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Original Article

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Frequency of ABO and Rhesus blood groups among blood donors in Lagos, Nigeria

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ABSTRACT

Background: The ABO is a blood group system that is responsible for most blood transfusion reactions, transplant rejections and determining some forensic cases. The ABO and Rhesus blood group systems have been shown to show variations in different part of the world and race. **Aim:** The study is to show the frequency of ABO and Rhesus blood groups amongst blood donors in Lagos, Nigeria and confirm Hardy-Weinberg equilibrium. **Methods:** This is a two-year retrospective study of all blood donors from the two major tertiary health institutions in Lagos State between July 2004 and June 2006. Data from the blood bank records were extracted and analysed using SPSS version 20. Hardy-Weinberg equation was used to confirm if the population is in equilibrium. **Results:** In all, 11,911 donors were analysed and showed A+ 20.4%, A- 0.97%, B+ 16.7%, B- 0.87%, AB+ 2.2%, AB- 0.17%, O+ 55.6%, O- 3.1% and RhD positive frequency is 95.6%. The allelic frequency in this study is O – 0.7631, A - 0.1303, B – 0.1066 and Rh – 0.7786. There is no significant difference between the blood group distributions from the two institutions. **Conclusion:** Blood group O was the commonest blood group seen followed by group A. This is at variance with other studies in Nigeria where blood group B was the second commonest. The population was also found to be in Hardy-Weinberg equilibrium. The study provides important and reliable geno-geographical information that can advance the fields of blood transfusion, organ transplantation and forensic medicine in Nigeria.

Key words: Blood group, ABO, Rhesus, allelic frequency, Hardy-Weinberg equilibrium, transfusion reactions

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INTRODUCTION

The blood group is a description of one's characteristics of red blood cell due to substances (carbohydrate and protein) on the cell membrane.[1] The two most important and common classifications of blood group in humans are the ABO and the rhesus factor (Rh factor).[1] There are 400 other human antigens, most of which are much rarer than ABO and Rh.[1]

The blood group is determined by the presence of antigens on the red blood cell surface.[1] Although these antigens are proteins, some of these proteins are attached with polysaccharides.[1] The ABO is a blood group system that is responsible for most blood transfusion accidents. It was among the first human traits proven to be Mendelian.[2] The ABO blood group system was first discovered by Landsteiner.[3] Later, Weiner (1939) defined the Rh-Hr system.[4] Together these two systems have proven to be of vast importance in blood transfusion.[5]

Reports from various racial and geographical areas have documented variations in the distribution of the blood group types. The blood group O is the commonest blood group globally; however blood group A is the commonest in Sweden and Norway.[6] The A antigen is commoner than the B.[6] The AB blood group is the most rare blood group since it requires the presence of both A and B antigens.[6]

Another blood group system is Rhesus blood group, which is named after the Rhesus monkey in which the rhesus factor was first identified by Landsteiner.[3] This factor is either present (indicated as '+' and described as rhesus positive, Rh+) or absent (indicated as '-' and described as rhesus negative, Rh-) on the red blood cell surface.

Rahman *et al.* concluded in their study that the variations in the distribution of the different phenotypes are important epidemiological data with regards to migration and inter-marriages.[5] The ABO and Rhesus blood group systems have been shown to show variations in different part of the world and race. In Nigeria, some studies have been done on them; among the few that were done, they showed not much difference with those from other parts of the world.

Enosolease and Bazuaye pointed out in their study that the discovery of ABO blood groups has contributed immensely to blood banking services and transfusion medicine in Benin, South Nigeria.[7] Alamgeer *et al.* in Pakistan submitted that the ABO blood system is one of the strongest predictors of national suicide rate and a genetic marker of obesity.[8]

Akhigbe *et al.* also related the type of ABO blood group to the rate and severity of malaria infection in Ogbomosho. They concluded in their study that blood group O has the highest frequency of malaria parasitemia but with lower prevalence of severe malaria when compared to non O blood groups.[9]

Lagos, the former capital city of Nigeria and the commercial nerve centre of the country is a cosmopolitan society where there is great influx of people from all parts of the country. Therefore this paper is to determine the ABO and Rhesus blood group frequencies among blood donors, the genetic and phenotypic frequencies of the blood group and to confirm if the population is in Hardy-Weinberg equilibrium.

METHODOLOGY

This is a retrospective descriptive study among blood donors at Blood banks of Lagos University Teaching Hospital (LUTH), Idi Araba and Lagos State Teaching Hospital (LASUTH), Ikeja, Lagos from July 2004 to June 2006. The data were extracted from the blood bank register and it included all blood donors in the register during the two year period including those voided due to infection by blood borne diseases.

At the blood banks in the hospitals, ABO and Rh typing was done using the ABO grouping and Rhesus Typing Antisera (Biotec Laboratories, United Kingdom). The procedure was in accordance with the manufacturer's guidelines. Two milliliters of blood was collected and allowed to clot at 37^0C and 40% suspension of test red cells in autologous serum was prepared for both ABO and Rh-D grouping.[10] A drop of anti-A, anti- B and anti-D was placed on a

labeled slide and a drop of blood sample was added to each slide and mixed. Findings of the agglutination test were recorded after mixing.[10]

The study was approved by the ethical committee of the institutions. Ethical procedures were followed in accordance with the ethical standards of the Lagos State University Teaching Hospital, Ikeja committee guidelines on data handling with the Helsinki Declaration of 1975, as revised in 1983.

Statistical analysis

The data were analysed using SPSS for Windows version 20 and presented in tables, percentages and the frequencies of the ABO gene and the Rh phenotypes were calculated using Hardy-Weinberg equation. The percentage and genotypic frequency of ABO and Rh blood groups in the two teaching hospitals were subjected to chi-square test and a *P*-value <0.05 was regarded statistically significant. The Hardy-Weinberg equation was also used to ascertain genetic equilibrium. Hardy Weinberg equation states that p + q + r = 1; and if the population is in equilibrium, the second generation is expected to show $(p + q + r)^2 = p^2 + q^2 + r^2 + 2pq + 2pr + 2qr = 1$, where p, q and r are allelic frequencies of A, B and O respectively.

RESULTS

A total of 11,911 blood donors were seen during the period of study and comprise blood donors in LUTH for the two years under review is 4,424. The first year under review, Year I (July 2004–June 2005) had 1,193 blood donors and the second year, Year II (July 2005–June 2006) had 3231 blood donors.

Table 1 shows blood group O has the highest frequencies of 666 (55.83%) and 1783 (55.18%) for the two years under review and blood group AB occurs with the least frequencies of 2.56% (27) and 3.59% (116) for the two years under review.

The total sample size of blood donors in LASUTH for the two years under review was 7,487.The first year under review, Year I had 4,588 blood donors and Year II had 2,899 blood donors.

Table 2 shows blood group O has the highest number of blood donors with 2712 (59.11%) and 1825 (63.00%) with blood group AB accounting for 74 (1.61%) and 62 (2.10%) for the two years under review. Rh + has the most frequency among all the blood groups and blood group AB Rh – is the rarest among blood donors.

Table 3 show the allelic frequencies showed highest value for blood group O followed by blood group A. This sequence in LUTH and LASUTH shows same pattern and the test for statistical significance is $p > 0.05$ showing no statistically significant difference in the two centres. Since there is no statistical difference between the data from LUTH and LASUTH an average allelic frequency in this study are A = 0.1303, B = 0.1066 and O = 0.7631 and RhD 0.7786 and Rhd 0.2214.

Table 4 shows homozygous A and B (AA and BB) are seen to have the least genotypic frequency, which is followed by Blood group AB. Blood group O also shows the highest genotypic frequency.

However, homozygous Rh +ve (DD) has the highest genotypic frequency and Rh –ve (dd) genotype has the least.

Table 5 shows group O having the highest phenotypic frequency in ABO system and Rh+ve in the Rh system. Since at the second generation, according to Hardy Weinberg equation, $(p + q + r)^2 = p^2 + q^2 + r^2 + 2pq + 2pr + 2qr = 1$. The summation of the frequencies is equal to 1, confirming that the population is in equilibrium. The difference between the percentages of blood group in the second generation from this table is statistically not significant from the frequencies of the blood groups of the donors. $p = 0.87$

DISCUSSION

The ABO and Rhesus blood group systems are the commonest blood group system considered in blood transfusion. These systems are also important in organ transplantations, hereditary diseases, genetics and in determining migration of races.[11] The blood group system has also been reported to be associated with some diseases/clinical conditions as some of the blood

groups are particularly prone to developing certain diseases.[11] Akhigbe *et al.* showed in their study that blood group AB showed the lowest frequency of malaria parasitemia while blood group A has the highest severe malaria cases. This is in their submission due to the ability of O antigen to impair sequestration and rosette formation, thus reducing adherence of parasitized red blood cells to the vasculature with consequent improvement of blood flow.[9]

Table 1: Frequency distribution of ABO and Rhesus blood groups of donors in Lagos University Teaching Hospital (LUTH)

Blood group	No. of Rh pos	No of Rh neg	Total	% frequency	No. of Rh pos	No of Rh neg	Total	% frequency	Mean % frequency
A	244	15	259	21.70	672	38	710	21.97	21.84
B	221	20	241	20.21	592	30	622	19.26	19.73
AB	24	3	27	2.56	107	9	116	3.59	3.08
O	626	40	666	55.83	1706	77	1783	55.18	55.51
Total	1115	78	1193	100	3077	154	3231	100	100
% Rh	93.5%	6.50%			95.23%	4.76%			

Table 2: Frequency distribution of ABO and Rh blood groups of donors in Lagos State University Teaching Hospital (LASUTH), Ikeja

Blood group	No of Rhesus (+)	No of Rhesus (-)	Total	% frequency	No of Rhesus (+)	No of Rhesus (-)	Total	% frequency	Mean % frequency
A	906	34	940	20.49	611	29	640	22.10	**21.30**
B	834	28	862	18.79	344	28	372	12.80	**15.80**
AB	72	2	74	1.61	56	6	62	2.10	**1.86**
O	2519	193	2712	59.11	1766	59	1825	63.00	**61.01**
Total	4331	257	4588	100.0	2777	122	2899		
% Rh	95.70	4.30			95.80	4.20			

Table 3: The allelic frequencies of ABO and Rh blood groups among blood donors in LUTH and LASUTH

Blood group	LUTH Year I	LUTH Year II	LASUTH Year I	LASUTH Year II	Average
A	0.1334	0.1356	0.1234	0.1288	0.1303
B	0.1194	0.1216	0.1078	0.0775	0.1066
O	0.7472	0.7428	0.7688	0.7937	0.7631
Rh D	0.745	0.7818	0.7926	0.7951	0.7786
Rh d	0.255	0.2182	0.2074	0.2049	0.2214

p=0.79

Table 4: Genotypic frequencies of ABO and Rh blood groups among donors from Lagos University Teaching Hospital (LUTH), Idi-Araba and Lagos State University Teaching Hospital, Ikeja

Blood Group			LUTH Year I	LUTH Year II	LASUTH Year I	LASUTH Year II	Average
A	AA	p^2	0.0178	0.0184	0.0152	0.016	0.0169
	AO	2pr	0.1994	0.2014	0.1897	0.2045	0.1988
B	BB	q^2	0.0143	0.0148	0.0116	0.0060	0.0117
	BO	2qr	0.1784	0.1806	0.1658	0.1230	0.1620
AB	AB	2pq	0.0317	0.0330	0.0266	0.2000	0.0278
O	OO	r^2	0.5583	0.5518	0.5911	0.6300	0.5828
Rh +ve	DD	p^2	0.5550	0.6112	06282	0.6322	0.6067
	Dd	2pq	0.3800	0.3412	0.3288	0.3258	0.3440
Rh –ve	dd	q^2	0.0650	0.0476	0.0430	0.0420	0.0494

Table 5: Phenotypic frequencies of ABO and Rh blood groups among donors from Lagos University Teaching Hospital, (LUTH), Idi-Araba and Lagos State University Teaching Hospital, Ikeja

Blood group		LUTH Year I	LUTH Year II	LASUTH Year I	LASUTH Year II	Average	Percentage %
A	$p^2 + 2pr$	0.2172	0.2198	0.2049	0.2211	0.2157	21.57
B	$q^2 + 2qr$	0.1927	0.1954	0.1774	0.1292	0.1736	17.36
AB	2pq	0.0319	0.0330	0.0266	0.0200	0.0279	2.79
O	r^2	0.5583	0.5518	0.5911	0.6300	0.5828	58.28
Rh +ve	$p^2 + 2pq$	0.9350	0.9524	0.9570	0.9580	0.9506	95.06
Rh –ve	q^2	0.0650	0.0476	0.0430	0.0420	0.0494	4.96

Enosolease and Bazuaye showed that the ABO system is useful in genetic studies of population and also in resolving medico-legal issues like disputed parentage.[7] From this study, the frequency of ABO and Rh phenotypes does not vary significantly in the data from LUTH and LASUTH. Blood group O is the most common blood group (58.26%) while blood group AB is the least common (2.47%). Bakare *et al*. at Ogbomosho, Nigeria showed blood group O has the highest frequency distribution of 50% although lower than the 58.28% in this study and they also found that blood group AB had the least frequency of 5.9% which is higher than the 2.47% in our findings.[12] Kulkami *et al.* showed 46.6% group O frequency in their study, a figure lower than that of this study.[13] Other studies in Africa show highest frequencies of group O of 48.62% and 49.10% by Ndoula *et al* and Hamed *et al.* respectively.[14,15] The frequencies of blood group AB in these studies are higher than that of this study, 4.45% and 4.05% against 2.47% in this study.

Akhigbe *et al.* in their study showed the prevalence of A+, A-, B+, B-, AB+, AB-, O+ and O- were 20.05, 1.25, 20.86, 1.87, 2.58, 0.27, 49.82 and 3% respectively which is similar to that seen in this study which showed 20.4, 0.97, 16.7, 0.89, 2.2, 0.17, 55.6 and 3.1% respectively; with blood group O+ as the most prevalent and AB- least prevalent.[16] Aird and Bentall found out that all South American Indians belong to blood group O and the commonest groups in Australian aborigines are O and A.[17] Also Frances in the United States of America showed, 46% of his test sample as blood group O which was the commonest and 4% were group AB.[18] In Saudi Arabia, 52% of the individuals are blood group O (commonest) and 4% were group AB.[19] Marzban *et al* also discovered that 41.16% are group O (the commonest) in Ahwaz, Iran.[20]

The findings in this study agree with the findings of Chandrasekhar and Sudarsan that blood group O is the commonest and blood group AB was observed as the least common.[21] This study showed that group A (21.57%) is more common than group B (17.77%). This finding agrees with the result of Iyiola *et al.* in Lagos and Omotade *et al.* in Ibadan, who found out the same pattern of frequency in their study.[22,23] This pattern is also similar to other African studies recording 28.28% versus 18.56%, and 25.07% versus 21.86% by Hamed *et al.* and Ndoula *et al.* respectively.[14,15] However, Kulkami *et al.* study in Northern Nigeria showed that group B (25.95%) was more common than group A (23.05%) and other studies by Eru *et al.* in Markurdi with B - 24.5% to A - 18.4%; Akhigbe *et al.* in Ogbomosho 22.73 to 21.30% ;

and Adeyemo and Soboyejo also in Lagos with 24.5% to 18.4%.[13,16,24,25] The higher frequency of B group compared to group A in the latter studies may be as a result of the relatively smaller population size of the subjects which were between 150 and 1672 subjects compare to our study with 11,911 subjects and that of Iyiola *et al.* with 23,832 subjects.[16,22,24,25] Although these variations may also be geographical.

The allelic frequency in this study however showed A* 0.1303, B* 0.1066 and O* 0.7631 (O >A >B). This sequence is at variance with two Nigeria studies by Falusi *et al.*[26] where B is higher than A (0.1554 to 0.1490) and Kulkami *et al.*[13] but it is in agreement with Khalil *et al.* where A> B(0.1914 to 0.1403).[27] The allelic frequency of O being 0.7631 is similar to that seen by Omatade *et al.*[23] 0.7393; and Falusi *et al.* 0.7068.[26]

The rhesus group showed a predominance of RhD all over the world which is confirmed in this study with 95.06% and allele frequency of 0.7786. Other studies in Nigeria by Bakare *et al.* showed (96.7%; 0.82), Omatade *et al.* showed (95.2%; 0.7809), as well as Kulkarni *et al*. which showed 96.36%.[12,13,23] Mollison *et al.* observed 95% Rhesus positive individuals in the English population.[11] Also, in the United States, 85% belong to the Rhesus positive group.[18] However, Chandrasekhar and Sudarsan discovered Rh negative frequency as low as (0.69%) for Andra Pradesh population.[21]

Following the use of Hardy-Weinberg equation for equilibrium, for the second generation, it was found that the phenotypic frequency of the ABO and Rh blood system are in equilibrium. This is seen in the average of Blood group A showing 0.2158 and O showing 0.5828. However, the changes seen that of B and AB are statistically negligible (p> 0.05). Hence the population can be said to be in equilibrium.

Lagos being a cosmopolitan city with expected influx of people daily, the pattern seen among the blood donors did not show that there is disruption of the Hardy-Weinberg equilibrium. This may be attributable to the fact that most of the patients that got admitted and hence needed to use blood and therefore require to provide donors are people that are fully resident within Lagos and the donors were not likely be fresh immigrants. Therefore the allelic frequency remained stable since other conditions for Hardy-Weinberg equilibrium are met.

It can also be concluded that in tertiary institutions in Lagos metropolis, the pattern of blood needed for their patients will not change over the generations which is important for health services planning especially blood banking and transplantation medicine.

CONCLUSION

Blood group O is the commonest blood group in Lagos. There are more people with blood group A than group B among blood donors. There is Hardy-Weinberg equilibrium in the population of the donors. The influx of people into Lagos is too infinite to distort the gene frequency of the population. This study also documents important geno-geographical information. With advancements in the field of transplantation and forensic medicine such population mapping can be of immense help. However, it is suggested that further study be carried out over a longer period of years and the haemoglobin variants of different sexes be analysed.

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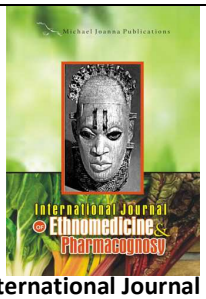

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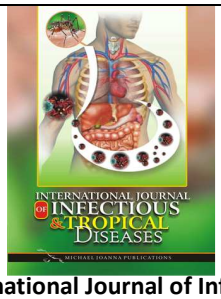

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