



Full Length Research Paper

Gene Frequencies of ABO and Rh (D) Blood Group Alleles in Minna, North - Central Nigeria.

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ABSTRACT

Due to its genetic and medical importance, information on distribution and prevalence of ABO and Rhesus blood type is germane in a society. There is dearth of information in Minna North-central Nigeria, it was thus imperative to study its prevalence and allelic frequencies of ABO and Rhesus blood types in the state. This investigation examined the prevalence and gene frequencies for the ABO and Rh (D) alleles in Minna North-central Nigeria, from January 2008 to December 2012 (5 years). Retrospective data for 13937 individuals were extracted over this period for prevalence of ABO and Rh blood groups. This was employed to evaluate the genotypic and allelic frequencies based on Hardy–Weinberg (H-W) equations. Chi-square goodness-of-fit test was also calculated to compare observed and expected frequencies. This study recorded prevalence rate of 44.457%, 25.544%, 19.294%, and 10.705% for O, A, B and AB blood group respectively while 96.721% and 3.279% were Rhesus D positive and negative respectively. Allelic frequencies of the ABO blood groups include O (0.667), A (0.170), B (0.163), and D (0.818) and d (0.182) for Rhesus D positive and Rhesus d negative respectively. On the other hand genotypic frequencies reported were 0.445, 0.029, 0.227, 0.027, 0.217 and 0.055 for OO, AA, AO, BB, BO and AB respectively. All frequencies reported in this study differ significantly from H-W equilibrium (goodness-of-fit χ^2 for ABO =819.58, df=3, $P \leq 0.05$ and goodness-of-fit χ^2 for Rh= 0.091, df =1, $P \leq 0.05$). This pioneering study on ABO and Rhesus blood types in Minna strengthens and corroborates the fact that there is genetic variation in ABO and Rhesus blood types. In future results from this study can act as baseline information for geneticist, clinicians and allied professional on the distribution of these germane blood types in Minna.

Keywords: Blood groups, Rhesus, alleles frequencies, gene frequencies.

INTRODUCTION

The ABO and Rhesus (Rh) blood system are the most important blood group system; they are one of the most polymorphic and immunogenic systems known in human. This makes them useful in genetics and medicine. Individuals who lack the A and/or B antigens on their red blood cells generally have naturally occurring antibodies in their plasma that are directed against the missing antigens. For this reason, ABO grouping should include both forward (cell) and reverse (plasma) procedures. Proper determination of the ABO group is necessary when selecting red blood cell-containing products for transfusion in order to prevent immediate hemolytic transfusion reactions, thus it is important in blood transfusion.

Study on blood grouping is germane because of its importance in evolutionary studies, its importance in its relationship with several diseases in gaining popularity by the day. Studies have shown and reported association between ABO blood group phenotype and relative risk of infectious and non infectious diseases which include malaria (Fry *et al.*, 2007; Panda *et al.*, 2011; Wolofsky *et al.*, 2012; Vigan-Womas *et al.*, 2012), sensitivity to *Helicobacter pylori* (Borén *et al.*, 1993) liver fibrosis (Shavakhi *et al.*, 2012), hemorrhage (Dentali *et al.*, 2013) cancer (Iodice *et al.*, 2010; Xie *et al.*, 2010), eye diseases (Khan *et al.*, 2009), skin diseases (Valikhani *et al.*, 2007), cardiovascular diseases (Skaik, 2009; Biswas *et al.*, 2013; Sode *et al.*, 2013), diabetes (Koley, 2008; Okon *et al.*, 2008), Smallpox (Krieger and Vilente, 1969), Leprosy (Urade and Chakravarty, 1999) and Cholera (Swerdlow *et al.*, 1994) though the explanation for the association between ABO blood groups and disease is still unclear. In recent times, studies have shown that there could be relationship between ABO blood group and cancer though this seems to be limited to pancreatic cancer (Woo *et al.*, 2013; Pelzer *et al.*, 2013; Greer *et al.*, 2011; Iodice *et al.*, 2010).

ABO and Rh blood groups are valuable tools in contemporary medicine (blood transfusion, relationship with some diseases, organ transplantation and genetic polymorphism). This make them important during population genetics and anthropological studies (Sigmon, 1992) due to the fact that they have ability to serve as genetic marker. The distribution of these two blood groups has been repeatedly investigated in various populations all over the world and their frequencies exhibited considerable variation in different geographic locations, reflecting the underlying genetic and ethnic diversity of human populations (Bakare *et al.*, 2006; Hanania *et al.*, 2007; Iyiola *et al.*, 2012; Rajshree and Raj, 2013.).

Several studies have been carried out on allelic frequency and distribution of ABO and Rh blood group in Nigeria (Bakare *et al.*, 2006; Iyiola *et al.*, 2012; Chima *et al.*, 2012) but there is dearth of information on allelic frequency and distribution of ABO and Rh blood groups in Minna Niger state, North-central Nigeria. The present study was therefore planned to investigate allelic frequency and distribution of ABO and Rh blood group in Minna. This will serve as source of information to Health care centers and blood banks in this area.

MATERIAL AND METHODS

Medical record from three Health centers namely General Hospital (GHP), Bay Specialist hospital (BSH), and Top Medical Hospital (TMH) in Minna over a period of five years (January, 2008 to December, 2012) was used in this study. Blood specimens were collected from patients and others who came for blood test.

Estimation of blood type (ABO and Rhesus factor) phenotypes and gene (Allele) frequency To estimate phenotypes and gene (alleles) frequencies for ABO blood type; p, q and r was assigned to allele A, B, and O respectively. Their frequencies were calculated according to Hardy-Weinberg (H-W) Law $\{p^2 (I^A I^A) + 2pr (I^A I^O) + q^2 (I^B I^B) + 2qr (I^B I^O) + 2pq (I^A I^B) + r^2 (I^O I^O)\}$ while allele D and d in rhesus type were assigned p and q respectively and their frequencies was calculated using H-W equilibrium $p^2 + 2pq + q^2 = 1$ (Klug *et al.*, 2006). Ethical approval was sought and collected from health institutions concerned and local government health authority. All blood samples were collected from participants by drawing peripheral venous into ethylenediaminetetraacetic (EDTA) tubes under septic conditions.

Determination of blood groups

With the assistance of chief technologist in Top Medical Hospital, Minna, a week training was undergone before the data was released. Drops of antigens for A, B, AB and O blood groups were placed separately with sterile pipette, on a clean tile with one row of four columns each marked A, B, AB and O respectively. A drop of blood was placed on the anti sera on each column. The cell and serum in each circle were then mixed with a stirrer, and the tiles were rocked for a while. After one minute, the mixture was examined for agglutination. Agglutination in a particular mixture indicated the ABO blood group. When there was no agglutination in the anti-A and B mixture, the sample was O. In the case of anti D column, agglutination means the donor is Rhesus positive while absence of agglutination signifies Rhesus negative.

Allele frequencies were calculated under the assumption of H-W equilibrium and expressed as percentages. Chi-square test was used to compare observed allelic and genotypic frequency distributions of the blood group and Rh antigens to that expected under the H-W equilibrium (Klug *et al.*, 2006).

RESULTS

Table 1 showed that a total of 13937 individuals were tested in this study, 6196 (44.457%), 3560 (25.544%), 2689 (19.294%), and 1492 (10.705%) were found to have blood group O, A, B, and AB respectively. A total of 13480 (96.721%) of the population was Rhesus 'D' positive while 475 (3.279%) were Rhesus 'D' negative. Distribution of blood group and Rhesus factor pattern for each hospital were also recorded in Table 1.

Table 1: Phenotypic distribution of ABO and Rhesus blood group system from 2008 to 2012 in Minna, North-Central Nigeria

Study site	ABO system			Rh system			
	O	A	Total	Sex	Rh +	Rh -	Total
TOP MED	496(40.194)	365(29.579)	1234	Male	578(46.840)	5(0.405)	583(47.245)
		240(19.449)		Female	644(52.188)	7(0.567)	651(52.755)
				Total	1222(99.028)	12(0.972)	1234
BAY	929(53.146)	344(19.680)	1748	Male	454(25.973)	18(1.030)	472(27.002)
		276(15.789)		Female	1249(71.453)	27(1.545)	1276(72.998)
				Total	1703(97.426)	45(2.574)	1748
GENERAL	4771(43.551)	2851(26.025)	10955	Male	3667(33.473)	188(1.716)	3855(35.189)
		2173(19.836)		Female	6888(62.875)	212(1.935)	7100(64.811)
				Total	10555(96.349)	400(3.651)	10955
GROSS							
TOTAL	6196(44.457)	3560(25.544)	13937		13480(96.721)	475(3.279)	13937

Values in parenthesis represent percentages of occurrence

As shown in Table 2, frequency of allele O, A and B were 0.667, 0.170 and 0.163 respectively. While D and d were 0.818 and 0.182. Also genotypic frequencies of OO, AA, AO, BB, BO and AB were 0.445, 0.029, 0.227, 0.027, 0.217 and 0.055 respectively. We recorded a genotypic frequency of 0.667, 0.300 and 0.033 for DD, Dd and dd respectively. Genotypic and allelic frequencies of each study site were also recorded in Table 2.

The observed and expected number of ABO and Rh blood group among individuals sampled were recorded in Table 3. As shown in Table 3; using chi square analysis we found out that the distribution and proportion of ABO blood antigens in Minna North-central Nigeria differ significantly from those expected under Hardy–Weinberg equilibrium (goodness-of-fit X^2 for ABO =819.58, df=3, $P \leq 0.05$). Also, proportion and incidence of Rh blood antigens was not significantly differ from those expected under Hardy–Weinberg equilibrium (goodness-of-fit X^2 for Rh= 0.091, df =1, $P \leq 0.05$).

Table 2: Gene and allele frequency of ABO and Rh blood type in Minna, North-Central Nigeria

Study site	Gene (allele)	Frequency	Genotype	Frequency	Phenotype	Frequency (%)
TOP MED	O	0.634	OO	0.402	O	40.2
	A	0.296	AA	0.088	A	
	B	0.07	AO	0.375	A	46.3
			BB	0.005	B	
			BO	0.089	B	9.4
			AB	0.041	AB	4.1
	D	0.901	DD	0.812	Rh (D)+ve	
			Dd	0.178	Rh (D)+ve	99
			d	0.099	Dd	0.01
	BAY	O	0.729	OO	0.531	O
A		0.233	AA	0.054	A	
B		0.038	AO	0.34	A	39.4
			BB	0.002	B	
			BO	0.055	B	5.7
			AB	0.018	AB	1.8
D		0.839	DD	0.704	Rh (D)+ve	
			Dd	0.27	Rh (D)+ve	97.4
			d	0.161	Dd	0.026
GENERAL		O	0.66	OO	0.436	O
	A	0.174	AA	0.03	A	
	B	0.166	AO	0.23	A	26
			BB	0.028	B	
			BO	0.219	B	24.7
			AB	0.058	AB	5.8
	D	0.808	DD	0.653	Rh (D)+ve	
			Dd	0.31	Rh (D)+ve	96.3
			d	0.192	Dd	0.037
	GRAND TOTAL	O	0.667	OO	0.445	O
A		0.17	AA	0.029	A	
B		0.163	AO	0.227	A	25.6
			BB	0.027	B	
			BO	0.217	B	24.4
			AB	0.055	AB	5.5
D		0.818	DD	0.667	Rh (D)+ve	
			Dd	0.3	Rh (D)+ve	96.7
d		0.182	Dd	0.033	Rh (d)-ve	3.3

Table 3: Observed and expected number of ABO and Rh blood group among individuals sampled in Minna Nigeria

ABO blood group			Rh system		
Blood group	Observed	Expected	Blood group	Observed	Expected
O	6196	6201	Rh(D)+ve	13480	13474
A	3560	3563			
B	2689	3401	Rh(d)-ve	457	463
AB	1492	772			
Total	13937	13937	Total	13937	13937
goodness of fit $X^2= 819.58$, $df= 3$ and $p <0.05$			goodness of fit $X^2= 0.091$, $df= 1$ and $p \leq 0.05$		

DISCUSSION

It is a known fact that there is considerable variation in distribution of ABO blood groups from race to race, Nigeria is no exception (Iyiola *et al.*, 2012) this study reported that (44.457%) of our subjects were group O, (25.544%) were group A, (19.294%) were group B while (10.705%) were group AB implying that prevalence of $O > A > B > AB$. This in tandem with results from other parts of Nigeria; Lagos, Ilorin, Nasarawa, Niger-Delta, Benin, Uyo, Port-Harcourt, Ogbomoso, all six geopolitical zones in Nigeria and Ibadan as reported by Iyiola *et al.* (2012); (2011); Pennap *et al.* (2011); Erhabor *et al.* (2010); Egesie *et al.* (2008); Enosolease and Bazuaye (2008); Ekanem, (2006); Jeremiah, (2006); Bakare *et al.* (2006), Falusi *et al.* (2000) and Omotade *et al.* (1999) respectively but slightly different from the trend ($O > B > A > AB$) reported in Northern parts of the country like Gusau, Abuja, Kano and Adamawa as presented by Erhabor *et al.* (2013); Olaniyan *et al.* (2013); Chima *et al.* (2012) and Abdulazeez *et al.* (2008) respectively.

Although occurrence of blood type O is the highest from all Nigerian study, type A is greater than B in our study, this is not in tandem with other results from Northern Nigeria; this might be due to the fact that there could have been inter regional marriage in our study site because Minna North central Nigeria is proximate (gateway) to other parts of the country. Our result is thus in congruent in previous reports from all Nigerian studies accessed and confirm that group O is the most common among ABO blood group. It is evident that individuals with blood group O had a lower incidence of pancreatic cancer, compared to those with non-O blood groups (Woo *et al.*, 2013; Pelzer *et al.*, 2013). Thus higher incidence of blood type O in our study might be of evolutionary advantage against pancreatic cancer aside from its importance in blood transfusion and improved malaria outcomes in blood group O individuals, this might be due to absence of A or B antigens (Wolofsky *et al.*, 2012).

A similar result ($O > A > B > AB$) was obtained from a study by Hamed *et al.* (2012) during a nationwide study in Mauritania, different ethnic/racial groups in the United State (Garratty *et al.*, 2004), Saudi Arabia (Sarhan *et al.*, 2009) and Iraq (Jaff, 2010). But there was a slight discrepancy ($O > B > A > AB$) from studies conducted in Antananrivo (Madagascar) (Randriamanantany *et al.*, 2012) and Guinea (Loua *et al.*, 2007). Results from Turkey and Jordan by Kuku *et al.* (2004) and Hanania *et al.* (2007) reported a different distribution ($A > O > B > AB$) of ABO blood group. Lastly, our results is also different from prevalence ($B > O > A > AB$) reported from Western Rajasthan (India), Northern India, Utter Pradesh (India), Punjab (Pakistan) and Azad Jammu and Kashmir (Pakistan) by Rajshee and Raj, (2013); Chandra and Gupta, (2012); Rai and Kumar, (2011); Anees and Jawad, (2011) and ($B = O > A > AB$) Khan *et al.* (2009) respectively.

With respect to Rhesus D antigen, the frequency of 96.721% was recorded for Rh positive which consist of DD (66.7%), Dd (30%) while the remaining (3.279%) accounted for Rh negative (dd). Outcome of our study is in congruent with 95.7% positive rate reported in Abuja (Olaniyan *et al.*, 2013), 98.8% in Gusau (Erhabor *et al.*, 2013), 97.0% in Lagos (Iyiola *et al.*, 2012), 95.5% among women in Enugu (Okeke *et al.*, 2012), 94.8% in Kano (Chima *et al.*, 2012), 94.0% in Nassarawa (Pennap *et al.*, 2011), 95.5% in Ilorin (Iyiola *et al.*, 2011), 93.0% in Niger-Delta (Erhabor *et al.*, 2010), 98.0% in Niger-Delta (Egesie *et al.*, 2008), 93.88% in Benin (Enosolease and Bazuaye, 2008), 97.4% in Adamawa (Abdulazeez *et al.*, 2008), 96.68% in Uyo (Ekanem, 2006), 96.7% in Ogbomoso (Bakare *et al.*, 2006), 96.77% in Port-Harcourt (Jeremiah, 2006), 94.30% in six different geopolitical zones in Nigeria (Falusi *et al.*, 2000) and 95.0% reported in Ibadan (Omotade *et al.*, 1999). Similar results was obtained from other parts of the world; Antananarivo (Madagascar) 98.90% (Randriamanantany *et al.*, 2012), Mauritania 94.23% (Hamed *et al.*, 2012), Guinea 95.94% (Loua *et al.*, 2007), Western Rajasthan (India) 91.75% (Rajshee and Raj 2013), Northern India 95.45% (Chandra and Gupta 2012), Utter Pradesh (India) 95.59% (Rai and Kumar, 2011), Punjab (Pakistan) 87.1% (Anees and Jawad, 2011), United State Black non-Hispanic 92.9% (Garratty *et al.*, 2004), Saudi Arabia 92.8% (Sarhan *et al.*, 2009) Iraq 91.73% (Jaff, 2010), Turkey 89.3% (Kuku *et al.*, 2004)

Frequencies of alleles O (0.667), A (0.170) and B (0.163) recorded in this study is in tandem with others from Nigeria (Omotade *et al.*, 1999; Falusi *et al.*, 2000; Iyiola *et al.*, 2011; 2012) in which prevalence of allele $O > A > B$ but slightly different from results from Ogbomoso, Nigeria ($O > A = B$) obtained by Bakare *et al.* (2006). Similarly, our result is also in congruent with results from Mauritania (Hamed *et al.*, 2012), Tunisia (Said *et al.*, 2003), Germany (Wagner *et al.*, 1995), Jordan (Hanania *et al.*, 2007) but dissimilar occurrence ($O > B > A$) was observed in Guinea (Loua *et al.*, 2007), Madagascar (Randriamanantany *et al.*, 2012) and Punjab (Pakistan) (Anees and Jawad, 2011). In all population prevalence of allele O was highest.

Prevalence of ABO in this study differ significantly from those expected under Hardy-Weinberg equilibrium, this is similar to results from Ilorin and Lagos as reported by Iyiola *et al.* (2011; 2012). This might be due to the fact that Minna, Ilorin and Lagos comprised of mixed-populations because people settle in those places easily (high incidence of migration).

CONCLUSION

This study has provided pioneer report on prevalence and allelic frequencies of ABO and rhesus blood type in Minna North-central Nigeria. Genetic diversity in blood types among individuals in Minna has been established and supported by this study. We hope this will serve as a baseline reference material for clinical, genetics and allied studies in Minna, North-central Nigeria.

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