Frequency of ABO, Rh and Kell Blood Group among Blood Donors in Brazzaville, Republic of the Congo

ABSTRACT

Introduction: Blood group antigens play an essential role in transfusion safety and in avoiding the risk of alloimmunization. The ABO, Rh and Kell blood group systems are the most clinically important. The aim of this study was to determine the frequency of ABO, Rh and Kell blood groups among blood donors in Brazzaville, Republic of Congo.
Methods: This was a cross-sectional study conducted among blood donors in Brazzaville, republic of Congo, from June 2021 to November 2022. The blood samples were tested for ABO, Rh and Kell antigens by standard tube agglutination method. The statistical analysis was done using SPSS version 21.0.
Results: A total of 350 participants were included, of which 258(73.7%) of donors were males. The antigen frequencies of ABO and Rh(D) blood group system showed that O was the most prevalent blood group 46.8% followed by A (28.9%), B (16.9%), and AB (7.4%). The Rh-positive donors were more prevalent (94.86%) as oppose to the Rh-negative (5.14%). The most common Rh phenotype is the Dccee (64.86%) while the rarest phenotype is the dCcee (0.86%). The prevalence of K and k antigen was 0.9% and 99.1%, respectively.
Conclusion: This study determined the phenotypic variability of ABO and Rh blood group antigens with low prevalence of Kell antigen. The extensive phenotypic status of Rh and Kell systems in blood donors is important for the efficient management of blood banks and transfusion services.

Keywords: ABO, Rh, Kell, blood donors, antigen, blood group.

1. INTRODUCTION

Blood group antigens are important hereditary factors to consider before each blood transfusion [1]. Red cell antigens (RCA) are classified into 36 blood group systems, with over 360 RCA, of which ABO, Rh, Kell, Duffy, Kidd, Lutheran and MNS are clinically the most important for transfusion, pregnancy and transplantation [2, 3]. The clinical importance of RCA is linked to their ability to induce alloantibodies that can cause alloimmunization, hemolytic disease of the fetus and newborn (HDFN), and hemolytic transfusion reactions [4, 5]. Acute hemolytic transfusion reactions (AHTR) are a particularly important acute complication of inadequate transfusion. The risk of AHTR is approximately 1 per 70,000 and 1 per 1.8 million units transfused, respectively [6]. Incompatibility of ABO, RH and KEL system antigens between donor and recipient red blood cells can lead to alloimmunization, particularly in multi-transfused patients such as those with sickle cell disease (SCD), young females, and pregnant women [7, 8]. The availability of established data on the frequency of different blood group antigens and phenotypes in blood donors is necessary for better planning and management of blood transfusion services [1, 4]. Indeed, the donor's blood group must be compatible with that of the recipient, otherwise a hemolytic accident may occur in the recipient, leading to serious immunological complications [5, 9]. In the Republic of Congo, studies on the distribution of blood groups among blood donors are lacking. This information is important for guiding blood donor recruitment, managing stocks and assessing the likelihood of having compatible blood products for patients suffering from erythrocyte alloimmunization [10]. Thus, the main objective of the current study was to determine the frequency and distribution of ABO, Rh and Kell blood groups among blood donors in Brazzaville, Republic of Congo.

2. MATERIALS AND METHODS

2.1. Study setting

This was a cross-sectional study conducted among blood donors at the National Blood Transfusion Center in Brazzaville, republic of Congo, from June 2021 to November 2022.

2.2. Sample collection and methods

All data from eligible blood donors who met the selection criteria of the national blood bank were included in this study. These criteria were based on a predefined measure including age between 18 and 60 years, weight > 50 kg, blood pressure of 150/90 mmHg or less and absence of medical history. Samples were collected with full written consent. Blood samples were collected into ethylenediaminetetraacetic acid (EDTA) tubes for analysis. Routine immunohematological tests performed on collected samples were ABO grouping and RhD. In addition, an extended phenotyping was performing for C, c, E, e, and K antigens by conventional tube technique using commercially available monoclonal antisera (Bio-Rad Laboratories, DiaMed, Switzerland) according to manufacturer instructions.

2.3. Data analysis

The data collected was recorded on an excel spreadsheet and analyzed using SPSS version 21.0 software. Statistical analysis included descriptive statistics of mean and percentage.

3. RESULTS

A total of 350 participants were included in this study. The distribution of demographic characteristics is shown in Table 1. There were 258 (73.7%) male and 92 (26.3%) female, with an average age of 33.5±5.2, ranging from 18 to 60 years. The most common blood group for the ABO system was O (46.8%) followed by A (28.9%), B (16.9%), and AB (7.4%). The D-antigen was present in 94.86% of participants and 5.14% were D-negative (Table 2). The prevalence of K and k antigen was 0.9% and 99.1%, respectively. The most common Rh phenotype observed was Dccee (64.86%) while the rarest phenotype is the dCcee (0.86%) (Table 3). Among donors, group O was predominant regardless of gender, and a significant relationship was found according to age groupe (Chi-square :35.69, *p*-value :0.000) and donor type (Chi-square : 29.58, *p*-value : 0.000). Moreover, the distribution of the Rh phenotype did not differ statistically with gender (Chi-square : 3.21, *p*-value :0.072), age group (Chi-square :3.15, *p*-value :0.207) and donors types (Chi-square : 2.603, *p*-value :0.272) (Table 4).

4. DISCUSSION

Blood transfusion is a crucial treatment for patients suffering from blood deficiencies. The antigens of the main blood group systems play a very important role in determining transfusion outcomes in recipients of blood and blood components. The distribution of different blood group antigens is necessary for the efficient management of blood banks and blood transfusion centers [10]. The ABO, Rh and Kell blood groups must be known at local and regional level. In the current study, the O blood group was the most predominant ABO blood group and AB blood group the least frequent. This is in agreement with studies in Ethiopia and Saudi arabia, which also showed the predominant group to be O and the least common to be AB [11, 12]. On the other hand, this study does not agree with certain results reported in other parts of the world, including India and Pakistan, where the reported B was the most common blood group followed closely by the O blood group [8, 13]. Generally, group A is most prevalent in north-western Europe, and group B in parts of south-east Asia [14, 15]. However, according to studies conducted worldwide, the distribution of the blood group system varies according to population.

The Rh blood group system is the most polymorphic and clinically significant in transfusion medicine after the ABO blood group system [16]. This study shows the predominance of Rh(D) positive (94.8%), while Rh(D) negative (5.2%) had a relatively lower prevalence. This finding is in line with the studies reported among blood donors in Madagascar, Uganda and Turkey [17–19]. Once again, this study, compared with previous results, confirms the low occurrence of Rh-negative blood in African, Western and Asian populations [20–22]. In this study, the Dccee (64.86%) was the most common phenotype and dCcee (0.86%) was less frequent. Our findings are similar to those obtained in other countries including Iran and India [14, 22]. Indeed, in addition to transfusion safety, knowledge of the rhesus blood system is important for preventing hemolytic disease of the newborn, which occurs in a rhesus-negative mother carrying a rhesus-positive fetus.

Kell antibodies are the third most potent immunogenic response after ABO and Rh antibodies. They are generally produced in response to antigen exposure during pregnancy or previous transfusions. In Kell blood group system, Kell (K) antigen was found positive in 0.86% blood donors and negative in 99.14% in this study. This is in concordance with other study, Siransy et *al.*, shows the frequency of 0.8% of K positive antigen and 99.2% of K negative antigen among blood donors in Cote d'Ivoire [21]. On the other hand, this study results are lower than the studies conducted among blood donors by Zerihun *et al.*, in Ethiopia and Alalshaikh *et al.*, in Saudi arabia, which shows the frequency of K positive antigen with 2.4% and 14%, respectively [11, 23]. Incompatibility with Kell antigen has important transfusion implications. To avoid acute or delayed hemolytic transfusion reactions, it is suggested that complete blood typing including Kell antigen be performed for transfused patients. However, if an individual is allo-immunized and develops anti-k antibodies, it becomes very difficult to find k-negative blood due to the high frequency of the k antigen [13, 24].

Antigen testing of blood donors helps reduce the number of alloimmunizations and their potential complications, such as hemolytic transfusion reactions and hemolytic disease of the fetus and newborn. It also helps prevent the formation of common alloantibodies in multi-transfused patients such as in patients with Thalassemia, dialysis patients and cancer patients.

5. CONCLUSION

This study enabled us to determine the frequencies of ABO, Rh and KEL1 antigens among blood donors in Brazzaville. In addition, phenotypes of the RH system were determined. Knowledge of the antigen distribution of these major blood groups may help to provide compatible blood units for transfusion and patient safety. Therefore, it may be recommended that ABO and Rh (D) typing, as well as the extended phenotypic status of the Rh and Kell systems, be systematically determined in order to improve transfusion practices.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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Table 1. Characteristics of blood donors in Brazzaville.

Characteristics	n (%)
Gender	
Female	92(26.3)
Male	258(73.7)
Age group (years)	
18-30	111(37.0)
31-45	165(47.0)
46-60	74(21.0)
Blood donors type	
Family/replacement	208(59.4)
Voluntary	100(28.6)
Regular	42(12.0)

Table 2. Distribution of ABO, Rh and Kell blood group antigens among blood donors in Brazzaville.

Blood group systems	n (%)
ABO	
A	101(28.9)
B	59(16.9)
O	164(46.8)

AB	26(7.4)
Rhesus	
D	332(94.8)
C	63(18.0)
E	52(14.9)
C	350(100)
e	350(100)
Kell	
Kk	3(0.9)
kk	347(99.1)

Table 3. Frequency of Rh phenotypes among blood donors in Brazzaville.

Rh phenotypes	**n (%)**
Dccee	227(64.86)
DCcee	53(15.14)
DCEce	39(11.14)
DccEe	13(3.71)
dCcee	3(0.86)
dccee	15(4.29)

Table 4. Frequency of ABO and Rh blood groups phenotypes according to gender, age and blood donors types.

Characteristics	**ABO phenotype : n(%)**				**Rh status : n(%)**	
	AB	**B**	**A**	**O**	**Positive**	**Negative**
Gender						
Female	2(2.2)	15(16.3)	26(28.3)	49(53.3)	84(91.3)	8(8.7)
Male	24(9.3)	44(17.0)	75(29.1)	115(44.6)	248(96.1)	10(3.9)
	Chi-square : 5.77		*p*-value : 0.123		Chi-square : 3.21	*p*-value :0.072
Age group (years)						
18-30	12(10.8)	30(27.0)	38(34.2)	31(27.9)	104(93,7)	7(6.3)
31-45	8(4.8)	28(17.0)	41(24.8)	88(5.3)	160(97.0)	5(3.0)
46-60	6(8.1)	1(1,3)	22(29.7)	45(60.8)	68(91.9)	6(8.1)
	Chi-square :35.69		*p*-value :0.000		Chi-square :3.15	*p*-value :0.207
Blood donors types						
Family/replacement	12(5.8)	43(20.7)	59(28.4)	94(45.2)	197(94.7)	11(5.3)
Voluntary	6(6.0)	4(4.0)	34(34.0)	56(56.0)	97(97.0)	3(3.0)
Regular	8(19.1)	12(28.6)	8(19.1)	14(33.3)	38(90.5)	4(9.5)
	Chi-square : 29.58		*p*-value : 0.000		Chi-square : 2.603	*p*-value :0.272