hemoglobin C (HbC), which also occurs as a result of a variation in the β-chain gene. This variant causes a mild chronic hemolytic anaemia. The heterozygous hemoglobin of most individuals is HbAA (normal), with other variants like HbAS (sickle cell trait), HbAC, HbSS (sickle cell disease), HbSC. These variants cause moderate to severe hemolytic anemia leading to high degree of morbidity and mortality (Akhigbe et al., 2009; Patel et al., 2009). Although heterozygotes are symptoms free, they present specific hematological characteristics that are useful for their identification (Erhabor et al., 2010).The World Health Organization (WHO) figures estimate that 6% of the world population is a carrier for Hemoglobin disorders (Patel et al., 2009). The highest prevalence of sickle cell disorder is found among people of African or Caribbean descent and may occur among those from the Eastern Mediterrenean, Middle East, India and Pakistan (Erhabor et al., 2010). The result of this study will therefore form the basis for providing genetic counseling services to students on matters that concern crucial decisions like marriage and blood transfusion which will help to reduce hemoglobinopathies and hemolytic diseases. This in turn will be reflected by the drop in morbidity and mortality from such conditions.

2. MATERIAL AND METHODS

2.1 SAMPLE COLLECTION

A total of 200 students were selected randomly from among students of the Department of Microbiology, Nasarawa State University, Nigeria. Using a disposable needle and syringe, 2ml of blood was collected from each student by venipuncture and transferred into a labeled ethylenediamine tetraacetic acid (EDTA) containing bottle.

2.1.1 ABO AND RH BLOOD GROUPING

For the ABO and Rh blood group determination, a drop of blood from each student was dropped on a clean white tile in 3 places in a row. A drop of anti A, anti B, and D (from Biotech Laboratories monoclonal, UK) was added respectively and mixed with each blood sample using glass rods. Blood groups were determined on the basis of agglutination of test serum by the respective antiserum.

2.1.2 BLOOD GENOTYPING

Genotypes were determined using the cellulose acetate electrophoresis technique. A small quantity of blood was placed on a tile and mixed with two drops of water to lyse. With the aid of an applicator, the hemolysate was placed on the cellulose acetate paper and electrophoresced in Tris buffer solution for 15-20 minutes at 230v. Hemolysates from blood samples of known HbAS and HbAC were run as control.

2.2 ETHICAL CLEARANCE

This study was approved by the Nasarawa State University ethical committee and informed consent was obtained from the participants.

2.3 STATISTICAL ANALYSIS

Chi square test was used and a p value o < 0.05 was regarded as statistically significant.

3. RESULTS

Two hundred students were selected for this study of which 123 (61.5%) were males and 77 (38.5%) females between the ages of 19-28 years. Blood group O had the highest frequency of occurrence (Table 1).

Table 1: Distribution of ABO blood groups by sex among students of a tertiary institution in Nigeria

Sex	No. screened	Blood groups					
		O	A	B	AB	Rh+	Rh-
Male	123	54 (43.9%)	31 (25.2%)	34 (27.6%)	4(3.3%)	118 (96.9%)	5 (4.1%)
Female	77	38 (49.4%)	20 (25.9%)	16 (20.8%)	3 (3.9%)	70 (90.9%)	7 (9.1%)
Total	200	92 (46%)	51 (25%)	50 (25%)	7 (3.5%)	188 (94%)	12 (6%)
X^2		0.3056	0.0110	0.8922	1.0573	0.1273	1.9936
P-value		0.5804	0.9163	0.3448	0.8107	0.7213	0.1579

There was no significant difference in the blood group distribution between the male and female students (p>0.05). Most of the students (94%) were RhD positive and there was no statistical association between blood group and RhD status (Table 2).

Table 2: Distribution of RhD blood groups in relation to the ABO groups among students of a tertiary institution in Nigeria

Blood group	RhD positive	RhD negative
O	88 (44%)	4 (2%)
A	47 (23.5%)	5 (2.5%)
B	46 (23%)	3 (1.5%)
AB	7 (3.5%)	0 (0%)
Total	188 (94%)	12 (6%)
X^2	0.2079	3.2572
P-value	0.9763	0.3535

One hundred and fifty seven (78.5%) of the students had the HbAA genotype while no student had HbSS, HbAC or AbSC genotypes (Table 3). There was no statistically significant difference in the distribution of these genotypes among males and female students (p>0.05).There was also no association between the blood group systems and where the students come from (p ≥ 0.05) (Table 4).

Table 3: Distribution of Genotypes by gender among students of a tertiary institution in Nigeria

Sex	Hemoglobin genotype					
	HbAA	HbAS	HbSS	HbAC	HbSC	Total
Male	95 (47.5%)	28 (14%)	0	0	0	123
Female	62 (31%)	15 (7.5%)	0	0	0	77
Total	157 (78.5%)	43 (21.5%)	0	0	0	200
X^2	0.0650	0.2375				
P-value	0.7987	0.6260				

Table 4: Phenotypic distribution of ABO and Rh blood group systems by zone among students of a tertiary institution in Nigeria.

Zone	Blood groups							
	O	A	B	AB	Total	Rh+	Rh-	Total
North	17 (8.5%)	11 (5.5%)	10 (5%)	1 (0.5%)	39	39 (19.5%)	0	39
West	21 (10.5%)	20 (10%)	9 (4.5%)	1 (0.5%)	51	47 (23.5%)	4 (2%)	51
South	20 (10%)	11 (5.5%)	13 (6.5%)	1 (0.5%)	45	41 (20.5%)	4 (2%)	45
Others	29 (14.5%)	21 (10.5%)	10 (10%)	4 (2%)	64	61 (30.5%)	4 (2%)	65
Total	87 (43.5%)	63 (31.5%)	42 (21%)	7 (3.5%)	199	188 (94%)	12 (6%)	200
X^2	0.0912	1.8229	2.9826	1.9607				
P-value	0.9929	0.6099	0.3942	0.5805				

4. DISCUSSION

From this study blood group O was the most predominant group, occurring in 46% of the participants. It occurred in about 2 times the frequency of each of groups A (25.5%) and B (25%). Only 3.5% of the participants were of blood group AB which occurred the least.The gene frequencies with respect to ABO in this study can be represented as O>A>B>AB. Although the distribution of ABO blood groups varies from one population to the other, in most studies blood group O has been reported as the predominant group. For example among the Caucasians and blacks in United States it was reported as 47.0% and 46.0% respectively (Seeley et al., 1998). However, in Nepal group A has been reported as the most prevalent (Pramanik and Pramanik, 2000) while in Pakistan a study showed the predominance of group B (Hameed et al., 2002).

The findings from this study are in agreement with other studies in Nigeria which also reported group O as the most prevalent and group AB as the least. Bakare et al. (2006)

noted group O prevalence as 50% and AB as 5.9%, while Oluwadare and Shonekan (2008) reported group O in 53% and AB in 3.9% of their participants. Group O prevalence of 55% and AB of 2.7% was reported by Adeyemo and Soboyejo (2006). Even more recent studies from other parts of Nigeria have still reported the predominance of group O over the other blood groups with group AB being the least prevalent (Akhigbe et al., 2009; Erhabor et al., 2010; Gali et al., 2010). Even in a study among people living with HIV and AIDS, group O was reported in 50.6% and AB in 11.7% as the most and least prevalent blood groups, respectively (Abdulazeez et al., 2008). The high prevalence of group O individuals in nature is of great advantage because of their status as ''universal'' donors. It is pertinent to note that there has been an increase in the level of occurrence of blood demanding health conditions in many parts of sub-Saharan Africa (Uneke et al., 2005). However, some researchers (Jeremiah, 2005; Erhabor et al., 2010) have noted the misuse of the word ''universal donors'' .They advice that some level of caution be exercised in using blood group O in transfusion because some plasma contain A and B hemolytic antibodies (hemolysin). Erahbor et al. (2010) noted that plasma negative for high titer hemolysin could be given to those with groups A, B, and AB in emergency situations while that with high titer reserved for group O patients.

Gender was not found to have any association with the distribution of ABO and Rh systems and neither was there any association between ABO and Rh D occurrence (Tables 1 and 2). The frequency of the Rhesus blood grouping antigen in this study was found in 94.0% of the study population while the remaining 6% were Rhesus negative. This finding agrees with studies from other parts of Nigeria which reported positivity of 96.7% (Jeremiah, 2006), 94% (Adeyomo and Soboye, 2006), 97.7% (Bakare et al., 2006), 93.2% (Akhigbe et al., 2009) and 93% (Erhabor et al., 2010). The prevalence of Rh negative in this study was relatively high because most of the Nigerian studies reported 3.2% - 7% (Jeremiah, 2006; Bakare et al., 2006; Adeyomo and Soboyejo, 2006; Akhigbe et al., 2009; Erhabor et al., 2010). The relatively high percentage of the Rhesus negatives in the female population of this study (9.1%) is a cause for alarm because of its implication in the hemolytic disease of the newborns. This calls for health education programs for women of child bearing age and the inclusion of such a test at all levels of maternal and child welfare schemes.

Only hemoglobin genotypes HbAA and HbAS were reported in this population with a frequency of 78.5% and 21.5% respectively (Table 3). However, other studies in Nigeria have reported the presence of 3 – 6 genotypes (Jeremiah, 2005; Bakare et al., 2006; Adeyomo and Soboyejo, 2006; Akhigbe et al., 2009; Erhabor et al., 2010). The normal hemoglobin (HbAA) prevalence ranges from 55-75% while the sickle cell trait (HbAS) is 20-30% in Nigeria (Adeyemo and Soboyejo, 2006; Egesie et al., 2008). Apart from being higher than the reported range for Nigeria the HbAA frequency reported in this study is also higher than that observed by other researchers who reported 71.02% (Oluwadare and Shonekan, 2008) 68% (Bakare et al., 2006) 70% (Adeyemo and Soboyejo, 2006) and 66% (Egesie et al., 2008). The absence of the other hemoglobin variants especially the HbSS which is reported to be high in Nigeria (Erhabor et al., 2010) and the very high prevalence of HbAA implies that the sickling gene pool is gradually shrinking thus lowering the occurrence of hemoglobinopathies in the Nigerian populations. Probably more people are listening to the voice of reasoning by the numerous genetic counseling facilities in place. Gender had no effect on the incidence of the hemoglobin variants in this study ($p \geq 0.05$).

Similarly there was no association between the distribution of blood groups and geographical zones (Table 4). A similar observation was reported in a study in Adamawa state, Nigeria (Abdulazeez et al., 2008).

5. CONCLUSIONS

This study showed that the frequency of ABO blood group was stable in the study population. The report of only one genotype variant means there is a decline in hemoglobinopathies in the population. However, this study reported the highest frequency of rhesus negatives so far in any published Nigerian study.

Knowledge of the distribution of ABO, Rh blood groups and hemoglobin variants in any population is useful in health care planning, medical diagnosis, allocation of resources and targeting the population that need counseling. If such information is well managed it can make a difference in the quality of decisions that individuals will make especially as it concerns marriage, blood transfusion and other medical demands.

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