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Frequency and Polymorphism of ABO and Rh (D) Blood Group Antigens among Kurdish Population in Zakho City, Kurdistan Region, Iraq

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Abstract: ***Objective and aim**: Accurate knowledge of ABO and Rh (D) blood group systems phenotype has been extensively studied among different populations. However, the Kurdish population resident in Zakho City has not yet had their data collected. Thus, this study has been conducted to address this issue. **Material and Methods**: This is a Prospective, cross - sectional study conducted at the premarital screening center at Zakho emergency teaching hospital for the determination of ABO and Rh (D) blood group antigens by slide agglutination method using specific antisera (Anti - A, Anti - B, Anti - D). All 11, 910 Kurdish individuals who attended mandatory premarital screening between January 2, 2021, and January 31, 2024, were included in this study. **Results**: Blood group A was found to be most prevalent and detected in 4, 817 (40.4%) of the studied population, followed by group O in 4, 276 (35.9%), then group B in 2, 008 (16.9%), and finally, group AB in 809 (6.8%). Rh (D) positive phenotype was detected in 10, 950 (91.9%), while 980 (8.1%) persons were found to be Rh (D) negative. No significant differences were found between ABO and Rh (D) distribution with either sex or religion. **Conclusion**: Blood group A was found as the most common blood group in the ABO system, followed by groups O, and B, and the least one is the AB blood group. Most of the studied individuals were Rh (D) positive. ABO and Rh (D) distribution were quite similar to the Kurdish population living in Iraq, Iran, Turkey, and Syria, while being quite different from Iraqi Arabs, Indians, Chinese, Pakistanis, Americans, and Caucasians.*

Keywords: ABO, Rh (D), Kurdish population, Phenotype, Prevalence.

1. Introduction

In 1901, an Austrian immunologist, Karl Landsteiner truly opened the doors of blood banking with his discovery of the first human blood group system, ABO [1]. This marked the beginning of the concept of individual uniqueness defined by the RBC antigens present on the RBC membrane [1]. To date, the International Society of Blood Transfusion (ISBT) Working Party for Red Cell Immunogenetics and Blood Group Terminology (ISBT WP) maintains an official record of all currently recognized blood group systems. There are currently 47 recognized blood group systems containing 366 red cell antigens. The 47 systems are genetically determined by 52 genes [2]. However, the ABO system and Rh (D) are the most important of all blood groups in both transfusion and transplant medicine [1]. ABO blood group system is the only blood group system in which individuals already have antibodies in their serum to antigens that are absent from their red blood cells (RBCs) without any prior exposure to RBCs through transfusion or pregnancy. Due to the presence of these antibodies, transfusion of an incompatible ABO type may result in immediate lysis of donor RBCs and produce a very severe, if not fatal, transfusion reaction [1].

The ABO system is based on the presence of A and/or B - type antigens on the red blood membrane and is also present in most epithelial and endothelial tissues [3, 4]. The formation of these antigens is expressed by three allelic genes located on the long arm of chromosome 9q [3, 4]. These genes encode different specific glycosyltransferases that add sugars to an O antigenic carbohydrate structure, which is a basic precursor substance [3]. If there is only type A antigen on the red cell membrane, the blood group will be A, and it will have anti - B antibodies. If there is a type B antigen, it will be B and will carry anti - A antibodies. If both types of antigens are present, the blood group will be AB, and both anti - A and anti - B antibodies will be absent. The O blood group means that both antigens are lacking in the wall of red blood cells but have anti - A and anti - B antibodies [5].

The term Rh refers to a specific red blood cell (RBC) antigen (D) and to a complex blood group system currently composed of 55 antigens carried on two proteins (RhD and RhCE), each consisting of 417 amino acids and located on chromosome 1 [1, 2]. However, only five (D, C, c, E, and e) hold clinical significance. Among them, the Rh (D) antigen is most extensively studied due to its high immunogenicity and association with hemolytic transfusion reaction and hemolytic disease in the newborn or fetus [6, 7].

Rh (D) is the second in importance only to the ABO blood group system in terms of transfusion, due to it is high immunogenicity. Unlike ABO, antibodies that are routinely found in individuals who lack the corresponding antigen, and are produced only after exposure to foreign red blood cells through transfusion or pregnancy to produce significant hemolytic disease of the fetus and newborn (HDFN) as well as hemolytic transfusion reactions [1]. In 1939 Levine and Stetson described a hemolytic transfusion reaction in an obstetrical patient after delivering a stillborn infant, in whom

the woman required transfusions from her husband who had the same ABO blood group [8].

A year later, Landsteiner and Wiener described an antibody made by guinea pigs and rabbits when transfused with rhesus macaque monkey RBCs. This antibody agglutinated 85% of human RBCs and was named anti - Rh after the rhesus monkey [9]. A subsequent investigation by Levine and coworkers demonstrated that these agglutinins cause hemolytic transfusion reaction, and the antibody described by Landsteiner and Wiener appeared to define the same blood group. Many years later, it was recognized that the two antibodies were different. However, the name Rh was retained for the human - produced antibody, and anti - rhesus formed by the animals was renamed anti - LW in honor of first reporting it (Landsteiner and Wiener) [8, 9].

Many studies from Iraq including both Kurd and Arabic populations determine the distribution of ABO and Rh (D) throughout the country [10, 11, 12, 13]. However, no specific study was conducted to determine the prevalence and phenotyping distribution of ABO and Rh (D) blood group antigens among the Kurdish population residents in Zakho City, Kurdistan region, Iraq. Thus, this study was conducted to address this issue. This data is crucial for optimizing blood transfusion services and understanding genetic diversity in the region.

2. Material and Methods

This prospective cross - sectional study was conducted at the only authorized premarital screening center at Zakho Emergency Teaching Hospital between January 2nd, 2021, and January 31st, 2024. The study included the first five couples who attended mandatory premarital screening daily to ensured a manageable daily workload while maintaining representativeness, with a total of 11, 910 participants included in this study.

Non - Kurdish populations and non - residents of Zakho City were excluded from this study. Verbal informed consent was obtained from all participants. Sociodemographic data were collected, including names, dates of birth, residency, phone numbers, and photos of couples. These records were stored and kept in confidential files and accessed only by authorized premarital staff.

Four milliliters (ml) of blood were collected from each participant by proper phlebotomy techniques. The blood was distributed into a K3 - Ethylene - Diamine - Tetraacetic - Acid (EDTA) vacutainer tube and well mixed on a rotatory mixer.

One drop (40 µL) of Monoclonal reagent (anti - A, anti - B, and anti - D, BIOSCOT ® CE marked IgM monoclonal reagents, U. S. and Canada) was applied to a clean, labeled microscope slide and one drop (40 µL) of tested red cells were added, well mixed over an area about 2 cm in diameter by gently and continuously rocking the slide and then macroscopically read after 2 minutes. The presence of agglutination indicates a positive reaction, while the absence of agglutination indicates a negative reaction.

The phenotypic frequency of ABO and Rh (D) blood group antigens was calculated by dividing the number of positive cases for each antigen by the total screened population and the results were expressed as a percentage. Descriptive statistical methods, using IBMS SPSS statistics, version 25, were used to describe the findings of the study; a Fisher's exact test with a p - value of < 0.05 is considered statistically significant.

3. Results

From all 11, 910 enrolled subjects, 5955 (50%) were males and 5955 (50%) were females. The median age group was 25.7 years, ranging from 15 – 68 years. Blood group A was found to be the most prevalent and detected in 4, 817 (40.4%) of subjects, followed by group O in 4, 276 (35.9%), then group B in 2, 008 (16.9%), while group AB was found to be the least prevalent and detected in 809 (6.8%) of the studied population. Rh (D) positive was found in 10, 950 (91.9%) subjects, while 960 (8.1%) of the studied population were found to be Rh (D) negative [Table 1].

Table 1: Prevalence of ABO and Rh (D) blood group antigens among studied population

ABO and Rh (D) phenotype	Number/Percentage
A	4, 817 (40.4%)
O	4, 276 (35.9%)
B	2, 008 (16.9%)
AB	809 (6.8%)
Rh (D) positive	10, 950 (91.9%)
Rh (D) negative	960 (8.1%)

As shown in Table 2, there are no statistically significant differences between ABO and Rh (D) among males and females, with a P value of 0.788.

Table 2: Prevalence of ABO and Rh (D) blood group antigens among different sexes.

Sex	ABO & Rh (D) phenotype								Total number
	A -	A+	AB -	AB+	B -	B+	O -	O+	
Females	198	2, 116	36	386	82	905	160	2, 072	5, 955
Males	194	2, 309	30	357	98	923	162	1, 882	5, 955
Total number	392	4, 425	66	743	180	1, 828	322	3, 954	11, 910

Table 3, shows no statistically significant differences between ABO and Rh (D) phenotypes among different religions of the Kurdish population, with a P value of 0.367.

Table 3: Prevalence of ABO and Rh (D) blood group antigens among different religions of the Kurdish population.

ABO & Rh (D) phenotype	Religion			Total number
	Christian	Muslim	Yezidi	
A	23	4, 768	26	4, 817
O	13	4, 242	21	4, 276
B	16	1, 980	12	2, 008
AB	7	798	4	809
Rh (D) positive	57	10, 834	59	10, 950
Rh (D) negative	2	943	4	960

4. Discussion

The study of human blood group systems has both evolutionary and physiological implications. It can help scientists understand historical human population movements and how different populations are biologically linked. The phenotypic distribution of blood groups is essential in modern medicine, genetic studies, anthropology, and tracing human ancestors [14]. Both ABO and Rh antigens are transmitted as codominant and governed by autosomal chromosomes (chromosome 9 and 1 respectively) so it is expected that there will be no differences between different sexes, however because of the different religions used in this study (Muslim, Christian, and Yezidi) comparisons were done to exclude any religious differences in ABO and Rh (D) antigens polymorphisms.

In the present study, blood group 'A' was predominant, followed by 'O', 'B', and 'AB' which is compatible with that of the Kurdish population living in Iraq, Iran, Syria, and Turkey [10, 15 - 18] and also similar to reports from neighboring Arab countries like Syria and Jordan [19, 20]. As shown below in table 4.

Table 4: ABO blood group distribution similarities to other studies

	A (%)	O (%)	B (%)	AB (%)
Iraq (Duhok/Kurd)	37.2	32.5	23.8	6.5
Iran/Kurd	37.2	37.1	17.9	7.8
Syria/Kurd	38.1	35.6	17.4	8.9
Turkey/Kurd	40.81	33.7	18.5	6.98
Turkey/Kurd	44	32.9	16.2	7.7
Syria/Arab	46.26	37.5	13.1	3.12
Jordan/Arab	38.4	36.6	18	7
Current study	40.4	35.9	16.9	6.8

In contrast to the studies done in Iraq (Arab), Iran, Saudi Arabia, and the United States where the prevalence of blood group O was higher than that of the A group [12, 13, 21 - 23], this difference in the blood group distribution may be due to geographical variations, external environment, and genetic factors [14], as shown below in Table 5.

Table 5: ABO blood group distribution contrast to other studies

	A (%)	O (%)	B (%)	AB (%)
Iraq (Najaf)	26.5	39.7	24.4	9.4
Iraq (Baghdad)	27.5	35.5	28.5	8.6
Iran	30.5	40.1	22	7.4
Saudi - Arabia	23.4	44.5	26.4	5.7
Whites/US	40	45	11	4
Black/US	26	50	20	4
Hispanic/US	31	56	10	3
Asian/US	28	40	25	7
Current study	40.4	35.9	16.9	6.8

The distribution of Rh (D) antigen in our study shows 91.9% for Rh (D) positivity and 8.1% for Rh (D) negativity, which is comparable with most studies of Iraq, Iran, Turkey, Syria, and Saudi Arabia [10, 13, 18, 19, 21, 22]. It is lower than that reported in Chinese, Pakistan, and some parts of India [24 - 26] and slightly higher than that of the Caucasian population [1], as shown below in **Table 6**.

Table 6: Distribution of Rh (D) antigen compared to other studies.

	Iraq/ Duhok	Iraq/ Baghdad	Iran	Syria	Turkey	Saudi - Arabia	China	Pakistan	India	Caucasian	Current study
Rh (D) positive (%)	91.1	90.33	91.1	87.1	89.2	88.2	98.9	97	99	85	91.9
Rh (D) negative (%)	8.9	9.66	8.9	12.9	10.8	11.2	0.6	3	1	15	8.1

5. Conclusion

The present study confirms that blood group A was the most common ABO blood group system followed by O, B, and AB blood groups, respectively, among the Kurdish population living in Zakho City, Kurdistan region, Iraq. Most Kurdish populations were Rh (D) positive, while only 8.1% of subjects were found to be Rh (D) negative.

Our knowledge of ABO and Rh blood groups system has evolved to include not only transfusion - related problems, and alloimmunization in multi - transfused patients but also specific disease associations with RBC surface antigens. Awareness of different blood groups in our areas will help to guide the effective management of blood banks/volunteer blood donors list. The study also has a significant impact on clinical situations that arise from ABO and rhesus incompatibilities.

Such studies are important and need to be carried out in other regions of Kurdistan and Iraq to reduce the challenges we face in hemolytic transfusion reactions and hemolytic disease of the fetus and newborn.

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