

ABO and Rhesus Blood Groups Distribution in Healthy Individuals: An Update Cross Sectional Study from Tertiary Care Center in Makkah City, Saudi Arabia

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ABSTRACT

Background: The ABO and Rh blood group system is among the most important systems in blood transfusion practice due its vital role in successful process of the transfusion between donors and recipients. Determination of this system in term of frequency in healthy individuals is important to keep blood bank inventory effectively managed and operated. This study was aimed to determine the frequency and distribution of ABO and Rh blood group patterns among voluntary blood donors attended the tertiary healthcare hospital namely Alnoor hospital located in Makkah city, Saudi Arabia.

Methods: A total number of 5000 samples were recruited for this study to determine the frequency of ABO-Rh blood group system in healthy individuals following obtaining the ethical approval. ABO and Rh blood groups were determined using the test tube method with blood group reagents: anti-A, anti-B, and anti-D.

Results: Male participation comprised the majority of the total samples with 99.28% while female participation comprised 0.72% only. The young-adulthood age categories represented the highest number of participation with 28.86% and 21.62% for the age groups 26 – 30 years and 31 – 35 years respectively. Saudi participants represented 63.94% while the remaining (36.06%) represented Non-Saudi of the total samples. The distribution of ABO and Rh blood group among Saudi and Non-Saudi showed similarity in the frequency ranking where blood group O+ showed a prominence frequency followed by A+, B+, AB+, O-, A-, B- and AB- with exact percentages of 43.8%, 26.28%, 17.66%, 4.32%, 4.14%, 2.02%, 1.62% and 0.16% respectively.

Conclusion: The results of this study showed a predominance distribution of O blood group while AB remained the rarest group as shown by other previous studies performed in other Saudi Arabian cities and regions. Such study is important in transfusion practice to provide continuous support of blood components to the needed patients.

Key words: ABO blood group, Rh blood group, blood donors, Allele frequency

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INTRODUCTION

The diversity of Red Blood Cells (RBCs) is based on their antigenic structures located on the extracellular surface of their membranes which are composed of glycoproteins and glycolipids. This feature has made scientists to classify the RBCs into different groups based on the reactions of these antigens to their counterpart antibodies which can be detected *in vitro*. Up to date, more than 350 genetically-different blood

groups were described; however, the ABO and Rh blood group system has the most important significance in transfusion medicine [1,2]. Historically, the ABO blood group was discovered in 1900 by Landsteiner, while Rh blood group was discovered 40 years later. The antibodies of the ABO and Rh blood group system present in plasma of human individuals whose RBCs lack their antigens [3]. The importance of ABO and Rh group system is not limited to practice in blood transfusion only but it also has an impact in other clinical settings such as paternal assessment, forensic medicine and tissue transplant [4]. Blood group typing depends on the presence of specific antigen on the surface of RBC, where there are 30 different blood group antigens. Among these

antigens, the most important and complex oligosaccharides antigens are A and B antigen. These two antigens are genetically controlled by three allelic genes, A, B and O, found on the long arm of chromosome 9q and produced as a result of glycosyltransferase enzymes that add specific sugars of conformation dependent epitopes [5].

Similarly, the genetic control of Rh blood group system is located in chromosome 1 and determined by Rh (D) gene which produces RhD protein and another gene encode for RhC and RhE proteins. Therefore, depending on the presence of these antigens and their ability to agglutinate RBCs, blood's individual can be categorized into four major groups A, B, AB and O with a sign of positive which indicates presence of Rh(D) antigen or negative for absence of Rh(D) [6]. Since this system has a major impact on successful of blood transfusion, more attention is carried out to ABO and Rh system as a routine compatibility test in transfusion medicine laboratories [7,8]. Management of blood stock and prediction of the need for a particular blood group in a particular period remains a challenge issue. The most important role of blood banks is to provide appropriate blood components that the patients need. For this reason, determination of ABO and Rh blood groups system distribution in various population is necessary along with its importance in blood transfusion to avoid mismatched transfusion reactions. Therefore, blood grouping takes the top priority among others routine works in blood centers. Previous studies on distribution of ABO and Rh grouping have revealed a wide variation in the distribution of this system based on genetic, racial differences, geographical location and socio-economic status [9,10]. This variation also occurs within particular country and between different cities. In major cities like Makkah, Saudi Arabia, the holy capital of Muslim world, it is essential to determine the common ABO and Rh blood group type to keep blood bank inventory effectively managed and operated. The main aim of the present study is to determine and update the prevalence of ABO and Rhesus blood group distribution patterns in a cohort of blood donors who visited Al-Noor tertiary hospital. We believe that having record for the common blood groups in different cities is important for effective supply of blood components during medical emergencies.

MATERIALS AND METHODS

A total number of 5000 blood donor samples were recruited in the Blood Bank section of Alnoor Specialist Hospital, Makkah city. The study was approved as per the ethical approval letter no. (61147-2121436) and data was retrospectively obtained from January to September 2020. Blood samples included 4964 males and 36 females. ABO and Rh blood groups were determined by using the test tube method with blood group reagents: anti-A, anti-B, and anti-D (Mouse Monoclonal, Crescent Diagnostics). Hemoglobin level measurement was performed based on Complete Blood Count picture using XN-1000™ Hematology Analyzer (Sysmex, Lincolnshire, USA). Estimation of allele frequencies of the ABO blood group was performed using S2 ABOestimator software freely available online (Pedro J.N., Silva, Lisbon, Portugal) [11]. Data analysis was done using Excel application to generate the descriptive statistics. P values with less than (0.05) were considered significant.

RESULTS

The distribution of ABO and Rh blood group was determined in 5000 blood donors aged 16-69 years old comprising 99.28% (n= 4964) males and 0.72% (n=36) females during the period of January to September ,2020. The demographic characteristics is shown in Table 1 where majority of the donors were fallen under 26 – 30 years category followed by 31–35 years, 21–25 years with percentage distribution of 28.86%, 21.62% and 18.28% respectively. It is worth

Table 1: Demographic characteristics of the participants.

Age	Frequency (n)	Percentage (%)
<20	240	4.8
21 - 25	914	18.28
26 - 30	1443	28.86
31 - 35	1081	21.62
36 - 40	728	14.56
41 - 45	307	6.14
46 - 50	167	3.34
> 50	120	2.4
Total	5000	100
Gender	Frequency (n)	Percentage (%)
Male	4964	99.28
Female	36	0.72
Total	5000	100
Nationality	Frequency (n)	Percentage (%)
Saudi	3197	63.94
Non Saudi	1803	36.06
Total	5000	100

noting to mention that the older the age of donor the less willingness to donate. This typically happens after the age of 25 years. In respect of gender, males comprised the majority of blood donors with 99.28% (n=4964) while females represented a very minute proportion with 0.72% (n=36). In term of nationality, we found that 63.94% (n=3197) of the donors were Saudi and 36.06% (n=1803) non Saudi.

The main aim of the present study was to determine the prevalence of ABO and Rh blood group system among the recruited donors. As shown in Table 2, we found that blood group O+ was the most common group among the investigated donors followed by A+, B+, Ab+, O-, A-, B- and AB-. They comprised 43.8% (n= 2190), 26.28% (1314%), 17.66% (n=883), 4.32% (n=216), 4.14% (n=207), 2.02% (n=101), 1.62% (n=81) and 0.16% (n=8) respectively.

Makkah city is the holy capital city of Islamic world and thus multiethnic residents (non-Saudi) represent a significant population. The effect of nationality on distribution of ABO and Rh group system was investigated as shown in Table 3. More than third of the participants (36.08%) were Non-Saudi. The distribution of ABO and Rh blood group among Saudi and Non-Saudi showed similarity in the frequency ranking with a mild difference between blood

groups O- and AB+. Blood group O+ showed a prominence frequency in compared to other groups. However, we run the t-test to investigate if nationality plays a significant role in the distribution of blood groups. Our result showed that there was no significant difference between Saudi and Non-Saudi cohorts as the p-value were found bigger (p value = 0.41) than the cut off value (0.05) and thus rejecting our Null hypothesis.

Furthermore, our results showed a major predominance contribution of male donors (99.26%) than female donors (0.74%) as shown in Table 4. We run a comparison analysis through t-test to determine if the gender variable has a correlation with the blood group distribution and found out there was a significant difference between males and females as shown by the p-value.

To estimate the allele frequencies of the ABO blood group, we used the S2 ABOestimator software based on Bernstein method as displayed in Table 5. There was no significant difference between the ABO allele frequencies as determined by the p value.

DISCUSSION

The ABO blood group antigens carry an important clinical significance since they are naturally present on the surface of RBC and can cause transfusion reaction. In transfusion medicine, the consequence of ABO blood group incompatibility between donors and recipients may lead to death [12]. Frequency of ABO and Rh blood groups system among healthy individuals have been widely studied locally due to its impacts on health services. However, specific frequency determination of blood groups in major cities and regions is important

Table 2: ABO-Rh blood groups distribution among the cohort study.

Blood group	Frequency (n)	Percentage (%)
A+	1314	26.28
A-	101	2.02
B+	883	17.66
B-	81	1.62
AB+	216	4.32
AB-	8	0.16
O+	2190	43.8
O-	207	4.14
Total	5000	100

Table 3: ABO and Rh blood groups among Saudi and Non-Saudi residents.

Blood group	Frequency (n)		Total (n)	Percentage (%)	P value
	Saudi	Non-Saudi			
A+	848	466	1314	26.28	0.41
A-	63	38	101	2.02	
B+	494	389	883	17.66	
B-	53	28	81	1.62	
AB+	131	85	216	4.32	
AB-	5	3	8	0.16	
O+	1468	722	2190	43.8	
O-	134	73	207	4.14	
Total (n)	3196	1804	5000		
Percentage (%)	63.92	36.08		100	

Table 4: Distribution of blood donors according to the gender (n=5000).

Blood group	Gender		Total (n)	Percentage (%)	P value
	Male (n)	Female (n)			
A+	1304	10	1314	26.28	0.042
A-	100	1	101	2.02	
B+	875	8	883	17.66	
B-	78	3	81	1.62	
AB+	214	2	216	4.32	
AB-	8	0	8	0.16	
O+	2182	8	2190	43.8	
O-	203	4	207	4.14	
Total (n)	4964	36	5000		
Percentage (%)	99.28	0.72		100	

Table 5: Allelic frequencies of ABO blood group.

Type	p (A)	q(B)	r(O)	Total
Allele frequency	0.18	0.13	0.69	1
Std. Dev.	0.004	0.003	0.005	
Hardy-Weinberg Log Likelihood			-5830.97	
Test statistic			0.13	
p value			0.71	

Table 6: Comparison of the Distribution of Blood Groups in the Present Study and previous studies performed in other Saudi Arabian cities.

Region of Study	City of Study	ABO group system						Reference
		A	B	AB	O	Rh+	Rh-	
Western	Makkah	28.3	19.28	4.48	47.94	92.06	7.94	Present Study
Western	Jeddah	34.2	24.8	2.5	38.5	96.3	3.7	Alghamdi et al. [17]
Western	Jeddah	30.8	24.3	7.5	37.4	NA*	NA*	Mohamed et al. [19]
Western	Almadinah	31.4	16.1	6.5	46	NA*	NA*	Alwasaidi et al. [23]
Western	Makkah	29.9	17.5	4.2	48.3	92.2	7.8	Dahlawi et al. [20]
Western	Makkah	28.2	23	5.6	43	98	2	Dahlawi et al. [21]
Western	Jeddah	29.7	16	4.1	50.1	91.3	8.63	Alzahrani et al. [24]
Western	Makkah	28.6	17.9	3.8	49.5	91.9	7.9	Zaghoul et al. [27]
Western	NA	33.9	24.9	3	38.2	91.42	8.58	Al-Himaidi et al. [14]
Southern	Abha	33	12	3	52	91.6	8.4	Khan et al. [18]
Southern	Abha	33.4	6	3.8	56.8	92.8	7.2	Sarhan M et al. [15]
Southern	Najran	24.3	4.04	2.19	69.47	90.56	9.44	Al-Noaemi et al. [26]
Southern	NA*	33.68	11.34	2.79	52.23	89.7	10.3	Al-Himaidi et al. [14]
Northern	NA*	24.62	22.61	3.52	49.25	91.45	8.55	Al-Himaidi et al. [14]
Northern	Hail	24	18.23	10.63	46.8	81.8	18.2	Farshori et al. [25]
Northern	Sakaka, Domah, Al-Qurayat & Sweer	27.5	25.5	7.3	39.8	91.2	8.8	Eweidah et al. [22]
Eastern	NA*	24.62	22.61	3.52	49.25	91.45	8.55	Al-Himaidi et al. [14]
Eastern	Al-Khobar	26.3	18.5	4.3	51.5	92.25	7.75	Bashwari et al. [16]
Middle	NA*	24.5	20.45	6.57	48.48	90.91	9.09	Al-Himaidi et al. [14]

for blood bank inventory and management [13]. The current study showed similar results to the previous works done on the distribution of ABO and Rh in different cities and regions of Saudi Arabia [14-27]. To further elucidate the small differences between our study with other previous works done on the distribution of ABO-Rh blood group system among other Saudi Arabian cities and regions, we summarized these differences in Table 6. The most common ABO blood group in all studies is O blood group with the highest prevalence found in Najran city comprising 69.47% [26] while the least O blood group found in Jeddah with 37.4% [19]. On the

other hand, the rarest blood group in all studies was found to be AB with the lowest reported AB group in Najran city comprising 2.19% of the studied subjects [26]. In term of Rhesus blood group, it can be observed that Makkah city contained the highest percentage of positivity with 98% [21].

Previous studies showed that the distribution of ABO blood group in various countries depends upon geographic location, environment, and genetic factors [28,29]. For this reason, the comparison of ABO distribution in Saudi Arabia and other close countries does not show

any difference. Similar to the result of ABO distribution in Saudi Arabia, the frequency of O blood group was found to be the highest blood group in Kuwait (44.6%) [30] and Bahrain (49.6%) [31]. However, blood group A showed the highest blood group prevalence in other countries such as Palestine (40%) [32] and Jordan (38.5%) [33]. This is probably due to the difference in geographical and ethnic background between gulf countries and other Arab countries. As can be seen in Table 6, our study showed that Rh-negative (7.94%) subjects were lower than Rh-positive (92.06%) which is in the same direction with other previous studies [14-27]. With this low percentage of Rhesus negativity, it is recommended to encourage and increase the recruitment of Rh-negative blood group donors to donate regularly. If such initiative doesn't take place, there will be an increase in the burden of blood banks to manage the stock of Rh-negative Red Blood Cells units.

In term of blood donation recruitment, we found that most of the donors were within the age of 26-35 years comprising 50.48% of the studied subjects. Donors of less than 20 years and more than 50 years represent small portion with 7.2% only. The low percentage of donation in young adults (<20 years) may be caused by the vasovagal reactions that is observed in this particular age group as reported previously [34,35]. In addition, the low number of elderly donors (>50 years) might occur due to misinformation of the age limit for donation and blood donation guidelines in term of age-related eligibility [36,37]. Another factor determines the tendency to blood donation is the gender of the donor. Most studies showed that female participation in blood donation is significantly lower than male [38-41]. There are several factors play role in this low participation. Previous study found that there is a high risk of iron deficiency particularly among women, which make them not suitable for blood donation [42]. Other reasons are related to donation deferral including low hemoglobin levels, poor venous access, and higher frequency of vasovagal reactions [43]. In addition, some women claimed a difficulty of reaching blood bank due to transportation issue [41].

In conclusion, our results showed that O+ blood group is the prominent type followed by A+, B+, AB+, O-, A-, B- and AB-. Such study is important

for analyzing population studies as well as blood donation services to keep blood bank inventory managed and operated in an effective manner.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest in this article.

AUTHORS' CONTRIBUTION

AK: concept, design, data acquisition and analysis, statistical analysis, manuscript preparation. TQ: concept, design manuscript preparation, editing and manuscript review.

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