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Distribution of ABO and RH Genes in Nigeria

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Summary

Phenotype and gene frequencies of ABO and RH (D) systems were studied in 37,846 random blood donors in five zones of Nigeria (South West (Yoruba) -Zone A, North West (Hausa -Fulani) -Zone B, Plateau (Birom) -Zone C, South East (Igbo) -Zone D and North East (Kanuri) -Zone E). We assessed the micro differences of genetic markers of ABO and RH blood groups between the ethnic groups in the ABO and RH blood group systems. Gene frequencies were ABO *O = 0.7068, ABO *A = 0.1490, ABO *B = 0.1443, RH *D = 0.8150 and results are similar to those earlier reported.

Phenotype frequencies of the blood groups were in agreement with Hardy-Weinberg equilibrium expectations, except in two zones B and C where deviation was thought to be due to a high frequency of blood group AB.

Keywords: ABO, RH, Genes, Blood group

Résumé

Les phonotypes et les fréquences des gènes ABO et facteurs Rhesus ont été étudiés chez 37846 donneurs de sangs sélectionnés au hasard dans 5 zones du Nigeria (sud-ouest (Yoruba) - Zone A Nord-ouest (Hausa - Fulani) - Zone B, Plateau (Birom) - Zones C, Sud-est (Igbo) - Zone D et Nord-Est (Kamun). Zone E). Nous avons étudié les micro différences des marqueurs génétiques des groupes sanguins ABO et des groupes RH entre les groupes ethniques dans les groupes sanguins ABO et des facteurs Rhesus RH. Les fréquences des gènes ABO étaient ABO *O = 0.7068, ABO *A = 0.1490, ABO *B = 0.1443, RH *D = 0.8150 et les résultats étaient similaires à ceux rapportés auparavant.

Les fréquences de phonotypes des groupes sanguins étaient en accord avec l'équilibre de Hardy-Weinberg, à l'exception de 2 zones B et C où la déviation était pensée due à la forte fréquence des groupes sanguins AB.

Introduction

Nigeria can be considered a melting point of cultures and languages. The people are part of two larger groups of Negroids and the Hamites. The Hamites originally lived in the Sahara but moved away when it started to become desert. The Negroid moved to Nigeria from various forest

regions. Today, Nigerians are of mixed origins. There are at least 250 ethnic groups who came together as a political entity by the amalgamation of 1914 under Frederick Lugard. Five major ethnic groups were chosen out of these to represent this large conglomerate of people in the present study (Fig. 1). These include the Yorubas of the South West (Zone A), Hausa/Fulanis of the North West (Zone B), Birom/Tiv of the Plateau (Zone C), the Igbo of the South East (Zone D) and the Kanuris of the North East (Zone E). These different groups are characterised by distinct languages, marriage customs and religion [1].

The Yorubas Zone A (Ibadan)

The Yorubas are traditionally farmers in the forest Zone of the South West. The Yorubas, numbering about 26 million, are traditional farmers of Negroid origin in the forest zone of the South West. Ibadan the largest city, is at an altitude of 748ft located at 7° 26' N: 3° 54' E. The Yorubas are said to have originated from the Sudan. They are found in Oyo, Lagos, Ogun, Osun, Ondo, Ekiti and parts of Kwara, Edo and Kogi States of Nigeria.

The Hausa/Fulani Zone B (Sokoto)

The North West Zone consists mainly of the Hausa Fulanis. They number about 38 million people and live in the Sudan Savannah lands of Sokoto, Kano, Katsina, Bauchi, Adamawa and Taraba States.

Sokoto city has a high altitude of 1150 ft, located 13° 01' N: 5° 16' E. Historically, the Hausas can be traced to the King of Baghdad, the modern day Iraq in the Middle East. They are a mixed race of Negroid Berbers and Arab stock. They are predominantly herdsmen and grain growers.

The Birom/Tiv Zone C (Jos Plateau)

The Biroms and Tivs are the largest ethnic groups in the Guinea Savannah Hills. The Jos Plateau is at an altitude above 2000ft and has a population of about 6.8 million people of Hamite origin. These groups of people are also found in the Federal Capital, Abuja and parts of the Niger, Benue and Kaduna States. They are mainly peasant farmers.

The Igbo Zone D (Enugu)

The Igbo or Ibos numbering about 9.2 million people are traditionally farmers in the forest zone of the South East. Enugu, the capital city, is situated at an altitude of 745ft with a location at 6° 27' N: 7° 29' E. The Igbo are found mainly in Anambra, Abia, Ebonyi, Imo, Enugu and parts of Delta States. They are well grounded in commerce and have migrated to various parts of the country.

The Kanuri's Zone E (Maiduguri)

The Kanuris are the predominant ethnic group in the dry North Eastern Sudan Savanna part of Nigeria. The people first settled in the Chad over one thousand years ago. They are believed to have migrated from the Zaghawa desert to settle in the fertile Lake Chad. They also work in the Lake Chad - Trans-Arab Sahara trade route from North Africa. They are of the Negroid and Berber stock and are about 6.2 million in number. Maiduguri is at a high altitude of 1160 ft located 11° 51' N 13° 10' E. The people are mainly cattle rearers and nomads.

Some epidemiological studies have established association between ABO and RH genes with certain disease conditions. There are various contrasting reports with respect to the relationship between ABO blood groups and malaria which is endemic in Nigeria. Arthreya and Corriel [2], Ademowo

et al, [3] reported a protection against malaria infection in individuals with blood group B. However, Osisanya [4] did not find an association between ABO blood groups and malaria [5]. Another study in the Gambia indicated an association between blood group O and resistance to malaria. Since malaria is associated with high morbidity and mortality in Nigeria, it is essential that the exact frequencies of these blood groups be adequately documented in different ethnic groups in the country. Several studies have previously been carried out to estimate the proportion of ABO blood group antigens in Nigeria [6,7,8,9]. There are four blood groups (A, B, AB, and O) in the ABO system based on the presence or absence of antigenic determinants located on the red blood cells. The political and economic situation in Nigeria in the past three decades have however necessitated the movement to urban centres thus leading to more intermarriages between different ethnic groups in the larger cities. It is therefore essential to examine the effect of such admixture in the different major zones of Nigeria.

The present study is based on a large number of individuals in the five largest ethnic groups representing the four zones mapped out by the Federal Ministry of Health for its health programmes taking into consideration the ethnic diversity in Nigeria. The Jos, Plateau has been added as a fifth zone in our study because of its peculiar location at a high altitude and distinct physical and climatic features. The indication for this also stems from the report that most conditions that are associated with genetic factors may also be influenced by environmental factors [10]. The purpose of this report is to determine the genetic variations in the ABO and RH blood groups in the different ethnic groups in Nigeria and to compare the findings with previous data.

Material and Methods

Blood samples were randomly obtained by venepuncture at the Blood Bank Centres, where the donors of the relevant ethnic groups live. Most of the tests were unrelated males and both parents most times belonged to the same ethnic groups. The age of the donors ranged from 24 to 40 years. Samples were collected from five Teaching Hospital

centres in Ibadan, Sokoto, Jos, Enugu and Maiduguri.

These volunteers originated from the relevant predominant ethnic groups as indicated (Fig.1).

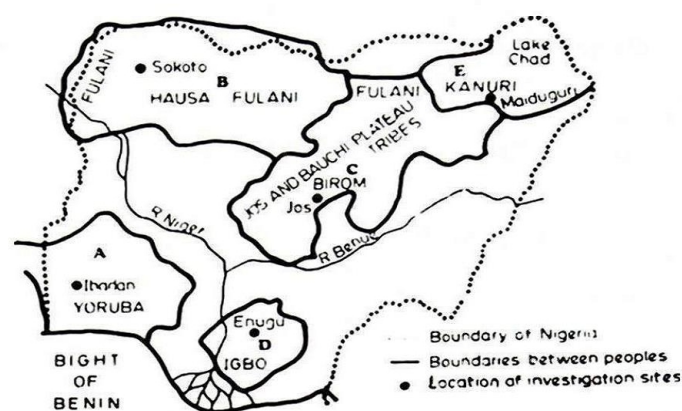


Fig. 1 Map of Nigeria showing the Location of the five zones studied

Tests were performed immediately after bleeding by standard test-tube and plate reaction techniques for ABO and RH blood group antigens [11]. Data collected from all centres were resorted and analysed according to the origin of birth. The gene frequencies were computed by the gene counting method [12].

Results and Discussions

The zones examined are as shown in Fig. 1. Phenotype and gene frequencies of the ABO and RH systems investigated are presented in Tables I & II. The figures for hospital patients in the present survey are essentially the same as those for random blood donors. This confirms that despite using blood donors at the University Teaching Hospital centres, the figures observed are indeed representative of the general population of the Nigerian tribes. The present survey involved 90 percent males. It is noteworthy however, that no connection has ever been discovered between sex and blood groups. The low proportion of female subjects should therefore not influence the results. The present study though with a relatively large number of individuals substantiates previously reported estimates of Worlledge *et al.* [6]

ABO System

Phenotype frequencies of the blood groups were in agreement with expected Hardy-Weinberg proportions, except in Zones B and C where observed deviation was due to high frequency of group AB. The reason for this significant deviation of the AB phenotype though difficult to explain, may be due to the observed high frequency of the B-gene in those areas where it combines with A gene to give a high AB phenotype. Demographic changes due to migration from other places may be responsible. It could also be partly due to the culture of the people which permits consanguinity within the families in that part of the country. These two zones are also contiguous such that inter-marriages are not uncommon. However further investigation to confirm the cause

of the finding needs to be carried out.

In this study, a homogeneous result (22-25%) was observed for the ABO *A gene between the zones. For the ABO *B gene, the lowest frequencies were recorded in the

Table 1: Phenotype distribution and Gene Frequency of ABO Blood Group System.

Ethnic Group (Site)	Phenotype	%	Observed n	Expected n	χ^2_1	Gene	Gene Freq. (x 10,000)
YORUBA (Ibadan)	O	49.9	8756	8751.46	0.002	A	1412
	A	22.0	3850	3858.36	0.018	B	1522
	B	23.9	4197	4174.05	0.005	O	7066
	AB	4.2	735	754.13	0.485		
TOTAL		17538	17538		$\chi^2_1 = 0.51$ (P>0.2)		
HAUSA/ FULANI (Sokoto)	O	46.7	2949	2969.46	0.141	A	1471
	A	22.2	1401	1389.96	0.088	B	1695
	B	27.3	1725	1642.68	4.125	O	6834
	AB	3.8	243	315.90	16.823		
TOTAL		6318	6318		$\chi^2_1 = 21.18$ (P<0.001)		
BIROM/ TIV (Jos)	O	41.5	1442	1459.92	0.198	A	1589
	A	23.0	799	799.48	2.882	B	1969
	B	30.6	1064	1008.04	3.107	O	6442
	AB	4.9	171	208.56	6.764		
TOTAL		3476	3476		$\chi^2_1 = 12.95$ (P<0.001)		
IGBO (Enugu)	O	56.9	2421	2425.92	0.010	A	1523
	A	25.3	1077	1054.00	0.502	B	0934
	B	15.3	650	638.40	0.211	O	7543
	AB	2.5	108	127.68	3.033		
TOTAL		4256	4256		$\chi^2_1 = 3.76$ (P>0.5)		
KANURI (Maiduguri)	O	55.6	3481	3473.19	0.018	A	1455
	A	23.7	1481	1483.15	0.003	B	1099
	B	17.3	1083	1101.41	0.308	O	7456
	AB	3.4	213	200.25	0.812		
TOTAL		6258	6258		$\chi^2_1 = 1.14$ (P>0.02)		

Inter-ethnic heterogeneity test between zones A,B,C,D,E

$$(\chi^2 = 630.2, df = 8, P < 0.0001).$$

South East (Zone D-15.3%) and the North East (Zone E-17.3%). The South West, Zone A, has 23% while the Central - Jos Plateau, Zone C differs significantly with the highest level of 30.6%. This is closely followed by the North West Zone B with 27.3%. The high ABO *B gene frequency in zones C and B may be explained by the contribution of 40.1% ABO *B gene from "Rukuba" a small local group in the Jos Plateau area [8] through migration the Gwari people of Kaduna with 38.8% ABO *B gene [13] may also contribute to the high proportion of the B gene by intermarriages with their neighbours within Zone B. The central Plateau/Kaduna areas of Nigeria can be regarded as the Epicentre of the *B gene diffusion in Nigeria. Each zone in the present study is characterised by a high frequency (42-57%) of the ABO *O gene. A cline of ABO *O gene increases from the North West (Zone B) 47% and West (Zone A) 50% to a maximum in the East (Zone D) 57% and the North East (Zone E) 56% with a deep of 42% in the Jos Plateau (Zone C). Although

the specific increases in the *B gene in Zone C and Zone B have contributed to the decrease in the ABO *O gene in these two Zones, the ABO *O gene still has the highest proportion in all the Zones studied. The chi-square values for the inter-ethnic heterogeneity test with respect to ABO ($\chi^2 = 630.3$) and RH ($\chi^2 = 688.6$) were found to be significant ($P < 0.0001$). This may be due to the observed differences in the

Table 2: Gene frequencies of RH blood group system

Zones	Phenotypes	Sample Size (n)	Phenotype (%)	RH d Frequency (x 10,000)
A	RH (D)	16505	94.11	
	RH (d)	1033	5.89	2427
	Total	17538	100	
B	RH (D)	6220	98.45	
	RH (d)	98	1.55	1245
	Total	6318	100	
C	RH (D)	3326	95.68	
	RH (d)	150	4.32	2078
	Total	4256	100	
D	RH (D)	4065	95.51	
	RH (d)	191	4.49	2119
	Total	4256	100	
E	RH (D)	6138	98.08	
	RH (d)	120	1.92	1385
	Total	6258	100	

Inter-ethnic Heterogeneity test between Zones A,B,C,D,E
($\chi^2 = 688.5, df = 4, P < 0.0001$).

frequencies of the B gene between the Zones. A separate study is currently on to consider the implication of the ABO *B gene epicentre, the ABO *B gene distribution and the influence on malaria infection in these different zones.

RH - System

The study records a low frequency of RH (d) in all the zones. The Northern Zones, B and E have the lowest proportion 1.6 and 1.9% respectively while the Western Zone A has the highest 5.0% with the other Zones C and D in between with 4.3% and 4.5% respectively.

The observed data on RH system is in contrast to that of the Eastern Highlands of Papua New Guinea where almost 100% of the population have RH (D) [14]. It is also dissimilar to that in Indians with a preponderance of the RH (d) of 89.7% over the RH (D) gene of 10.3% [15]. Our data is however quite similar to findings among Africans, West Indians and Blacks living in Britain [16,17]. It is also in consonance with the report that the frequency of RH (d) is often low in parts of the world where malaria is endemic [10].

The observation of a higher frequency of RH (d) in the Southern Zones A & D is similar to a previous finding [6]. This is important especially in relation to the ABO incompatibility in the new-born which may result in

erythroblastosis foetalis in RH (D) children conceived by Rh (d) mothers [18]. This finding should be taken cognisance of in the planning of the blood transfusion programmes in the different areas of the country.

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