



Gene Frequencies of ABO and Rh(D) Blood Group Alleles in Five Yemeni Provinces

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Abstract

This study aims to determine the distribution pattern and gene frequency of the ABO and Rh(D) blood groups in five Yemeni Provinces and compare it with other studies in the world. Methods: The study comprises a total of 1113 healthy blood donors donating in blood banks, Hospitals, primary health centers situated in five Yemeni Provinces, namely Abyan, Al Jawf, Al Hudaydah, Amran and Lahij. ABO and Rh(D) blood groups were determined by standard methods. Calculations for allelic frequency were based on Hardy Weinberg equilibrium. Results: The O blood group was highly distributed: (78.79% (0.88714), 64.62% (0.80177), 63.73% (0.79895) and 60.4% (0.7773) in Al Jawf, Lahij, Al Hudaydah and Abyan, respectively). However, the lowest frequency 53.58% (0.73326) was in Amran, followed by the A blood group which was higher in Amran 34.25% (0.26375). The lowest frequency was in Al Jawf 23.05% (0.08358). The B blood group was highly distributed 10.29% (0.0640) in Abyan and the lowest frequency 5.07 % (0.02846) was in Al Jawf. The AB blood group had also a low frequency. The Rh-positive blood group frequencies were 96.32% O>A>B>AB, and O> A>B among Rh negative donors. Al Jawf Province population had a phenotypic distribution of the Rh-positive blood group of 95.93%. The Rh(D) and d allelic frequency was found to be 0.79826. Abyan, Al Hudaydah, Lahij and Amran had Phenotypic distribution and allelic frequencies of the Rh-positive blood group of 95.35% (0.74213), 94.58% (0.76719), 93.47% (0.74446) and 91.58% (0.70054) respectively. Conclusion: The frequency of ABO blood groups in both Rh positive and negative subjects among the five Yemeni Provinces was O>A>B>AB.

Keywords: ABO blood groups, Gene frequencies, Rh blood groups, Yemen

Introduction

The antigens of the ABO system were the first to be recognized as blood groups and actually the first human genetic markers known. Their presence and the realization of naturally occurring antibodies to those antigens lacking from the cells made sense of the erratic failure of blood transfusion hitherto and opened up the possibility of a safe treatment practice in life-threatening blood loss [1]. A total of 35 human blood group systems are now recognized by the International Society of Blood Transfusion (ISBT) [2]. The regulation of ABO blood group system is under the control of ABO gene expression [3]. These genes are located on the long arm of the autosomal locus at chromosome number 9 (9q34.1), which constitutes the four blood types. The Rh blood group antigens derive from 2 genes, namely RhD and RhCE that are located at a chromosomal position [4]. The genetics of ABO blood group system revealed that three alleles, namely I^A , I^B and i , determine blood groups. I^A produces A antigen; I^B produces B antigen and i produces neither. I^A and I^B are mutant alleles that show co-dominance with each other but both are dominant over the wild type allele i ($I^A = I^B > i$) [5]. These three alleles combine to yield six genotypes and four phenotypes [6].

The two alleles D and d are responsible of the inheritance of Rhesus blood group: allele D for Rh+ and d for Rh-. (Positive) or (negative) refers to either the presence or absence of the Rh(D) antigen on the surface of Rbcs, which indicates that allele D is dominant over the allele d. Gene frequency takes into consideration the numbers of various genotypes in the population. The relative allele frequencies are determined by the application of the Hardy-Weinberg Law [7,8,9,10,11]. The Hardy-Weinberg model describes a mathematical relationship that allows the prediction of the frequency of offspring genotypes based on parental allele frequencies. It also predicts that allele frequencies will not change from one generation to the next, indicating non-evolution [12].

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The distribution of these 2 blood groups has been repeatedly investigated in various populations all over the world during the last half-century. The frequencies exhibit considerable variation in different geographic locations, reflecting the underlying genetic and ethnic diversity of human populations [13].

Aim of the study

There is no known data of the distribution pattern and frequency of ABO and Rh(D) blood groups in these Yemeni Provinces: Abyan, Al Jawf, Al Hudaydah, Amran and Lahij. This study aims at providing information on the distribution pattern of the phenotypes and genotypes as well as the gene frequencies of these genetic variants in this region.

Subjects and Methods

The subjects of this study are a total of 1113 unrelated individuals of both genders. They were drawn from these different Yemeni geographical regions: Abyan, Al Jawf, Al Hudaydah, Amran and Lahij. Such a population referred to the blood banks, Hospitals, primary health centers and laboratories, during the period between September 2012 and June 2013. ABO and Rh(D) blood grouping was carried out by agglutination test using the direct slide test of blood grouping reagent: anti-A, anti-B and anti-D human sera test (manufactured by: Tulip Diagnostics India, Agappe Diagnostics, India, and Diagast, Spain). Blood group (ABO) and Rhesus factor were done by the antigen antibody agglutination test. A drop of anti-A, anti-B, anti-AB and anti-D was added to a drop of finger prick blood on a clean slide and was mixed well. Agglutination was recorded as a positive reaction[14].

Statistical Analysis

The result was calculated as frequency of each blood group and expressed as percentage, Allelic frequencies. We calculated the allele frequencies (p, q, and r) for the ABO locus according to Hardy-Weinberg's law and Chi-square test for accuracy and validity. We also used the S2 ABO estimator by Silva Square which is a program to estimate the allele frequencies of the ABO blood group system [15]. Rh(D) allele frequencies were calculated according to the Hardy-Weinberg equation[16].

Result and Discussion

The present study was undertaken to assess the frequency of distribution of ABO and Rh(D) blood groups in general populations in five Yemeni Provinces as presented in Tables 1 and 2, in the total sample, O Phenotype has the highest frequency: 63.23% (44.03% O+ and 4.99% O-) followed by A phenotype with 26.25% (25.97% A+ and 5.07% A-), B with 8.76% (10.06% B+ and 3.04% B-), while blood group AB has the lowest frequency with 1.75% (5.32% AB+ and 1.51% AB-). The overall picture of phenotypic frequencies of ABO blood groups is O>A>B>AB (Table 1 &2).

Table(1):Distribution of ABO and Rh blood groups systems in five Provinces in Yemen

Blood groups	Total study subjects	Blood Prevalence (%)	Comment
A	293	26.25	O>A>B>AB
B	79	8.76	
AB	18	1.75	
O	705	63.23	
Total	1113		
Rhesus (D) blood groups			
Rh positive	1042	93.88	
Rh negative	71	6.12	
Total	1113	100	



Table 1 shows the frequency of Rh(D) phenotypes among the study population. In the present study, the frequencies of phenotype are 93.88% (Rh(D) positive) and 6.12% (Rh negative). Knowledge of frequency of ABO blood groups is an important tool to determine the direction of recruitment of voluntary donors as required for each zone across the country. Similarly, a study in Germany by Wagner et al (1995)[17] reported that the distribution of O blood group was the highest (64%), followed by A blood group (26%), B blood group (8%) and the lowest frequency was for AB blood group (2%). This applies to the majority of studies that have been conducted on blood group distribution around the Arab countries, specifically Kuwait [18], Saudia Arabia[19], Gaza–Strip[20], Iraqi population/Kurd [21] and Mauratania [22]. All these studies have described O as the most frequent and ‘AB’ as the least common blood group; the second most common is ‘A’ followed by ‘B’ and ‘AB’, in the order O>A>B>AB.

However another study showed a decrease in the frequency of blood group O, and a significant increase in blood group B in the order B > O > A > AB and B=A>O > AB [23,24,25,26,27]. A further study revealed a higher frequency of A and B blood groups and a decrease in O blood group which differs from all the other studies in the order A > B > O > AB in Pakistan [28]. In this study, Allele frequencies show a high frequency of the i allele over I^A and I^B alleles in the order i > I^A > I^B respectively in all the Yemeni Provinces. Table 2 and 3 indicate the distribution of Phenotypes and Genotypes of ABO blood groups and Rhesus in the five provinces.

Table (2): Prevalence of ABO blood group and Rh phenotypes distribution in different Province in Yemen

Governorate		Blood Group								Total
		A		B		A B		O		
		Rh+	Rh-	Rh+	Rh-	Rh+	Rh-	Rh+	Rh-	
Abyan	No	64	4	24	2	4	1	141	10	250
	%	25.70	1.73	9.61	0.68	1.72	0.15	56.32	4.08	100
Total No (%)		68(27.43)		26(10.29)		5(1.87)		151(60.4)		
Al Jawf	No	22	2	7	1	1	0	120	4	157
	%	21.87	1.18	4.32	0.75	0.83	0.00	76.76	2.03	100
Total No (%)		24(23.05)		8(5.07)		1(0.94)		124(78.79)		
Al Hudaydah	No	64	4	21	1	3	0	153	9	255
	%	25.18	1.51	8.17	0.51	1.30	0.00	59.93	3.30	100
Total No (%)		68(26.69)		22(8.68)		3(1.41)		162(63.73)		
Amran	No	64	6	18	2	5	0	100	10	205
	%	31.20	3.4	8.74	0.87	2.29	0.00	48.79	4.79	100
Total No (%)		70(34.25)		20(9.61)		5(2.56)		110(53.58)		
Lahij	No	59	4	20	1	3	0	149	11	247
	%	23.72	1.67	7.92	0.54	1.39	0.00	60.37	4.25	100
Total No (%)		63(25.46)		21(8.46)		4(1.46)		159(64.62)		



Blood groups and (allele frequencies of ABO blood groups i , I^A and I^B) values (Table 2 & 3): O Blood group is highly distributed in Al Jawf with 78.79% (0.88714), Lahij 64.62% (0.80177), Al Hudaydah 63.73% (0.79895) and Abyan 60.4% (0.7773). However the lowest frequency was in Amran 53.58% (0.73326). This observation is in accordance with previous reports from Nigeria, Southern Nigeria; Binis and Yorubas had 'O' group frequency of 57.7% and 51.1%, respectively [29]. While in the northern part it was reported as 52% [30]. Followed by A blood group as higher in Amran with 34.25% (0.26375) while being the lowest frequency in Al Jawf with 23.05% (0.08358); Many studies have shown 'A' being the second most common blood group in the middle Euphrates region in Iraq [31], and the Studies at nearby areas of Punjab Southern India [32]. Then B blood group was highly distributed 10.29% (0.0640) in Abyan and lowest frequency 5.07 % (0.02846) was in Al Jwaf. AB Blood group was also a low frequency in Al Jawf (0.94%) and in Amran (2.56%). Table 2 also shows the Frequency of Rh-positive blood group as O>A>B>AB and O> A>B among the Rh negative donors.

These results are in accordance with studies in the Nianwa, the northern part of Iraq in that the allele frequencies were in the order of ($i > I^A > I^B$), where ($i = 0.647$, $I^B = 0.172$, $I^A = 0.194$) [33]. In other Region in Iraq such as Missan Province it is shown that the gene frequencies were ($i = 0.5951$, $I^B = 0.2385$ and $I^A = 0.1663$), [34], and ($i = 0.3662$, $I^A = 0.3836$ and $I^B = 0.1804$) in Jordon [35]. However in the other countries such as Bahrain and Korea there have a different ABO spectrum in the order of ($i > I^B > I^A$) [36,37].



Table (3): Gene frequencies of ABO blood groups alleles in different Province in Yemen

governorate	phenotypes	Observed (n)	Observed %	Genotypes	Allele frequency	Standard Deviation
Abyan	A	68	27.43	$I^A I^A, I^A i$ (p)	0.1585	0.01708
	B	26	10.29	$I^B I^B, I^B i$ (q)	0.0640	0.01113
	O	151	60.4	ii(r)	0.7773	0.01937
	Hardy-Weinberg Log Likelihood=-243.0725 Test statistic=0.0016 P-value=0.9683					
Al Jawf	A	24	15.2	$I^A I^A, I^A i$ (p)	0.08358	0.01602
	B	8	5.07	$I^B I^B, I^B i$ (q)	0.02846	0.00961
	O	123	78.79	ii(r))	0.88714	0.01826
	Hardy-Weinberg Log Likelihood=-103.0081 ² Test statistic=0.0826 P-value=0.0023					
Al Hudaydah	A	68	26.69	$I^A I^A, I^A i$ (p)	0.15070	0.00980
	B	22	8.68	$I^B I^B, I^B i$ (q)	0.05033	0.01652
	O	162	63.73	ii(r)	0.79895	0.01843
	Hardy-Weinberg Log Likelihood=-230.7353 Test statistic=0.2420 P-value=0.6228					
Amran	A	70	34.25	$I^A I^A, I^A i$ (p)	0.26375	0.02111
	B	20	9.61	$I^B I^B, I^B i$ (q)	0.06298	0.01219
	O	110	53.58	ii(r)	0.73326	0.02307
	Hardy-Weinberg Log Likelihood=-208.8165 Test statistic=0.0174 P-value=0.8949					
Lahij	A	63	25.46	$I^A I^A, I^A i$ (p)	0.14628	0.01656
	B	21	8.46	$I^B I^B, I^B i$ (q)	0.05194	0.01011
	O	159	64.62	ii(r)	0.80177	0.01860
	Hardy-Weinberg Log Likelihood=-224.375 Test statistic=0.0200 P-value=0.8876					

This study is the first to describe the distribution of the Rh(D) allelic frequency in Yemen. It showed variations from one Province to another, with a maximum recorded in Al Jawf 0.79826 and minimum observed in Amran 0.70054. The results presented in Table 4 show that the distribution of the Rh factor among Al Jawf Province population had Phenotypic distribution of the Rh-positive blood group was 95.93% while Rh-negative blood group Phenotypic was 4.07%, the Rh(D) and d allelic frequencies were 0.79826 and 0.20174 respectively. Abyan, Al Hudaydah, Lahij and Amran had Phenotypic distribution and allelic frequencies of the Rh-positive blood group as 95.35% (0.74213), 94.58% (0.76719), 93.47% (0.74446) and 91.58% (0.70054) respectively. Frequencies of common Rh antigens are like the frequencies reported in world populations. They were nearly the same as data obtained from Bahrain [36], Saudia [38], [19], UAE [39], Iraq [31], Sudan [40] and India [41].

**Table(4): Rh(D) Phenotypes and allele frequencies among different Provinces of the Yemen**

Governorate	phenotypes	Genotype	Observed No.	Phenotypic frequency %	allelic frequency
Abyan	Rh+	DD, Dd	233	95.35	D =0.74213
	Rh-	dd	17	6.65	d =0.25787
	Total				
Al Jawf	Rh+	DD, Dd	150	95.93	D =0.79826
	Rh-	dd	6	4.07	d =0.20174
	Total				
Al Hudaydah	Rh+	DD, Dd	241	94.58	D =0.76719
	Rh-	dd	14	5.42	d =0.23280
	Total				
Amran	Rh+	DD, Dd	187	91.58	D =0.70054
	Rh-	dd	18	8.97	d =0.29949
	Total				
Lahij	Rh+	DD, Dd	231	93.47	D =0.74446
	Rh-	dd	16	6.53	d =0.25538
	Total				

Conclusion

The present study is original in that it is the first comprehensive study that documented the distribution of ABO and Rh(D) blood groups and allelic frequency in five Yemeni Provinces. It concluded that blood group O is the most frequent blood group in all provinces, followed by A, B, and AB blood groups respectively. The Rh +ve record is the highest Rh phenotype hesitancy from Rh-ve. It also has a significant implication in the management of blood bank and transfusion services. Besides, it is also important for parental testing, legal medicine, organ transplant and in population genetic study and identification of Rh system to prevent the erythroblastosis foetalis which will decrease the maternal and other mortality rates.

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